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A dynamic sequential route choice model for micro-simulation

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RÉSUMÉ

Dans les études sur le transport, les modèles de choix de route décrivent la sélection par un utilisateur d'un chemin, depuis son origine jusqu'à sa destination. Plus précisément, il s'agit de trouver dans un réseau composé d'arcs et de sommets la suite d'arcs reliant deux sommets, suivant des critères donnés. Nous considérons dans le présent travail l'application de la programmation dynamique pour représenter le processus de choix, en considérant le choix d'un chemin comme une séquence de choix d'arcs. De plus, nous mettons en œuvre les techniques d'approximation en programmation dynamique afin de représenter la connaissance imparfaite de l'état réseau, en particulier pour les arcs éloignés du point actuel. Plus précisément, à chaque fois qu'un utilisateur atteint une intersection, il considère l'utilité d'un certain nombre d'arcs futurs, puis une estimation est faite pour le restant du chemin jusqu'à la destination. Le modèle de choix de route est implanté dans le cadre d'un modèle de simulation de trafic par événements discrets. Le modèle ainsi construit est testé sur un modèle de réseau routier réel afin d'étudier sa performance.

Mots clefs: Choix de route, programmation dynamique approximée, choix séquentiel, attraction, répulsion

ABSTRACT

In transportation modeling, a route choice is a model describing the selection of a route between a given origin and a given destination. More specifically, it consists of determining the sequence of arcs leading to the destination in a network composed of vertices and arcs, according to some selection criteria. We propose a novel route choice model, based on approximate dynamic programming. The technique is applied sequentially, as every time a user reaches an intersection, he/she is supposed to consider the utility of a certain number of future arcs, followed by an approximation for the rest of the path leading up to the destination. The route choice model is implemented as a component of a traffic simulation model, in a discrete event framework. We conduct a numerical experiment on a real traffic network model in order to analyze its performance.

Keywords: Route choice, approximate dynamic programming, sequential choice, attraction, repulsion

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NOTATIONS

UE : User-equilibrium
SUE : Stochastic user-equilibrium
G : Graph
N : Set of nodes
A : Set of arcs
IIA : Independence of irrelevant alternatives
OD : Origin-destination
DTA : Dynamic traffic assignment
DUE : Dynamic user-equilibrium
MTE : Markovian traffic equilibrium

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INTRODUCTION

Over the past few years, traffic simulation has become increasingly popular as a means to study transportation over large transport networks. One important aspect of most traffic simulation models is that route choice aims to mimic the individual choice of a path, a path is here viewed as a series of consecutive links, joining an origin to a destination. But, several questions remain. Are traffic conditions throughout the network known? Does the user have a complete knowledge of the network? Will he/she pick the shortest path possible based (or not) on traffic conditions or will he stick with the path he is most familiar with? How does he/she react to unforeseen traffic conditions such as accidents? All these questions are but a glimpse of the complexity behind route choice modeling.

In this thesis, we present a novel route choice model based on approximate dynamic programming in a micro-simulation experiment. This model attempts to incorporate the dynamic aspect of route choice as a road user can experience changing traffic conditions on a network. Instead of making a static choice at the beginning of the trip as with most of the popular approaches in the field, we will allow a user to consider different path options at every intersection. We believe that this type of behavior will become more and more common with the advent of technologies that allow users to receive real-time information on the network conditions such as GPS navigation, traffic bulletin on the radio or even Google Maps' real time traffic feature. Dia (2002) states that *the provision of real-time travel information is increasingly being recognized as a potential strategy for influencing driver behavior on route choice, trip making, times of travel and mode choice*. We will seek to demonstrate that our model produces reasonable results within the limitations of our experiment.

The thesis is organized as follows. In Chapter 1, we will present a gentle introduction to traffic simulation and review popular route choice models. We then emphasize how our route choice model differs from the usual ones. In Chapter 2, we give implementation details about our traffic simulation model and present a description of the simulation output. In Chapter 3, we describe the numerical experiment conducted in our simulation and present the results, highlighting the main interesting properties. We finally conclude in Chapter 4 and present some future research avenues.

CHAPITRE 1

OVERVIEW OF TRAFFIC SIMULATION AND MOTIVATION

1.1. The general model

In order to simulate traffic, one needs to build a model that can be divided into three components (Daellenbach 1995): structure, process, and the associated relationships. Elements of structure are the components of the model that remain unchanged during the span of the simulation. In our case, the roads and their properties would be a prime example, as it is safe to assume that, over the course of the study, roads will not simply vanish or appear, their length will not change, the number of lanes will be the same, etc. Elements of process are the components that are subject to change. The most pertinent aspects here would be the traffic flow throughout the network, its causes and consequences. One then has to define the relationships between structure and process and between processes. The network itself will have a direct impact on how the flow propagates, but traffic flows also mutually affect themselves because of congestion, spill backs, etc. We now define more precisely these three components in our context of traffic simulation.

1.1.1. Elements of structure

First, as an element of structure, modeling the road network is the most important aspect. This is done through a representation with a directed graph $G = (N, A)$. Intuitively, it is simple to see that the roads are represented by arcs and that the intersections are represented by the nodes. It is important to note that a two way street will be represented by two distinct arcs going in opposite directions. There is more information to add however, such as arc lengths, number of lanes, speed limits, turnings at intersections and so on. There are different levels of details at which a network can be modeled, for example, in Fig 1.1, we can see that an intersection can be broken down into several nodes with the appropriate arcs to be more realistic.

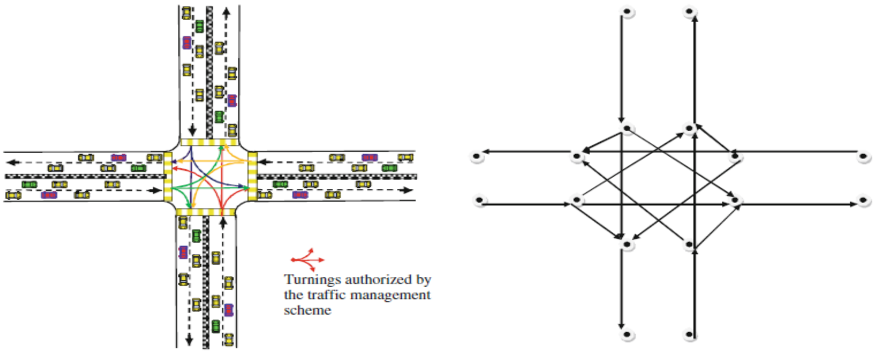

Figure 1.1: A detailed representation of an intersection (Barceló 2010)

This representation gives us the means to properly account for travel times relating to crossing intersections. A left turn for example will almost always take more time to complete than turning right or simply continuing forward. Indeed, with this level of detail, the timing of the lights can have a direct impact on whether it is possible or not to use each of the three links (turning left, continuing forward, turning right) at any given time, thus truly capturing the realism of going through an intersection. This realism comes at the cost of a heavier simulation, since additional data structures will be required to hold the necessary information. The runtime of the simulation will increase as a result.

1.1.2. Elements of process

As an element of process, modeling the transportation demand is the most obvious task. Although it is possible to describe the demand based on the activities that necessitate people and thus require transport from these people, the most common approach is an OD-matrix. Each row represents an origin and each column represents a destination and the value at $M(i,j) = d_{ij}$ is the demand from origin i to destination j. The first technique used to obtain such an OD-matrix was the survey. This approach requires huge amounts of work and consequently a large monetary investment. Subsequently, other approaches were developed: one of them being the gravity model. *The gravity model is a very simple and elegant representation of the spatial distribution of trips. It is based on the analogy to Newton's gravitational law* (Muthuswamy, Levinson, Michalopoulos, and Davis, 2005). Other methods to estimate this matrix have emerged, most often based on the traffic flow observed on the links of a network. Also, with constant monitoring of these flows, it is possible to create a dynamic OD-matrix which will vary through time to account for the changes of transportation demand during an extended study period. Additional information such as the mode of transportation and the time frame for the demand can be included depending on the complexity and purpose of the study.

1.1.3. Relationships between the elements

Modeling the relationships between these elements is quite complex. There are a number of "rules" that need to be implemented in order to model the interactions between the two types of elements. In our context we will mainly be looking for the impacts of traffic flow on the properties of the links and vice-versa.

1.1.4. User-equilibrium and stochastic user-equilibrium

One usually relies on the basic idea that each user on the network tries to minimize his/her travel time. This idea is fairly simple and easily accepted as true, but it is fundamental in building the logic behind how traffic will propagate through any given network. This leads to the concept of user-equilibrium (UE) which can be defined as *a stable condition reached only when no traveler can improve his travel time by unilaterally changing routes* (Sheffi 1985) and the notion of stochastic user-equilibrium (SUE) which is similar to the UE except that the travel time is now the *perceived travel time*, meaning that users believe they are experiencing the shortest travel time on their route even though there is perhaps, in reality, a better route choice. The perceived travel time can significantly skew one's perception of being on the fastest route due to the ignorance of traffic conditions over the whole network let alone ignoring relevant parts of the network. In other words it is possible that better paths are available for a user but because of ignorance or habits, they are not used.

1.1.5. Wardrop’s first principle

Wardrop's first principle states that the average journey times on all routes actually used are equal, and less than those which would be experienced by a single vehicle on any unused route. This means that vehicles will choose the path with the shortest average travel time, then as the average travel time increases due to the increasing traffic density, if there's another path with a now equal average travel time, it will begin attracting some traffic and so on. Thus, any unused path must have an average travel time greater than the one attributed to the set of paths with traffic. *Wardrop equilibria are commonly used as a solution concept of network games when modeling transportation and telecommunication networks with congestion* (Correa and Stier-Moses 2010). If we follow the previously discussed idea that users in a network are always choosing the path that minimizes their travel time, then Wardrop’s principle can easily be seen as its extension allowing us to solve networks with transportation problems, that is find a user-equilibrium. In fact, the user-equilibrium is often referred to as Wardrop equilibrium.

1.2. Traffic assignment

Traffic assignment is the process of determining how demand traffic, usually defined in terms of an origin–destination matrix, is loaded onto the network, and it provides the means for computing traffic flows on the network links (Barceló 2010). Static assignment, the more robust and proven type of traffic assignment, usually corresponds to an OD-matrix for a short period of time which contains all the trips that take place in this time frame. *The volume of traffic on the links is determined directly from the loading of the OD-matrix to links via routes* (Chiu et al. 2010). It is important to note that in static assignment, the traffic volume can exceed the physical capacity of a link. Because of this lack of realism, there is a need for more than these principles. We are looking for a more detailed modeling of traffic that must (Barceló 2010):

- *support a route choice mechanism that provides a procedure for loading a time-dependent demand onto the network and that explicitly deals with time dependencies of traffic flows on the network links*
- *be able to describe traffic flow dynamics which explains these time dependencies, that is, a “network loading process” that describes how flows propagate with time though the network along the selected paths*

1.2.1. Dynamic traffic assignment

Dynamic traffic assignment (DTA) has picked up in popularity over the last few years for two reasons. First, the demand from the market has changed and there is a need to know more about travel times and queue building: *in dynamic models, as in reality, explicit modeling of traffic flow dynamics ensures direct linkage between travel-time and congestion* (Chiu et al. 2010). Second, the computational power needed for DTA models is huge and was somewhat of a problem until the late 1990's (Kant 2008). Dynamic traffic assignment can be seen as a succession of static assignments. The user-equilibrium condition only holds for users who entered the network at the same time or during the same interval of time because traffic conditions on the network change over time as users move from link to link. Travel times for each arc of the network will vary over time depending on how traffic flow enters and exits them.

1.2.2. Dynamic user-equilibrium

The notion of dynamic user-equilibrium (DUE) can be formulated as follows: *if, for each OD pair at each instant of time, the actual travel times experienced by travelers departing at the same time are equal and minimal, the dynamic traffic flow over the network is in a travel time-based dynamic user equilibrium (DUE) state* (Ran and Boyce 1996). Various algorithmic schemes have been proposed to solve the DTA model, from purely analytical to heuristic approaches (Barceló 2010).

1.3. Discrete-event simulation

Simulation can be defined as a dynamic representation of some part of the real world achieved by building a computer model and moving it through time (Drew 1968). In the field of transportation, computer simulation has become an interesting and appealing approach to study traffic with various objectives. There are now many popular traffic simulators such as AVENUE, Aimsun, MITSIMLab, Dynameq and METANET, to name but a few (Barceló 2010). Most of them use a fixed time step, while a discrete-event approach can be less time consuming (Florian et al., 2005).

Discrete-event simulation is a means to model the evolution of a system through time with a representation in which state variables can only change at a discrete number of points in time. In other, more mathematical, words, a series of events $e_0, e_1, e_2, \dots$ occur instantaneously at times $0 = t_0 < t_1 < t_2 \dots$ in order to change the state of the system S_i which is the result of event e_i being applied to the previous state of the system. We summarize below the main components of a discrete-event simulation. For more details, we refer the reader to standard textbooks, e.g. Law (2007).

1.3.1. The main program

Any simulation must start with an initialization phase that will set the state of the system at time 0. A certain routine is called in order to set up the other components necessary for the simulation to run. The simulation clock must be initialized to zero, the event list must be created, one or more initial events must be scheduled so that the system state can evolve and continue to do so by creating more events as a result of those initial ones. From a programming perspective, it is the main function that initializes the internal variables and then calls the appropriate functions to deal with the list of events based on chronological order while keeping track of the simulation clock. The general process is illustrated in Fig 1.2.

1.3.2. The simulation clock

The concept of time is simply used to chronologically order the events of the simulation as they would be in real life occurrences. There are two ways to keep track of the clock: the first is to always jump to the next event, the second is to jump forward by a fixed interval. The first approach is the most common. At the start of the simulation, the clock is set to 0 and the time at which the next events will occur are determined. Typically, after dealing with an event, one or more events are created and scheduled in the future and the time for other future events can be updated if needed.

1.3.3. The event list

Each type of event needs to have a function to carry out the appropriate changes to the state of the simulation. It is also important to have a routine that can update the time of occurrence of future events based on earlier ones. Again, from a programming perspective, this can be seen as a list of events kept in chronological order of which the main function always takes the first event to deal with.

1.3.4. The random number generation routines

In our case, we will be using random numbers to determine part of the behavior of the simulation process, so it is important to have the tools necessary to generate them.

1.3.5. The statistics trackers

In most cases, there is a need to track statistics during the course of the simulation process. In fact, in our case, we are almost only interested in statistics gathered during the simulation as opposed to the state of the system at the end of the simulated time period. Thus, it is required to be able to gather information as the simulation is going on. These statistics trackers can be separate events that only gather data or they can be incorporated in the events that modify the state of the system.

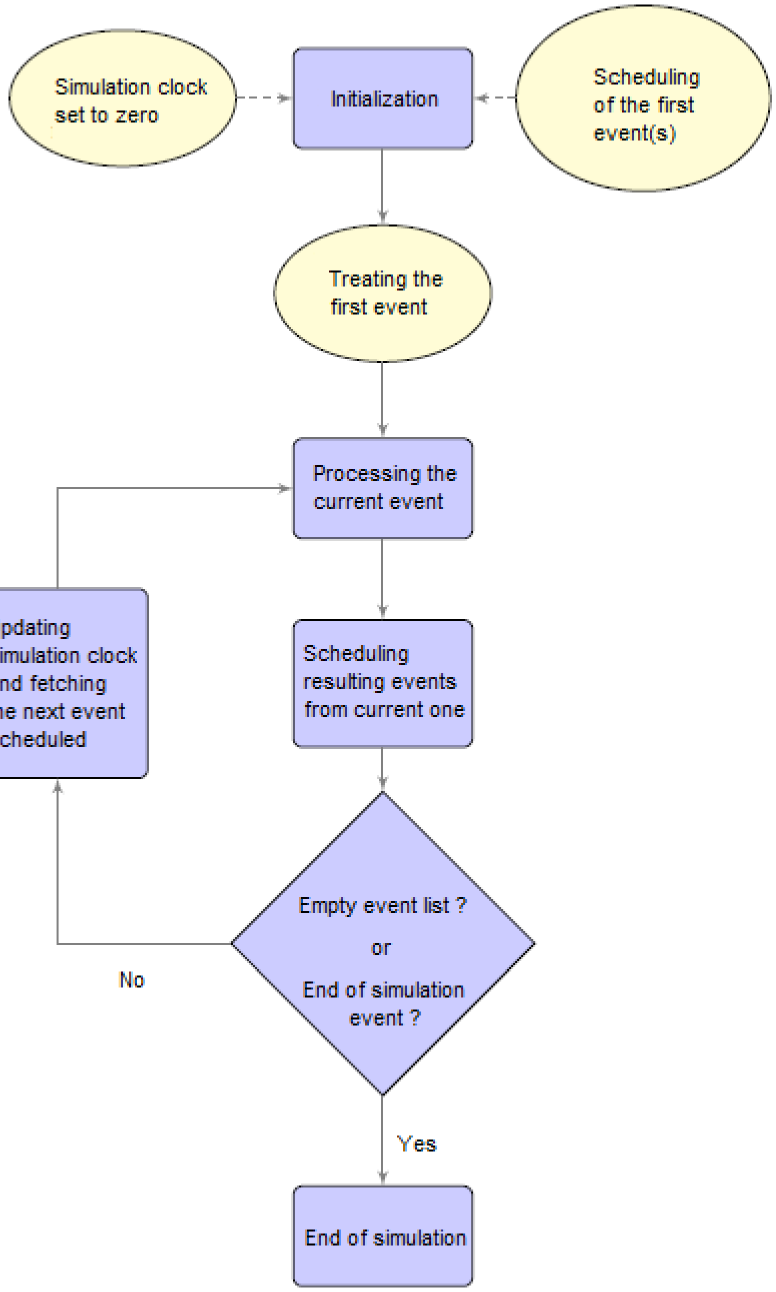

Figure 1.2: A flow chart of discrete-event simulation

1.4. Route choice

Based on travel times for the various links on the network, individuals are assumed to choose a route from the origin to the destination. There are two categories of route choice algorithms: preventive and reactive. Preventive algorithms assume that traffic conditions in the network are known and that users are aware of them while choosing a path. Reactive algorithms on the other hand do not make such an assumption; however, users have real-time information based on current conditions (Barceló 2010).

1.4.1. Joint approach and sequential approach

Route choice in simulation can be performed in two different ways: joint or sequential. The joint approach consists of choosing a path for an OD pair at the initial departure for every vehicle. The sequential approach, on the other hand, has users make a choice at every intersection. Due to the typical heavy computational requirements of the sequential approach, a joint approach is mostly used.

1.4.2. Discrete choice

Route choice is typically analyzed from a discrete choice theory perspective. At every decision point, a choice set is generated that includes every path considered from the current node to the destination. A (deterministic) utility function is associated to each of these paths, taking into account different variables such as the travel time. It is usual to sum to this utility a random term reflecting the uncertainty due to non-perfect network information. Thus, we have, for a certain path k and a vector of variables v, the random utility expression

$$U_k(v) = C_k(v) + \varepsilon_R(v), \forall k \in K$$

where C_k is the deterministic utility component, ε_k is the random error term and K is the choice set of paths. It is usual to require that $E[\varepsilon_k(v)] = 0$[1]. The vector of variables can include a notion of attraction and repulsion when considering an arc or a path: some component will describe a positive effect with respect to the user's goal, therefore exhibiting an attraction effect, while other components will tend to repel them when taking large values. In our case, a long travel time will repel most users as opposed to a shorter travel time. A greater number of lanes can be more attractive as it allows users to overtake slower vehicles. The effects of these variables can also vary from one user to another: someone in a hurry can prefer the shortest possible travel time even though it might lead to a longer trip in terms of distance (e.g. by forcing the user to make a detour in order to use the highway), but someone interested in saving gas will perhaps favor a shorter path with a slightly longer travel time.

If error terms are independently and identically distributed, following the Gumbel distribution, the probability associated which each path (based on their respective utility) is given by the logit formula:

$$P(k) = \frac{e^{C_k}}{\sum_{i=1}^{K} e^{C_i}} \forall k \in K$$

An important issue with this approach is that this choice function does not consider the similarity between the different considered paths. It is common to add a "commonality factor" to penalize similar paths in order to not "bury" somewhat interesting options under a few very interesting but very similar paths. We will elaborate on this in section 2.4.2.

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[1] This is not mandatory when only differences between utilities are of importance, as e.g. in a logit model. In this, the only requirement is to have a constant random term expectation.

1.5. Dynamic route choice literature review

Route-choice decisions have been studied for several decades (see e.g. Chapter 10 in Sheffi, 1985 for a short introduction): given a traffic network modeled as a directed graph, and an origin-destination matrix stating the traffic flow between every pair of nodes, the models assign to each vehicle a route. Since route-choice models based on deterministic shortest paths have been quickly recognized as not realistic, stochastic assignment has been proposed to produce a better network loading. The basic idea is that people choose a path based on the perceived travel time on the links that compose it, a direction explored in the work produced by Dial, 1971. His model however suffers a lot of criticism as it is equivalent to using a multinomial path choice logit model, using fixed characteristics of these arcs. The model therefore cannot properly capture correlations between the paths, and exhibits the independence of irrelevant alternatives (IIA) property, that states that the ratio between the probabilities of two alternatives are not influenced by the other alternatives present in the choice set. The second major difficulty comes from the enumeration of routes while the IIA allows to sample over the available routes when computing choice probabilities. Many efforts have been performed to select small subsets of paths, keeping enough information to correctly predict the choices. (see e.g. Manski, 1977, Ben-Akiva and Boccara, 1995, Bekhor et al., 2001, Cascetta, 2001, Chapter 4, Frejinger and Bierlaire, 2007), but to date, the question remains open.

Dial's model has been at the center of some subsequent work in route choice models. Bell (1995) proposes two alternatives to the Dial model. Akamatsu (1996) shows that Dial's model *sometimes produces an unrealistic flow pattern in that no flow is loaded on some paths where many vehicles are running in reality* and presents *a logit type stochastic assignment that does not restrict the assignment paths*. Li, Xin and Liu (2005) have also proposed an algorithm which *reduces errors introduced by the strict definition of "reasonable route" in Dial's algorithm*. On the other hand, path based models have been worked on a lot since Dial's model. The main issue with these models is the large amount of paths considered between any two nodes of the network and their correlation. *A substantial ongoing research effort is seeking to resolve this dilemma (see for example, Vovsha and Bekhor, 1998, Bekhor et al., 2001, Frejinger and Bierlaire, 2007), so far with limited success* (Fosgerau, Frejinger, and Karlström 2009).

Gentile and Papola (2006) for instance propose a sequential link choice model but, like Dial, they limit the choice to "efficient links". This concept of "efficient links" can be defined as the subset of links that distance a user from his origin and bring him closer to his destination. It is also worth noting that a route choice only occurs at certain "anchor points" which are associated to each OD-pair. These "anchor points" stem from the idea that travellers see their total path as a series of anchor points between which smaller paths are chosen. This knowledge representation is probably closer to reality than supposing that users are aware of every single path between every OD-pair of a network. Although showing decent results, this approach has only been tested on a Braess network composed of five nodes.

Baillon and Cominetti (2008) explore stochastic dynamic programming to establish traffic equilibrium using what is called a Markovian traffic equilibrium (MTE). A Markovian process can be loosely defined as a series of independent states and the transitions between these states. The independent nature of the states implies that one can make a decision on the transition to the next state based only on the current state ("memoryless"). When applied to our context, states represent the intersections and transitions are the links in between. They limit the considered arcs to the same “efficient links” defined previously, but the process is repeated at every intersection. Their model was not used in simulation but rather in solving the problem of reaching a traffic equilibrium state modelled as an optimization problem.

Ziebart et al. (2008) specify a route choice model using a Markovian decision problem with value functions to represent downstream utilities but the alternatives in the model are paths. The value functions are assumed to try to *efficiently optimize some trade-off between time, safety, stress, fuel costs, maintenance costs and other factors.* The nature of the approach relies on a training phase during which the parameter values in the value functions will be estimated in order to produce realistic results with different transportation demand data. The path data used for the training comes from GPS trace data of 25 Yellow Cab drivers. A certain process of filtering the data is required but with the estimated value functions, this approach seems to yield good results.

Fosgerau et al. (2009, 2011) also explicitly link the route-choice problem to dynamic programming. While first suggesting some approximation of the route valuation should be performed, they subsequently exhibited that same solutions to a logit-based path choice model can be obtained. The main advantage is that it is no more necessary to enumerate paths, especially when cycles are taken into consideration (leading to an infinite choice set). The estimation task remains however complex and issues like IIA are not addressed. Moreover, although the estimation is done with a dynamic sequential route choice model, the whole path remains chosen at the beginning of any trip. All these models affect a route to a user when entering into the network, preventing to modify his/her choice later, when traveling towards its final destination. Florian et al. (2005) however note that the possibility to make new choice *en-route* can help to obtain better simulation results, while they did not consider themselves this approach in their numerical experiments.

1.6. Our proposed dynamic route choice model

Instead of assigning a complete route to each individual as in standard approaches, we aim to reproduce the individual behavior using a dynamic decision process, as a route choice can be seen as a sequence of arc selections, from the origin to the destination. We believe that such a representation is more realistic than simply choosing a complete path from the origin to the destination because it allows for choices to be made based on newly acquired surrounding information.

We here assume that an individual aims to choose a route with maximum expected utility, using an l-step look-ahead strategy. This approach, standard in dynamic programming, allows the choice to remain small at each decision step, and to adjust the preferences in case of unexpected events encountered further during the trip. We also argue that this is a better way to model the individual perception: a choice is locally made, taking into account surrounding conditions, and inference is performed about the future links on the followed path, with a decreasing degree of available information the further the link is from the current location. Therefore, the first arcs of a route are considered with higher weights, and after l-steps, a simpler approximation, most likely pre-computed, can be used, for instance the shortest path to the final destination node (possibly taking the time of day into consideration for its computation), or some stochastic shortest path heuristics (see e.g. Nikolova and Karger, 2008). The expression of the utilities can incorporate various aspects, depending on the available data, but also on the main factors affecting the decision process, and can easily be modified to incorporate consideration of incidents. In this research, two major aspects are considered in the utilities: an attraction effect, reflecting how much closer to the destination the individual can be by choosing an arc, and a repulsion effect, mainly due to traffic density on the arc. At any given node of the road network (i.e., an intersection), we consider dynamic characteristics of the arcs emerging from this node, as well as the subsequent ones, but as stated before, the further is an arc, the less information is available.

1.7. Traffic flow modeling

The last major component to be addressed is the traffic flow modeling. *Modeling the dynamics of traffic flows to simulate their temporal propagation through traffic networks is also a nice illustration of Minsky's statement that a system can be modeled in different ways according to various approaches depending on the modeler's purposes* (Barceló 2010). There are three categories when it comes to traffic flow modeling: macroscopic, mesoscopic and microscopic. Macroscopic models simulate traffic as a stream with a speed, a flow and a density. Microscopic models deal with traffic at a much more precise level with each car being modeled. Modeling each car means that a greater level of precision is available in the behavior of each individual. However there is a tradeoff in terms of computational requirements. Mesoscopic models are somewhere in between, combining some simplifications of macroscopic models with some dynamics of microscopic models.

1.8. Dynamic programming approach

Finally, it is necessary to give a brief overview of dynamic programming since it is at the core of our route choice model. A dynamic programming approach to solving a problem is somewhat similar to a recursive approach; however, in the latter case the original problem is divided into "smaller" problems a number of times, until all the solutions to the "small" problems can be put together to give the solution to the original problem. In dynamic programming, the problem can be split in a number of steps that follow a certain order. The optimal time to sell an asset based on its fluctuating value, managing an inventory every month based on demand and current supplies or, in our case, deciding on which street to follow at every intersection to reach a destination are examples of such problems. Each of these steps can be solved or optimized in order, backwards or forwards, always using the solution of the current (and possibly many previous) step to find the one for the next step. After going through all of the steps, we have the solution for the whole original problem.

In the context of route choice, more specifically, calculating the utility attached to each considered path, these steps will be the number of links included in these paths. A 1 step solution would be to simply take the utility for each of the exiting links at the intersection at which the user is making a route choice. A 2 step solution would consider each of the exiting links and the links exiting from each of the intersections to which the first links lead to. For each of these 2 link long paths, we would add up the utility of both links and, with the total utility for each possibility, we can find the path with maximum utility. As the number of steps considered grows, the complexity of the problem increases dramatically, thus a certain maximum number of steps will be imposed after which an approximation will be added in order to provide a solution. The implementation of our dynamic programming approach in route choice will be detailed in the next chapter.

CHAPITRE 2

A NEW ROUTE-CHOICE MODEL FOR SIMULATION

2.1. Simulation model

In order to test our proposed route-choice model, we consider a discrete event simulation, progressing through discrete time intervals. Three types of events are considered: intersection arrivals, network entry and network departure. The events allow us to describe the vehicle life in the network: the vehicle appears at some initial node at a particular time, and move from intersection to intersection until it reaches the final destination, where we remove it from the network. When a vehicle reaches an intersection that does not correspond to its destination, the next link to follow is decided, the travel time is calculated and the arrival at the next intersection is scheduled accordingly. Since the simulation time only progresses through these events interaction between the different components of the simulation is somewhat limited: we probe the network state only when a vehicle arrives at an intersection. This is however sufficient to evaluate the behavior of our route choice model.

2.2. Hypotheses

It is important to note that our model is not an equilibrium model. We are not attempting to reach stable traffic flow conditions although they could come about. The motivation behind our route choice model is to be able to take into account dynamic events that affect the traffic flows in a network such as accidents or changing weather conditions. For these first experiments, those kinds of events will not be implemented in order to ascertain the basic traffic behavior resulting from our route choice model.

A number of hypotheses are adopted in this model for a few reasons. Some are a necessity to alleviate the programming endeavor and others are directly related to the goal of this research.

H1 Unlike most traffic micro-simulation models we do not have the hypothesis that path choices do not change once they are made at a user's entry into the network. Not only do we have users making decisions at every intersection, but we can dynamically change the conditions of the network to simulate real life events although, for this first experiment, we do not make use of this.

H2 Our model is unimodal. Considering different types of transports and their interactions on a network could yield more realistic and interesting results, but for initial testing purposes, only one type of generic vehicle will be implemented.

H3 All the attributes of the network are deterministic meaning that there is no randomness in the process to obtain their values. This hypothesis is a bit unrealistic of course, as different people will perceive the same network in different ways.

H4 Users do not take into account other users' route choices when making their own decision. This means that there is no predictive aspect in the users' behavior. This is not necessarily satisfied in reality since we could expect certain users to counter intuitively choose seemingly uninteresting paths expecting the traffic congestion to alleviate and, conversely, thinking that options that seem promising now will not be for long since most other users are expected to take them. However, it can be argued that this phenomenon is present in our model, at least to some extent, as each path, no matter how unattractive it may seem, will have a certain probability to be chosen by the user. This however remains an open question as for the same reasons, it can also be argued that some can exhibit some flow with respect to an O-D pair while there is a perceivable advantage to choose such a path. The model will however select such paths with a very low probability so that the effect can be viewed as marginal.

H5 On a related subject, there is currently no implementation of driver habits. Realistically, most users in a network will have habits concerning the paths they take to reach their usual destinations. Furthermore, users do not have a “memory”, meaning that every new decision (at an intersection) does not take into account the complete path that made that user choose the arc he/she just came from. This property is called the Markov property. If we consider each intersection (where a choice is made) to be a state in the process of travelling from an origin to a destination, then, indeed, the future state only depends on the current state. This implies that, depending on the model calibration, we might observe some users perform a few U-turns or take small detours for no apparent reason, because these paths with small illogical detours will still have a decent utility. This is however a phenomenon that can sometimes be observed in reality too, so we do not consider this to be a strong limitation in our study.

2.3. Transportation demand

The first aspect to be addressed is the transportation demand model. We are here using static traffic assignment, thus the data has been aggregated into a single OD-matrix in order to provide the simulated transportation demand on the network. Since there will be no change in the transportation demand for every OD-pair during the whole simulated period, it is expected that we will reach a state of equilibrium in traffic distribution on the network. This means that various values associated with network links such as flow and average speed will slightly vary around some stable values.

We have estimated a homogeneous Poisson process for each origin-destination pair, based on the original OD matrix. Since we follow the logic of a discrete-event simulation, the Poisson process is used to compute inter-arrival times on the network for each pair of nodes. These times are exponentially distributed, with the density, for the pair (i, j).

$$f_{(i,j)}\left(x, \lambda_{(i,j)}\right) = \begin{cases} \lambda_{(i,j)} e^{-\lambda_{(i,j)} x} \text{ if } x > 0, \\ 0 \text{ otherwise.} \end{cases} \tag{1}$$

The parameter $\lambda_{(i,j)}$ can be estimated using the standard maximum likelihood estimator $\hat{\lambda}_{(i,j)} = {}^{1}/_{\bar{x}_{(i,j)}}$, where $\bar{x}_{(i,j)}$ is the mean inter-arrival time. In other terms, the maximum likelihood estimator is nothing else then the average number of arrival per time unit, a quantity directly obtained from the OD matrix.

2.4. Traffic flow model

Based on this, traffic flow will be modeled by a microscopic approach. Each vehicle is represented in the simulation, but its behavior on a given link is not modeled, as it could be using some car-following and lane change models. It is important to note that we do not use any flow propagation formulas. We here simply compute the travel time on a given link, using the Greenshields linear model:

$$u(K) = u_f - \frac{K}{K_j} u_f \qquad (2)$$

where K is the traffic density on the link being considered, K_j is the jam traffic density (the traffic density at which the vehicles cease to move), u_f is the free flow speed on this link and the result $u(K)$ represents the speed at which the vehicle will travel along this link based on the current traffic density. This can be easily understood as a fraction of the free flow speed is subtracted based on the linearly varying fraction of jam traffic density currently on the link. This model was chosen because of its relative simplicity of implementation, its low computational cost, and its popularity in traffic studies.

Although trivial, the traffic density must be calculated since it is not a static property of the link unlike the free flow speed:

$$K_a = \frac{n_a}{l_a} \qquad (3)$$

where n_a is the number of vehicles on link a and l_a is the length of the link. The current model does not incorporate any intersection representation, in particular delays required to turn or to wait a green light. We currently impose a (arbitrary) constant 2 second delay, added to the link utility, in order to slow down the traffic, similarly to the effect due for instance to stopping at an intersection.

The jam traffic density is also calculated in the following way as the network is loaded in the simulation program:

$$jam\ traffic\ density = \frac{nb\_lanes.l_a}{average\ car\ length} \qquad (3.1)$$

where nb_lanes is the number of available lanes on the link. The number of lanes times the length of the link gives us a total amount of space that can be occupied by the cars on the link. This value divided by the average car length gives us an idea of how many cars can fit in the link. We here set the average car length to 4.20 meters, assuming an average car dimension of 4 meters, to which we add 20 centimeters to represent space in between the cars.

2.5. Route-choice model

We now describe how the proposed route choice model has been implemented in this simulation, as a few key elements of it are the focal points of this research. The first point of interest is the attempt to include a sequential route choice approach. In our model, users make a decision regarding their path at every intersection, evaluating the utility of the various links emerging from it, with respect to the final destination.

In our model, utility functions are both linear and additive. It is a straightforward adaptation of the usual utility function in discrete choice theory described in the overview section. For this research, we wanted to single out the consequences of the nature of our route choice model, thus we chose a utility function based only on perceived travel time which is fairly common. From the general equation for utility in the previous chapter, we have:

$$U_k(tt) = tt \; \forall k \in K \qquad (4)$$

where k is a path in path set K and tt is the travel time. We note that the deterministic component vector is simply $[1]$ multiplying the only variable in the vector of variables which is the travel time. There is also no term added for the uncertainty of the information available. Had we used more than one variable in the vector of variables, each of the values in the deterministic component vector would have to be estimated.

Given an O-D pair, a standard assignment model would consider all the possible paths linking the origin to the destination. This set can be very large, leading to various computational issues. Instead of sampling among the paths to reduce the size of the choice set, we will use approximate dynamic programming to have a simpler representation of the choice behavior. For a given path $p = l_1, \dots, l_n$ where l_i is the *i-th* link on this path, the utility of p is viewed as the sum of the utilities of the links:

$$U(p) = \sum_{i=1}^{n} U_i \qquad (5)$$

We assume that the user wants to maximize the expectation of the path utility. However, this next utility formula was designed to account for the incomplete knowledge of traffic conditions on the network of each user. More specifically, we argue that a user can approximate the travel time for his next possible links because of his proximity, but he/she is unaware of traffic conditions on subsequent links because they are too distant. We consequently assume that he will approximate the path utility past a certain number of links, so that he will consider the approximate expectation:

$$\hat{E}[U(p)] = \sum_{i=1}^{k} U_i + \hat{g}(l_j, \dots, l_n) \qquad (6)$$

where $\hat{g}(l_j)$ is the utility approximation for links $j > k$. We can also overweigh the first links, for which more information is known, as:

$$\hat{E}[U(p)] = \sum_{i=1}^{k} w_i U_i + w_{g(l_j, \dots, l_n)} \hat{g}(l_j, \dots, l_n) \qquad (6.1)$$

where $w_{\dots}$ are the weights.

2.5.1. Path set generation

In practice, at every intersection, there are a number of links that allow a user to exit that intersection based on the link the user is coming from and the allowed turns. Our model will use each of these links to generate a possible path to be considered. Thus $|P|$ is limited to this number of links, where P is the generated paths set. Before we describe how the utility function works for these paths, we first explain how the rest of the paths is generated. We proceed as follows: from the intersection to which each of these links leads, the shortest path (in terms of travel time) to the user's destination is added.

2.5.2. Use of approximate dynamic programming

We now have all the elements needed to use approximate dynamic programming. The first mathematical term of equation 6.1 is determined by dynamic programming:

$$\sum_{i=1}^{k} w_i U_i \qquad (6.2)$$

As roughly explained in the last paragraph of the overview section, this first part of the path is chosen based on the dynamic programming problem of finding the maximum utility over all possible paths of length k. As we just mentioned, this process is repeated for every exiting link of the current intersection. We then add to term (6.2) the approximation to complete each path to the destination:

$$w_{g(l_j,\dots,l_n)} \hat{g}(l_j, \dots, l_n) \qquad (6.3)$$

The links $l_j, \dots, l_n$ make the shortest from the last node in the path from (6.2) to the destination of the vehicle.

In practice, for a path $p_1 = l_1, \dots, l_n$ where l_i is a link, the utility is calculated as follows:

$$U(p_1) = -(Gs(l_1) + \sum_{i=2}^{n} fftt(l_i)) \qquad (7)$$

where $Gs(l_1)$ is the travel time based on the travel speed given by the Greenshields linear model and $fftt(l_i)$ is the free flow travel time based on the free flow speed of each subsequent link. The reason for negation of the whole term is that a shorter travel time is more attractive than a longer one and should thus have a higher utility value. This equation (7) is a particular case of equation (6.1) with the weights being set to 1 and $k = 1$. The weights can be estimated with values other than 1 in order to better reflect the diminishing importance that can be attributed to links further away. For initial testing purposes, the number of steps in the dynamic programming part of the utility calculation has been limited to 1. This means that his approximation for the next link is incidentally the result of Greenshields linear model and his perception of the travel times for the subsequent links is the sum of the free flow travel times for each of them. In order to alleviate the computational burden, a separate OD matrix with the shortest path travel time values is pre-calculated with Dijkstra's shortest path algorithm. Figure 2.1 illustrates the whole process.

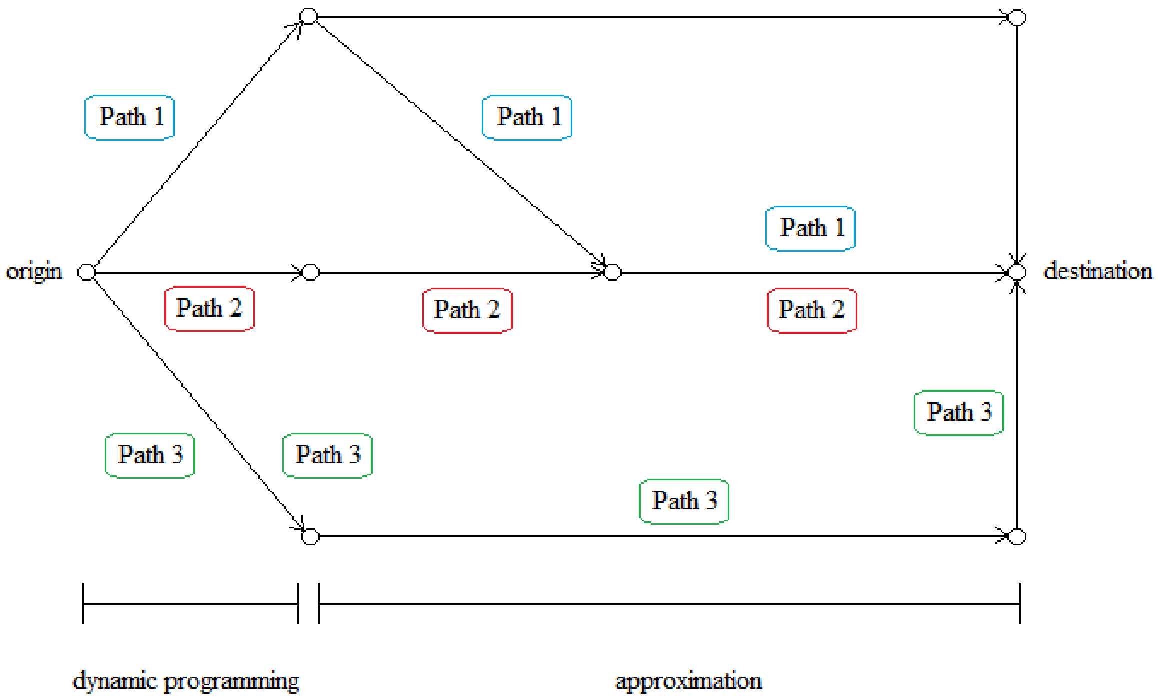

Figure 2.1: An illustration of the route choice model

If a user is currently at the "origin" node, he will consider three paths to reach his destination. For each of these paths, the travel time for the first link will be estimated using the Greenshields linear model and the travel time for the rest of the path will be the sum of the links' respective free flow travel time. The utility for each path is the sum of these two terms. For the sake of showcasing how the paths are constructed, let us argue that:

- the length of each link is directly proportional to its graphical representation;
- the speed limits are the same for all links (the free flow speed is the same).

Path 1 does not use the link at the top and its follow up link on the top right because the shortest travel time path is taken from the intersection to which the first link leads to. It is possible for some overlapping in the paths generated. Path 2 seems to be the most interesting, since both Path 1 and Path 3 appear to be much longer. However, this is only true for the approximation part of the utility function, because the first link's travel time is estimated with the Greenshields model and is thus dependent on the current traffic density on each of the first links. If the first link in Path 2 is heavily congested, then the other two paths may have significantly better utility values compared to that of Path 2.

Using a Gumbel distribution for our error terms in the utility function, as opposed to a mixed logit or multinominal probit model, does not allow us to take into account the correlation between different path choices. This causes a problem (in our case it is a problem, however it is appropriate in other contexts) known as the independence of irrelevant alternatives which we briefly mentioned in the literature review. Take for example these three alternative paths to reach a destination:

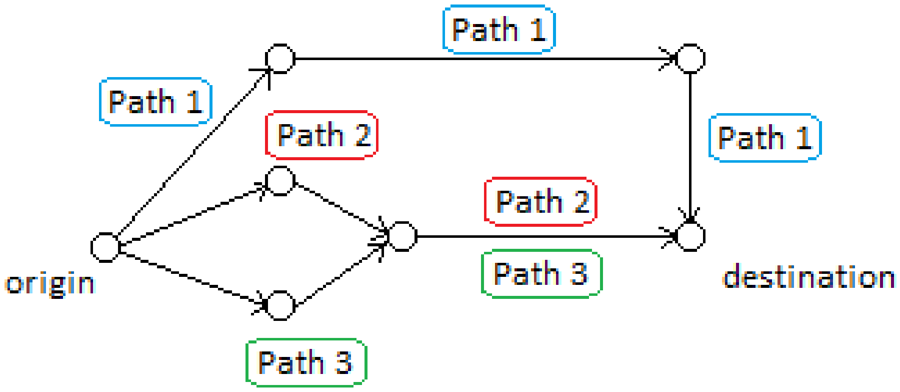

Figure 2.2: An example of IIA

Paths 2 and 3 have a strong correlation since after two arcs, they become the same for the rest of the path. If we imagine that the first two arcs of path 2 and path 3 are very short compared to the other arcs, then, in practice, they almost become the same alternative in a user's mind. However, IIA dictates that the probabilities for each possible path will be equal if their estimated travel time is the same of course.

Our route choice model deals with this issue to some extent: locally the IIA is still present. In the example above, if the number of steps in the dynamic programming part of the utility calculation is 1, each of the 3 paths will have a probability close to 33% even though Path 2 and 3 are the same after 2 arcs. In the distance however, our model does not have the same problem because we approximate the utility of paths past the dynamic programming part with the travel time of the shortest path to destination. Let us consider this example:

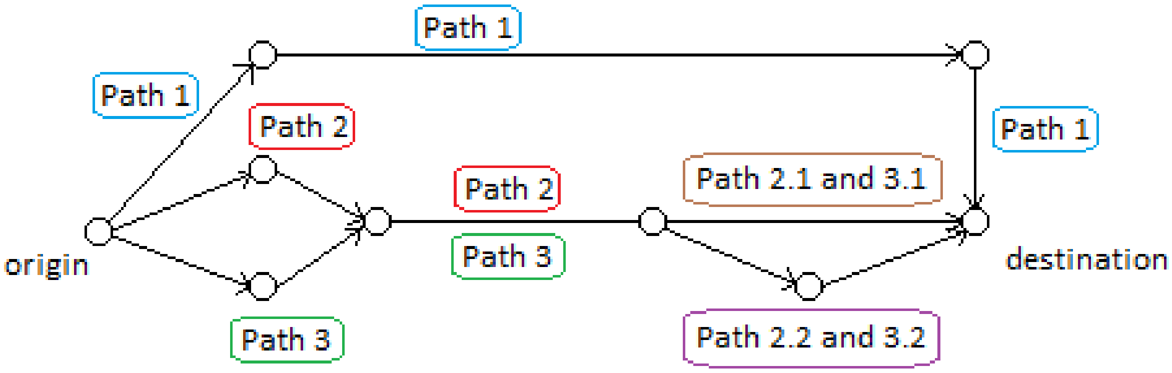

Figure 2.3: An example with "less" IIA

In this case, there are four paths in the lower half of the network due to the possibility of taking a small detour just before the destination. Our route choice will not consider these four paths (Path 2.1, 2.2, 3.1 and 3.2) because we simply take the travel time of the shortest path to the destination past the dynamic programming step. It will consider Path 2 and Path 3, so the

IIA problem still stands in the local part of the utility calculating function, but the problem does not exist in the approximation part.

2.5.3. Path choice

The probabilities for each path of the choice set are obtained through a multinomial logit choice model very similar to the one described in the overview section.

$$P(p_i) = \frac{e^{U(p_i) - \max(U(p))}}{\sum_{j=1}^{|p|} U(p_j)} \qquad (8)$$

where p_i is the path considered and *U()* is the utility function. By subtracting the maximum value of the utility across, we avoid as much as possible probabilities near zero unless the path is very uninteresting. A random number $0 < d \leq 1$ is then generated to select the path. The arrival to the next intersection is scheduled at the current time plus the travel time resulting from the Greenshields linear model. At this point, there is no modification of that time based on vehicles exiting the link and thus reducing the traffic density ahead for a vehicle having just entered said link.

2.6. Simulation output

Various data is collected during and at the end of the simulation. It can be categorized in three sections: link data, route choice probabilities data and reconstructed OD-matrix data.

2.6.1. Link data output

Link data is by far the largest data set from the three. It includes, for each link in the network, the following fields: the number of cars that used the link (a car using the same link twice counts as 2 and so on), the average time it took for the cars to get through the link, the standard deviation on this average time, the average density (number of cars per unit of length), the average flow (number or cars passing through a specific point of the link per unit of time), the average density and flow per number of lanes and the average speed of the cars that travelled the link. These basic measures will allow us to determine if the general behavior of vehicles on the network will match our expectations. We note here that the average speed of cars that travelled a link is calculated from the average travel time for that link, meaning that the travel times is the data recorded during the simulation whereas the average travel speed is the result of a simple equation.

2.6.2. Route choice probabilities data output

The route choice probabilities data is simply a (large) sample of the probabilities for each path considered by a vehicle at some intersection. The sampling process is random, only 1 out of 1000 route choice is recorded. For each entry, the vehicle's last link used, origin node, and destination are recorded along with the information on each possible path considered: the estimated travel time for the next link, the approximated travel time for the rest of the path and the associated probability. Since the route choice model is the main point of interest in this research, it is important to study this data.

2.6.3. Reconstructed OD-matrix data output

The reconstructed OD-matrix data is essentially a record of the vehicles having reached their destination. In the same format as the transportation demand OD-matrix, the reconstructed one allows us to see if vehicles for a certain OD pair might have trouble completing their trip. Reconstructing the OD-matrix is a simple way to verify that the overall behavior is satisfactory. It will not however provide great insight into whether or not the route choice model is valid unless significant discrepancies are observed between the two matrices.

CHAPITRE 3

NUMERICAL EXPERIMENTS

3.1. Network description

In order to illustrate the validity of the proposed approach, we apply the idea to a simple artificial network, and to the former network of the city of Namur, Belgium (Figure 3.1), using data previously collected for the PACSIM project (Cornélis and Toint, 1998).

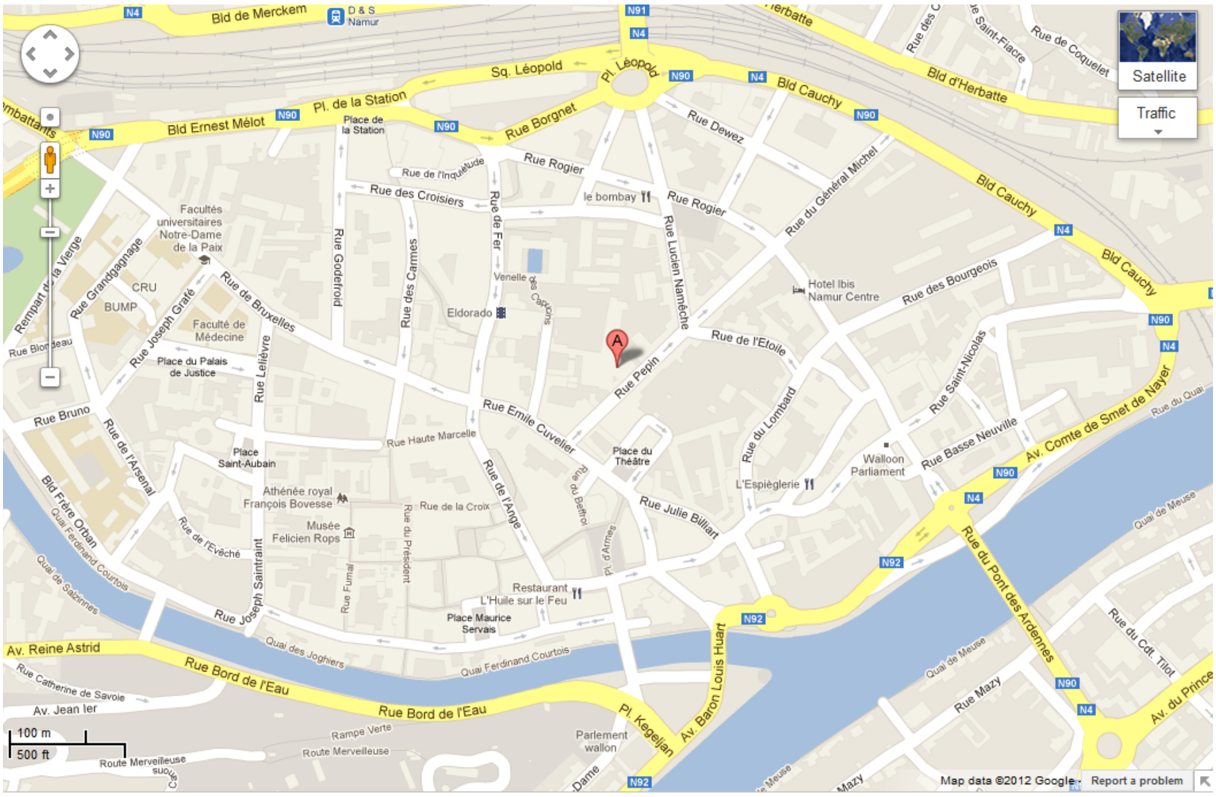

Figure 3.1: The downtown area of Namur

The network accounts for 438 nodes and 1090 links. Elementary properties of the structure have been taken into account: arc length, speed limits, number of lanes and turnings at each intersection. The time frame for this study is the morning rush hour period from 7h30am to 9h00am, with transport demand data provided in intervals of 1 minute each. Vehicle and transit purpose have been ignored as we are only interested here in origin, destination and departure time. In this study, we are using static traffic assignment, thus the data has been aggregated into a single OD-matrix in order to provide the simulated transportation demand on the network.

3.1.1. Roundabouts

An interesting feature of this network is the presence of roundabouts (Fig 3.2). Since roundabouts are not widespread in every part of the world, it might be beneficial for the reader to have a brief introduction to this simple yet elegant concept. The roundabout acts as a replacement for the standard intersection controlled by traffic lights. It allows for continuous traffic flow at a somewhat slower pace around a central "circular island."

Figure 3.2: A roundabout

Vehicles enter the roundabout when space is available and go around until they reach their exit. Despite initial confusion when introduced, roundabouts have been shown to be able to provide good traffic flow and are statistically safer than traditional intersections. There are a few roundabouts in the modeled network.

3.2. Implementation

The simulation program runs the 90 minute period of this network in about 11 minutes of real time and 10.6 minutes of computer processing time. The runs were conducted on a machine with an Intel® Core™ i7 processor with 8 cores, 12GB of RAM, running Fedora 14.

The program, named ORCS (Open Route Choice Simulation), has been implemented in C and is available at the address: http://amlet.slashbin.net/orcs. It also makes use of an open source library called ORATIO (http://amlet.slashbin.net/oratio) which provides the basic micro-simulation framework, available at http://amlet.slashbin.net/oratio.php.

Each run of the program begins with a phase during which the network and all its relevant information is loaded into memory. The first text file to be parsed is "NODES.DTA" which contains the information on the nodes. Although the geographical location of each node is included in the file, it is not currently used, while it could help later to visually represent the simulation. The second file parsed is "LINKS.DTA" which contains the information on the links connecting the nodes. Several fields describe the link characteristics: the origin node, the destination node, the length, the number of lanes and the speed limit. Two additional fields are currently ignored in our model: the width and the types of vehicles allowed onto the link. These information are not used as no calculation take the link width into account and we do not discriminate between vehicle types in the current implementation. The third file to be read is "TURNS.DTA" describing what turns can be made at the intersections in our network. Nodes and links are represented by objects with the proper attribute fields and turns are simply two lists of node identifiers available at each intersection, indicating the node a user has just come from and the node he/she can go to. If a certain pair of node identifiers is not present in the lists, then the turn cannot be made.

The next step is the calculation of Dijkstra's shortest path algorithm between every pair of nodes in the network. Although this step is quite time consuming, the values are stored in a matrix in order to be simply looked up when needed during the simulation when vehicles need to estimate the utility of each of the path considered. Since there are well over 40000 vehicles sent onto the network and a choice is made at every intersection for each of the vehicles, we save a lot of time by not having to recalculate Dijkstra's algorithm every time.

A fourth file is then parsed which is "MATRIX.DTA." This file contains the traffic assignment OD-matrix which is much needed to simulate the traffic demand on the network. The number of vehicles for each OD-pair is read and an event in the simulation is created which will create vehicles at the appropriate rate for each of these pairs.

After all this information is loaded, the simulation process begins. Every time a vehicle is created, it appears at a node in the network with the aim of reaching its destination thus an "arrival" event is processed. The first part of the event consists of updating various objects, the path of the vehicle so far is updated, the travel times are logged, the vehicle is removed from the list of vehicles of the arc it just exited, etc. This is obviously unnecessary if the vehicle has just been sent onto the network. A check is performed to see if the vehicle has arrived at its final destination. If it is the case, the vehicle is removed from the network and a few statistics are updated such as the reconstructed OD-matrix and the number of vehicles having reached their destination.

The second part of this arrival event is the main interest of this whole research: the route choice. Based on the last node visited by the vehicle, the available turns are obtained and a list of the possible exiting links is built. If this list is empty for some reason, the vehicle is removed from the simulation and a counter keeping track of such occurrences is incremented. For each of the possible links, the Greenshields linear model is applied to obtain the travel time, then the shortest path matrix described previously is accessed to retrieve the estimated travel time for the rest of the path. If the minimum travel time across all possible exiting links is infinite (i.e.; the destination is inaccessible from the current node), the vehicle is removed and a specific counter is incremented. From this point, the probabilities of choosing each alternative are calculated and the choice is randomly made. It is worth noting that the route choice probabilities data are sampled here with a 1 in 10000 chance (which still produces a enormous amount of samples). After updating a few fields such as the current edge for the vehicle, the last visited node and various statistics of the link, a new arrival event is scheduled simply by adding the estimated travel time resulting from the Greenshields linear model previously calculated to the current time of simulation. At that point the vehicle will make another route choice decision or be removed from the network if it happens to have reached its destination. Needless to say that this is what happens with every vehicle sent onto the network and is thus the main aspect of the simulation.

After the simulation clock reaches 5400 seconds, the end of simulation event is triggered, and the results are written to an output file. We have already mentioned that the route choice probabilities are sampled throughout the simulation and written in an ever growing file, however the link data and reconstructed OD-matrix need to be produced after the simulation has ended.

3.3. Results

3.3.1. General link data

We will first take a look at the data collected pertaining to each of the links in our network. Here is a generic sample of this data:

id	length	# lanes	counter	max speed	average speed	average time	st deviation	density	Flow
54	1350	3	1231	33.3333	31.7645	42.5003	0.000103443	0.00721989	0.227963
95	300	2	662	25	21.4278	14.0005	0.000412542	0.0057358	0.122593
134	1500	1	105	25	24.1935	62.0001	0.000112492	0.000803704	0.0194444
163	3100	3	887	33.3333	32.6315	95.0002	6.72032e-05	0.00504982	0.164259
178	294	2	1173	16.6667	14.9679	19.642	0.00103935	0.0145446	0.217222
218	300	1	504	16.6667	14.9988	20.0017	0.00123874	0.00622901	0.0933333
258	2700	1	320	25	24.5454	110	0.000181693	0.00245048	0.0592593
301	75	1	1478	11.1111	8.55959	8.76211	0.00790835	0.0320815	0.273704
327	140	4	2886	16.6667	13.4576	10.403	0.00133543	0.0398108	0.534444
392	400	1	756	19.4444	17.7201	22.5732	0.00102374	0.00789907	0.14
472	2800	1	70	16.6667	16.4706	170	0.000199531	0.000800992	0.012963
702	130	1	1366	8.33333	7.37878	17.6181	0.00844368	0.0343689	0.252963
967	10	1	5747	13.8889	3.53128	2.83183	0.0709117	0.300481	1.06426

Table 3.1 – General link data

Before discussing these results, it is imperative to specify a few things. The length of each link is in meters. The “counter” column is the number of vehicles that went through the link. Both “max speed”, the speed limit for the link, and “average speed” are in meters per second. The “average time” column is expressed in seconds. The density is in car per meter and the flow is in car per second. They are calculated as explained at the end of Chapter 2. In the output file, the identifier of both the origin node and the destination node are included, but have been left out as well as the flow and density per lane, for readability.

Nevertheless this generic sample allows us to verify to a certain extent the basic relations between the different data collected. Link 54 is fairly long (1350m) with 3 lanes, so it has a large capacity for traffic flow, thus despite having a good amount of traffic (1231 cars going through), the average speed of the cars, 31.7645 m/s, is close to the maximum speed of 33.3333 m/s. This is reflected in the low flow value of 0.00721989. In the same vein, link 163 (3100 meters 3 lanes) will have almost no change compared to the free flow speed. On the other hand, link 327 shows a noticeable drop in travel speed: the speed limit is 16.6667 m/s (60 km/h), but the average speed is 13.4576 m/s (48 km/h).

These links have been selected to showcase the diversity of the link properties of this network. We have rather short links between 5 to 10 meters long and very long links spanning over

6300 meters. The number of lanes varies from 1 to 4, although most of them (875 out of 1090) only have 1 lane. The counter values ranges from 0 to close to 6000 (the highest value observed was 5847). Figure 3.3 gives a representation of the distribution of the values for the car counter data set.

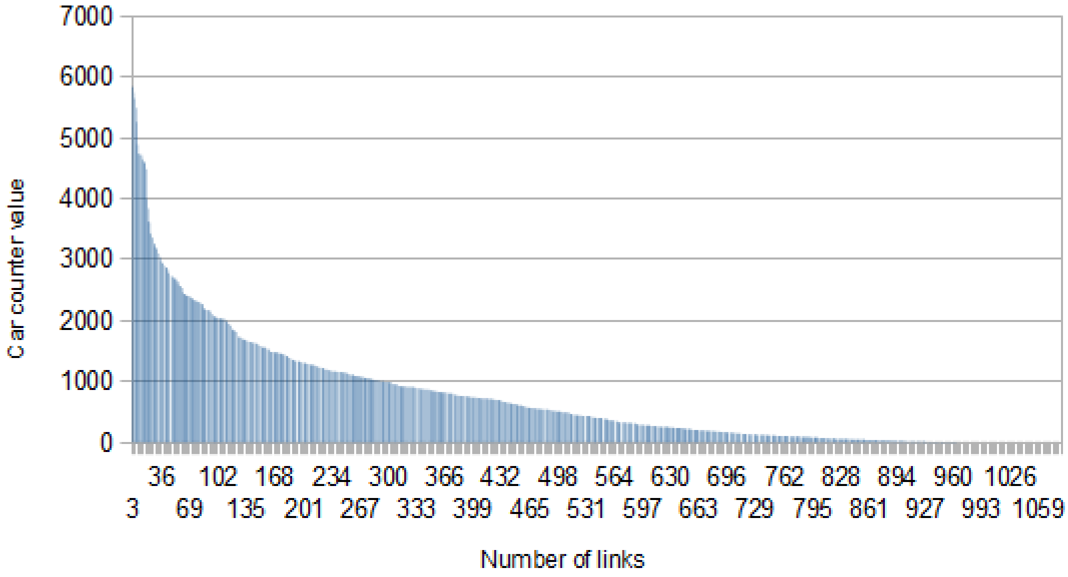

Figure 3.3: Car counter values

Links without any vehicle ever using them are not a cause for concern. They are due to the OD-matrix not having any transportation originate from there nor wanting to go there. This comes from the fact that the network area modeled is independent from the OD-matrix. There are 122 links with 0 traffic on them throughout the simulation. Speed limits over the network varies from 8.3333 m/s (30 km/h) to 33.3333 m/s (120 km/h). The standard deviation on all the recorded travel times for each link is always quite low. The highest observed value is 0.117141 although 1075 out of the 1090 links have a standard deviation below 0.05. This confirms our initial thoughts that the values collected will very quickly gravitate towards their mean values and that they will remain stable throughout the duration of the simulation. As explained in the model description section, this is due to the fact that the OD-Matrix does not change over time. Density values are somewhat low throughout the whole data set, only 42 links are above 0.1, the other 1048 links have less than 1 car per 10 seconds. Figure 3.4 represents these values.

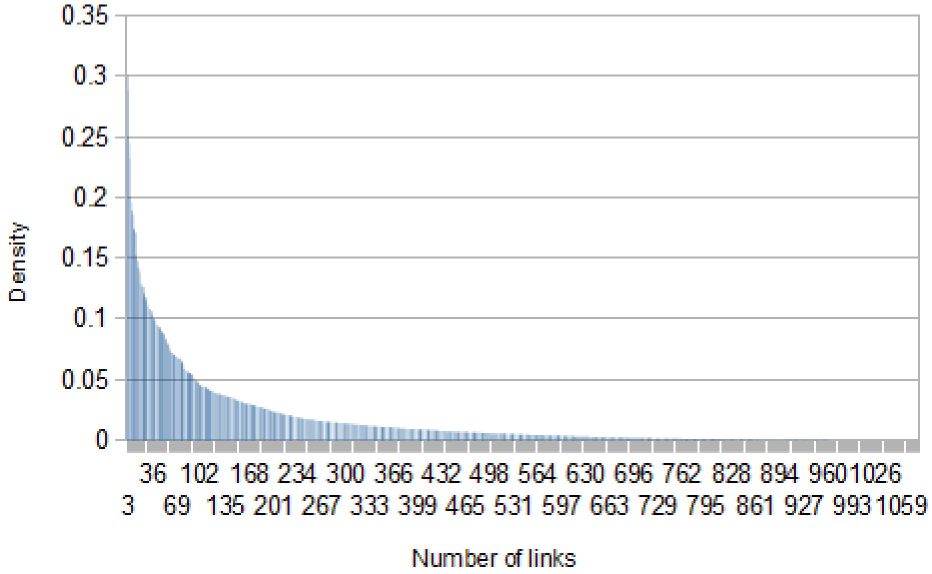

Figure 3.4: Density values

The flow values are not too surprising: 47 links have values between 0.5 and 1.08278, 217 links have values between 0.2 and 0.5 with the other 826 links ranging from 0 to 0.2. Figure 3.5 illustrates this.

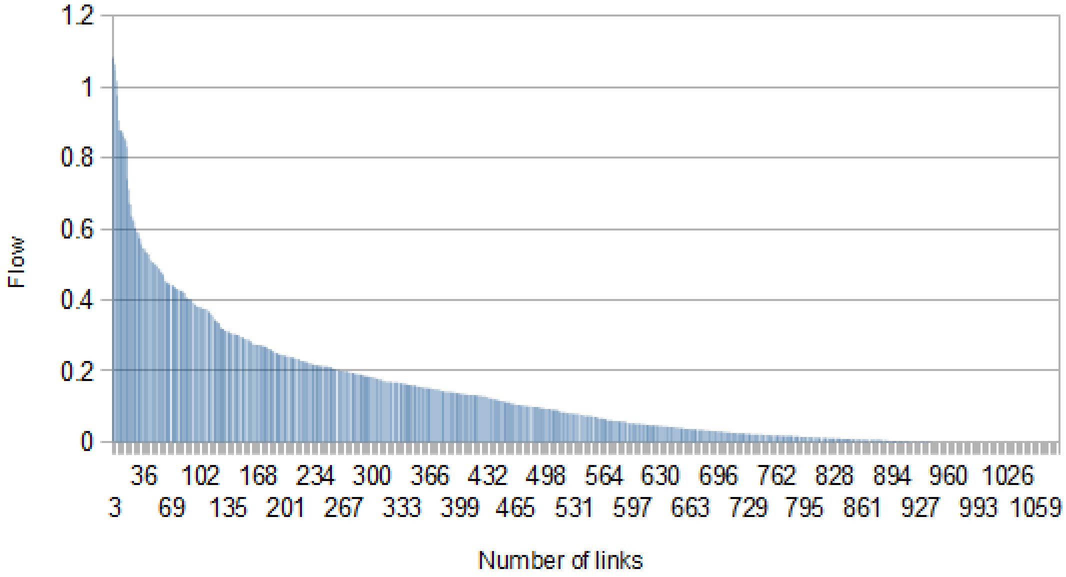

Figure 3.5: Flow values

From these two last fields, it becomes obvious that the transportation demand of the OD-matrix is not very high and so we can expect to see many links with little changes to their ideal traffic flow conditions.

We will now take a look at more specific subsets of link data in order to see what can be observed in them and not in an overall view. These subsets do not correspond to any specific criteria, they are merely a group of links that share a characteristic which show certain peculiar phenomena.

3.3.2. Short links

id	length	# lanes	counter	max speed	average speed	average time	st deviation	density	flow
903	5	1	1233	13.8889	2.08239	2.40109	0.0610242	0.109667	0.228333
980	5	1	1561	13.8889	2.06705	2.4189	0.0891999	0.14137	0.289074
1030	6	1	1163	11.1111	2.3189	2.58743	0.0694833	0.0931481	0.21537
902	6	1	1697	13.8889	2.4219	2.4774	0.0588405	0.129506	0.314259
968	6	1	2394	13.8889	2.39812	2.50196	0.0770884	0.185463	0.443333
927	6	1	2958	13.8889	2.36926	2.53244	0.117141	0.231543	0.547778
943	6	1	3197	13.8889	2.36372	2.53837	0.107602	0.249938	0.592037
1032	7	1	191	11.1111	2.65816	2.6334	0.0137959	0.0132011	0.0353704
923	7	1	284	13.8889	2.78904	2.50982	0.0155591	0.0190741	0.0525926
921	7	1	552	13.8889	2.78364	2.5147	0.0234672	0.0366667	0.102222
966	7	1	1579	13.8889	2.75682	2.53915	0.0417531	0.10672	0.292407
900	7	1	2931	13.8889	2.71026	2.58278	0.0759836	0.200503	0.542778
946	8	1	1837	13.8889	3.05866	2.61552	0.0442481	0.112361	0.340185
970	8	1	2865	13.8889	3.03128	2.63915	0.0575381	0.174005	0.530556
907	9	1	121	13.8889	3.39616	2.65005	0.00830771	0.00650206	0.0224074

Table 3.2 – Short links

Short links are greatly affected by almost any amount of traffic on them. There are enormous drops in the average speed observed compared to the maximum speed allowed on these links. This can be mainly attributed to the static 2 second delay that is added on all travel times. An extra 2 seconds is a noticeable increase in travel time if the arc is very short. As an example, link 903 is 5 meters long and has a maximum speed of 13.8889 m/s (50 km/h), thus, in our simulation model, a vehicle would take close to 1/3 of a second to travel along this arc. Adding 2 seconds to that time slows down the flow a lot and so it creates a tremendous amount of traffic which is why the average speed experienced on this link is 2.08239 m/s (7.5 km/h). This effect can be seen in the average time column: if we subtract the 2 seconds, the average times would all be below 1 second.

3.3.3. Long links

id	length	# lanes	counter	max speed	average speed	average time	st deviation	density	flow
107	6300	3	430	33.3333	32.9843	191	3.26067e-05	0.00244103	0.0796296
106	6300	3	1195	33.3333	32.9842	191	5.20164e-05	0.00680391	0.221296
242	4462	1	489	25	24.7229	180.481	0.00018331	0.0037098	0.0905556
225	4462	1	626	25	24.7228	180.481	0.000247786	0.00475053	0.115926

432	3900	1	47	25	24.6835	158	4.69112e-05	0.000352612	0.0087037
430	3300	1	35	16.6667	16.5	200	8.70399e-05	0.000392817	0.00648148
428	3300	1	146	16.6667	16.5	200	0.000198868	0.00164108	0.027037
816	3185	2	597	25	24.6135	129.4	0.00011734	0.00453329	0.110556
815	3185	2	906	25	24.6135	129.401	0.00016578	0.00684424	0.167778
954	3150	1	25	13.8889	13.7675	228.8	7.29011e-05	0.000336273	0.00462963
955	3150	1	5	13.8889	13.7675	228.8	4.29325e-05	6.73133e-05	0.000925926
161	3100	3	718	33.3333	32.6315	95.0002	5.39709e-05	0.00411362	0.132963
163	3100	3	887	33.3333	32.6315	95.0002	6.72032e-05	0.00504982	0.164259
71	3050	2	310	33.3333	32.6203	93.5001	4.86667e-05	0.00177468	0.0574074
115	3050	3	394	33.3333	32.6203	93.5001	3.19435e-05	0.00225003	0.072963
511	3000	1	25	16.6667	16.4835	182	6.26725e-05	0.000287222	0.00462963
512	3000	1	193	16.6667	16.4835	182.001	0.000186465	0.00219327	0.0357407

Table 3.3 – Long links

Long links in our network carry very little traffic flow. Some values for the number of vehicles having used the link are somewhat high (1195 for link 106, 906 for link 815), yet the length coupled with the number of lanes make for a very low density as can be seen in the density column of the table. Since the traffic density of the link is the only factor affecting the speed of a vehicle travelling along said link, there is almost no difference between the speed limit and the average speed. This is to be expected because the vehicles on those links are almost scarce enough to be able to travel as if no other vehicle is on the same link. This phenomenon is reflected in the very low standard deviation values. Since the Greenshields linear model, in this case, always gives a speed extremely close to the free flow speed, the observed values are almost all the same.

3.3.4. Heavy traffic links

id	length	# lanes	Counter	max speed	average speed	average time	st deviation	density	flow
150	750	3	5847	33.3333	30.61	24.5018	0.000643226	0.0355072	1.08278
1040	23	1	5841	11.1111	5.52406	4.1636	0.0457478	0.196103	1.08167
967	10	1	5747	13.8889	3.53128	2.83183	0.0709117	0.300481	1.06426
1041	23	1	5654	11.1111	5.52772	4.16085	0.0433581	0.189187	1.04704
965	10	1	5492	13.8889	3.53949	2.82527	0.067712	0.287944	1.01704
944	28	2	5267	13.8889	6.93365	4.03828	0.0113557	0.140754	0.97537
151	700	1	4890	25	23.3267	30.0085	0.00325663	0.0390526	0.905556
144	700	1	4741	25	23.3268	30.0084	0.00323185	0.0378418	0.877963
934	86	2	4738	13.8889	10.4813	8.20511	0.00490862	0.0838286	0.877407
935	20	2	4736	13.8889	5.77341	3.46416	0.0137065	0.152093	0.877037
930	392	2	4722	16.6667	15.356	25.5274	0.00169634	0.0570356	0.874444
960	10	1	4718	13.8889	3.56223	2.80723	0.0589098	0.244981	0.873704
371	850	1	4655	16.6667	16.0335	53.0139	0.0024496	0.0539996	0.862037
905	30	2	4623	13.8889	7.179	4.17885	0.00947357	0.119235	0.856111

909	400	2	4605	16.6667	15.3803	26.0073	0.00159305	0.0555699	0.852778

Table 3.4 – Heavy traffic links

Surprisingly, heavy traffic does not affect the average speeds and flow as much as anticipated. The noticeable discrepancies between maximum speeds and average speeds in the table above are due to the very short length of those links as discussed beforehand. The lack of significant drop in speed experienced by the vehicles of an "average" link such as link 151 or 144 (less than 2 m/s from the maximum speed despite the high amount of traffic) can be attributed to a number of reasons: adding a static 2 seconds to every trip has almost no effect on longer links, the lack of true signaling means that there is a lack of realism in terms of queue build up at intersections which should account for a lot of slowing down and, at the moment, vehicles travel at full speed continuously meaning that there is no deceleration nor acceleration. This can be summed as everything running too smoothly compared to real traffic conditions.

We will now discuss the behavior of our logit choice model by briefly analyzing some of the probabilities generated for a random sample of route choices.

3.3.5. Route choice probabilities

	Utility 1	Probs 1	Utility 2	Probs 2	Utility 3	Probs 3
Turn 1	419.81	6.55E-022	507.04	2.45E-010	2.32E-016	672.381
Turn 2	374.663	0.0265155	485.65	0.477515	1	636.38
Turn 3	371.06	0.973484	485.56	0.522485	2.20E-072	801.38

Table 3.5 – Route choice probabilities sample

There are three examples in the table above, the "Utility" column is the utility function value for each of the path considered and the "Probs" column are the probabilities associated, which are the result of the logit choice model discussed previously. It quickly became apparent that the probabilities generated by our current logit choice model are a bit too extreme. In the first example, Turn #3 has a 97.3% probability of being chosen, turn #2 has a 2.6% chance however, Turn #3 only has an expected travel time (because our utility is the equivalent of the expected travel time) 3 seconds shorter than Turn #2. In the second example, a 5% difference between the two main choices originates from a mere 0.9 difference in utility. The third example shows that any option with a significant additional travel over the shortest one will almost be completely ignored. This rather small sample, unfortunately, does in fact represent well the overall results. However this does not discredit our route choice model in any way, it simply means that some "tuning" needs to be performed on our current simple logit choice model in order to generate more reasonable probabilities for small differences in utility function values. The first way that comes to mind to address this problem is a route choice probability scaling factor: a factor that would multiply the utility of each path considered before applying the exponential function in the logit choice model. Obviously, the factor would be strictly less than one so that the smaller utility values translate into more balanced probabilities. Finding the right value for this new parameter would be somewhat tricky however, because if the factor is too small poor choices (longer travel times) can be seen as acceptable, but if the factor is not small enough, the original issue will remain.

3.3.6. Reconstructed OD-matrix

(Re) Origin	(Re) Destination	(Re) # Cars	Origin	Destination	# Cars
11002	11006	0	11002	11006	5
11002	11014	319	11002	11014	376
11002	11018	91	11002	11018	108
11002	11022	6	11002	11022	7
11002	11024	10	11002	11024	12
11002	11026	7	11002	11026	11
11002	11131	8	11002	11131	8
11002	11148	23	11002	11148	24
11002	11150	6	11002	11150	8
11002	11151	20	11002	11151	29
11002	11158	3	11002	11158	6
11002	11162	13	11002	11162	17
11002	11164	4	11002	11164	4
11002	11600	2	11002	11600	4
11002	11602	1	11002	11602	1
11002	11603	10	11002	11603	16
11002	12003	2	11002	12003	3
11002	12103	29	11002	12103	32
11002	12105	20	11002	12105	20

Table 3.6 – Reconstructed OD-matrix sample

The three columns starting with “(Re)” illustrate the reconstructed OD-matrix, as opposed to the three columns on the right which come from the original transportation demand OD-matrix. The “Origin” and “Destination” columns are the identifier numbers of the starting intersections and the destination intersections. The “# Cars” column is the number of vehicles having completed their trip on those OD-pairs. The reconstructed OD-matrix is encouraging as most OD pairs exhibit a number of arrived vehicles very close to the values in the original OD-matrix, used to simulate the transport demand. These numbers do not include vehicles still on the network at the end of the simulation, partly explaining the differences. There is one small issue however, as certain OD pairs have no vehicles arriving at their destinations. The root of this has been tracked down to a number of vehicles (around 500 at the end of the 90 minute period) that are stuck in a loop in the downtown area. This is due to the fact that the Dijkstra algorithm currently used does not take into account legal turnings and so the vehicles are attracted to a very short but impossible path, a point that should be corrected in a future version of the simulation. There is also a strong possibility that the network representation has a few remaining problems, as we have observed. As a general indicator, there are 48461 vehicles in the original OD-matrix and 39732 in the reconstructed one. A total of 45781 vehicles are sent onto the network during the simulation, when stopping it after the simulation clock reaches 90 minutes. When waiting that each vehicle in the network reaches its destination, if possible, 46 028 out of the created 46 034 vehicles do indeed reach their destination. Here, the concept of legal turns at intersections was abandoned due to inconsistency of Dijkstra’s algorithm from the Oratio library and the rest of the simulation program, as the available version of Dijkstra’s algorithm does not allow turn restrictions. The difference of 6 vehicles is due to the fact that these vehicles appear on the three isolated nodes that are not linked to the rest of the graph. The presence of these three nodes, forming a second connected component in the complete network graph, is somewhat surprising, even if present in the network description files. The simulation fortunately appears robust enough to overcome their presence and correctly behave on the rest of the network.

CHAPITRE 4

CONCLUSION

In this research, we have developed a dynamic route choice model following a sequential approach. We start with a small dynamic programming problem for a certain number of links then follow with an approximation for the rest of the path in order to generate a utility for each path considered. The model has been tested on a real network part of the city of Namur. It contains 438 nodes and 1090 links. The idea has been validated to some extent by our current results, while more research is needed to properly evaluate the proposed dynamic attraction/repulsion route choice concept, in particular if it is an improvement with respect to standard route choice methods.

4.1. Future research

The first issue that needs to be addressed is of a technical nature: the Dijkstra algorithm implementation used does not take into account the legal turnings at the intersections. This can and does create a problem in which vehicles would be continuously routed towards an apparently efficient path, which reveals to be not feasible. The effect manifests itself in a very obvious way for a 6 link cycle for which the vehicle count reaches 50 000. It is estimated that at the end of the simulated time frame, about 500 vehicles are stuck in this cycle. Obviously, these links were left out of the results discussion. Once the issue is resolved, the surrounding links will have slightly increased traffic values and it can be expected that a few links with 0 traffic flow will now have some as the traffic for certain OD-pairs is freed from the cycle.

The second issue is a lack of realism in the simulation in a few aspects, the first of which is the absence of lights or signs at intersections. At the moment, only a two second delay is added to the travel time along any link for any vehicle. Although it does slightly help in producing more realistic results, it is far from the varying delays experienced in real life traffic. Turning left is usually much longer than going straight or even turning right. There is also no queue up effect in links with heavy traffic flow. There is a slowdown of course, from the Greenshields linear model, but in realistic traffic modeling, there is a queue build up at the intersection which backs up the link as more and more vehicles enter the link.

There is also the potential for slight inconsistencies based on the density recorded on a link and its length. For example, link #967 in the first result table has a density of about 0.3 cars per meter and a length of 10 meters, which implies that 3 cars are on the link at any given time on average. However, the average length of a car has been set to 4.20 meters which means that only 2.38 cars can possibly fit on the link. Of course, it is only the average length of a car and thus it could be argued (in an illogical way) that it is still technically possible, but the problem remains: a certain limit to the number of vehicles on a link needs to be implemented.

In the previous chapter discussing the results, a problem with the route choice probabilities being a bit too extreme was explained. This lead to a few quick tests with a route choice probability scaling factor implemented. The preliminary results obtained from these first tests, showed us a new issue that will arise when this first problem is properly resolved through calibration (more on this later): vehicles were observed to have a significant increase in cycles within their paths. Short cycles become interesting options to users because compared to the shortest path available, they might not be that much longer. The easiest example to imagine would be an intersection with two legal exiting links: one link leads to the destination but is very long; the other link is a very short dead end with a U-turn available at the end. The two paths considered will be simply taking the very long link and taking the short link, coming back and then taking the long link. Because the very long link will have most of the weight in the utility, both options are plausible although one is clearly unrealistic. It is important to note that this issue does not arise in our current model because of the extreme route choice probabilities which make almost any option besides the best one uninteresting.

As a continuation of the previous point, another issue to be addressed is the lack of consideration for overlapping in the route choice set. Every path in the choice set is often not completely independent of the other paths and this should be accounted for through modifications to the current logit choice model.

A somewhat obvious avenue of research is an increase in the number of steps for the dynamic programming problem. It would be interesting to monitor its effects on the results. An increase would signify that the user sees the traffic conditions on more than one link ahead of him. This would be realistic for many shorts links that go downhill for example, however on very long links, it would not be a reasonable assumption.

An important point is the impossibility to compare our results with real data. It is the major issue holding us back from fully validating our route choice model. At the moment, the data can only be analysed by itself so we are somewhat limited in what we can deduce. With a comparison, it is possible that new issues will be discovered and addressed, but more importantly, it will allow us to calibrate our model to improve our results. Indeed, there is a number of parameters of which the values can be tweaked such as the route choice probability scaling factor discussed previously.

Finally, another point of interest would be take into account the interaction between user's decisions. Consider for instance two alternative paths to reach a destination: one has a substantial amount of traffic and the other barely has any traffic on it. For a user wanting to reach this destination, the choice will seem obvious, but it will seem obvious to all the other travelers wanting to reach this common destination, but possibly originating from different links. At some point of this alternative path, a huge amount of traffic can have accumulated on it, making it less desirable. Users could anticipate this accumulation, and modify their choice in accordance. Moreover, most users have one or a few familiar paths that they stick to for their routine trips, even though an onboard navigation system or a radio report advises them to use alternative routes. It would be quite interesting to account for this behavior in users in future work on this route choice model.

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ANNEXE

A. Full link data

id	length	# lanes	counter	max speed	average speed	average time	st deviation	density	flow
1	30	1	0	8.33333	0	0	0	0	0
2	1000	1	0	13.8889	0	0	0	0	0
3	1000	1	0	13.8889	0	0	0	0	0
4	90	1	0	11.1111	0	0	0	0	0
5	250	1	0	13.8889	0	0	0	0	0
6	250	1	0	13.8889	0	0	0	0	0
7	150	1	0	11.1111	0	0	0	0	0
8	600	1	0	13.8889	0	0	0	0	0
9	600	1	0	13.8889	0	0	0	0	0
10	350	1	0	11.1111	0	0	0	0	0
11	175	1	0	11.1111	0	0	0	0	0
12	200	1	0	11.1111	0	0	0	0	0
13	420	1	0	13.8889	0	0	0	0	0
14	1400	1	0	11.1111	0	0	0	0	0
15	370	1	25	13.8889	12.9189	28.6401	0.000305814	0.000359359	0.00462963
16	370	1	483	13.8889	12.918	28.6423	0.00141988	0.00692993	0.0894444
17	340	1	21	13.8889	12.8397	26.4803	0.00051353	0.000302832	0.00388889
18	340	1	1587	13.8889	12.8365	26.4871	0.00266574	0.0229139	0.293889
19	75	1	1255	13.8889	10.1253	7.40722	0.005574	0.0229531	0.232407
20	75	1	110	13.8889	10.1347	7.40033	0.00111101	0.00198765	0.0203704
21	850	1	537	13.8889	13.4489	63.2023	0.000850692	0.00743007	0.0994444
22	850	1	5	13.8889	13.4494	63.2	0	0.00007	0.000925926
23	600	1	0	13.8889	0	0	0	0	0
24	600	1	0	13.8889	0	0	0	0	0
25	500	1	0	11.1111	0	0	0	0	0
26	350	1	0	13.8889	0	0	0	0	0
27	350	1	0	13.8889	0	0	0	0	0
28	400	1	0	13.8889	0	0	0	0	0
29	400	1	0	13.8889	0	0	0	0	0
30	450	1	52	13.8889	13.0813	34.4002	0.000349181	0.000737449	0.00962963
31	450	1	137	13.8889	13.0812	34.4006	0.000677255	0.00193498	0.0253704
32	700	1	12	16.6667	15.9091	44.0001	0.000223773	0.000139683	0.00222222
33	700	1	99	16.6667	15.909	44.0003	0.000327521	0.00115238	0.0183333
34	100	1	0	13.8889	0	0	0	0	0
35	100	1	0	13.8889	0	0	0	0	0
36	420	1	246	16.6667	15.4407	27.2008	0.000644789	0.00294665	0.0455556
37	420	1	183	16.6667	15.4409	27.2006	0.000543307	0.00220547	0.0338889

38	525	1	0	16.6667	0	0	0	0	0
39	525	1	0	16.6667	0	0	0	0	0
40	250	1	0	11.1111	0	0	0	0	0
41	250	1	0	11.1111	0	0	0	0	0
42	200	1	0	13.8889	0	0	0	0	0
43	200	1	0	13.8889	0	0	0	0	0
44	1250	1	0	11.1111	0	0	0	0	0
45	1250	1	0	11.1111	0	0	0	0	0
46	250	1	0	11.1111	0	0	0	0	0
47	250	1	0	11.1111	0	0	0	0	0
48	500	1	0	13.8889	0	0	0	0	0
49	500	1	0	13.8889	0	0	0	0	0
50	500	1	0	13.8889	0	0	0	0	0
51	500	1	0	13.8889	0	0	0	0	0
52	900	1	38	11.1111	10.8433	83.0002	0.000233079	0.000648971	0.00703704
53	900	1	172	11.1111	10.8432	83.0012	0.000695794	0.0029393	0.0318519
54	1350	3	1231	33.3333	31.7645	42.5003	0.000103443	0.00721989	0.227963
55	331	2	204	25	21.7189	15.2402	0.000218879	0.00174108	0.0377778
56	2383	1	235	25	24.4861	97.3203	0.000169444	0.00179077	0.0435185
57	2000	1	248	25	24.3902	82.0003	0.000156923	0.00188722	0.0459259
58	2150	1	70	16.6667	16.4122	131	0.000176569	0.000794574	0.012963
59	1000	1	142	16.6667	16.1289	62.0005	0.000369172	0.00164407	0.0262963
60	234	1	44	25	20.5984	11.3601	0.000230507	0.000397278	0.00814815
61	700	1	44	25	23.3333	30.0001	0.000130572	0.000349206	0.00814815
62	2200	1	205	25	24.4444	90.0003	0.000148476	0.00156338	0.037963
63	97	1	486	16.6667	12.4012	7.82183	0.00215597	0.00725659	0.09
64	402	4	1749	33.3333	28.591	14.0604	0.000174738	0.0113276	0.323889
65	359	1	725	25	21.9423	16.3611	0.000736716	0.00614051	0.134259
66	1500	1	753	25	24.1932	62.001	0.000390631	0.00577074	0.139444
67	1400	1	894	25	24.1374	58.0012	0.000431655	0.00687209	0.165556
68	400	1	901	25	22.2206	18.0013	0.000755002	0.00753426	0.166852
69	400	1	1329	16.6667	15.3822	26.0042	0.0017596	0.0160329	0.246111
70	190	1	1325	16.6667	14.1742	13.4046	0.00260669	0.0173294	0.24537
71	3050	2	310	33.3333	32.6203	93.5001	4.86667e-05	0.00177468	0.0574074
72	1200	1	210	25	23.9999	50.0003	0.000181406	0.00162037	0.0388889
73	1200	1	0	25	0	0	0	0	0
74	1400	1	230	16.6667	16.2789	86.0007	0.000354035	0.00262566	0.0425926
75	434	2	1395	25	22.4162	19.361	0.000424335	0.0115297	0.258333
76	196	1	73	25	19.9186	9.84004	0.000171349	0.000677438	0.0135185
77	1300	3	555	33.3333	31.7072	41.0001	6.94642e-05	0.00324886	0.102778
78	523	2	1036	33.3333	29.564	17.6904	0.000216606	0.00650839	0.191852
79	300	1	449	25	21.4276	14.0006	0.000605079	0.00388827	0.0831481

80	1050	2	1150	25	23.8632	44.0008	0.000246165	0.00894056	0.212963
81	118	1	99	25	17.559	6.7202	0.000538713	0.00105148	0.0183333
82	152	1	0	25	0	0	0	0	0
83	2300	1	718	25	24.4678	94.0009	0.00027103	0.00545403	0.132963
84	340	1	838	16.6667	15.1767	22.4027	0.00140518	0.0102511	0.155185
85	176	2	1559	25	19.4663	9.04127	0.00074711	0.0148411	0.288704
86	2100	2	1561	25	24.4183	86.001	0.000202225	0.0118946	0.289074
87	1400	2	1272	25	24.1376	58.0009	0.000260688	0.00981138	0.235556
88	450	1	909	25	22.4986	20.0012	0.00063757	0.00749547	0.168333
89	1000	1	627	25	23.809	42.0008	0.000409559	0.00488852	0.116111
90	1100	1	584	25	23.9126	46.0008	0.000363488	0.00452896	0.108148
91	1500	1	8	16.6667	16.3043	92	0	0.00009	0.00148148
92	1350	3	557	33.3333	31.7646	42.5001	7.13299e-05	0.00326447	0.103148
93	500	1	513	25	22.7265	22.0008	0.000511117	0.00418	0.095
94	700	3	716	33.3333	30.4345	23.0002	0.000106307	0.00436111	0.132593
95	300	2	662	25	21.4278	14.0005	0.000412542	0.0057358	0.122593
96	700	1	514	25	23.3328	30.0007	0.000368463	0.00409894	0.0951852
97	230	3	1038	25	20.5347	11.2006	0.000393384	0.00937681	0.192222
98	700	2	852	27.7778	25.7348	27.2005	0.000265538	0.00613413	0.157778
99	1000	2	667	25	23.8093	42.0005	0.000220713	0.00518944	0.123519
100	1100	2	1167	25	23.9126	46.0008	0.000307177	0.00905269	0.216111
101	331	2	108	25	21.719	15.2401	0.000197451	0.000920891	0.02
102	700	1	558	25	23.3327	30.0008	0.000447678	0.00442884	0.103333
103	300	2	622	25	21.4278	14.0005	0.000390545	0.00537531	0.115185
104	700	3	5	33.3333	30.4348	23	0	0.00003	0.000925926
105	500	1	422	25	22.7266	22.0006	0.000481306	0.00345111	0.0781481
106	6300	3	1195	33.3333	32.9842	191	5.20164e-05	0.00680391	0.221296
107	6300	3	430	33.3333	32.9843	191	3.26067e-05	0.00244103	0.0796296
108	700	1	951	25	23.3323	30.0013	0.000601345	0.00757566	0.176111
109	600	3	239	33.3333	29.9999	20.0001	6.40365e-05	0.00147531	0.0442593
110	1500	1	0	25	0	0	0	0	0
111	1500	1	0	25	0	0	0	0	0
112	500	1	159	25	22.7271	22.0002	0.000278532	0.00129556	0.0294444
113	600	3	1531	33.3333	29.9994	20.0004	0.000175105	0.00945679	0.283519
114	2200	3	2426	33.3333	32.3527	68.0006	0.000122054	0.0139455	0.449259
115	3050	3	394	33.3333	32.6203	93.5001	3.19435e-05	0.00225003	0.072963
116	600	3	188	33.3333	29.9999	20	6.05073e-05	0.00116049	0.0348148
117	1500	1	0	25	0	0	0	0	0
118	500	1	122	25	22.7271	22.0002	0.000236805	0.000994074	0.0225926
119	402	3	1652	33.3333	28.5908	14.0605	0.000230449	0.010708	0.305926
120	500	1	253	25	22.7269	22.0003	0.00034065	0.00206148	0.0468519
121	600	3	1492	25	23.0763	26.0007	0.000272926	0.0119889	0.276296

122	1500	1	0	25	0	0	0	0	0
123	2200	3	1691	33.3333	32.3527	68.0004	0.000107197	0.00971566	0.313148
124	500	1	886	25	22.726	22.0013	0.000702679	0.00722407	0.164074
125	800	3	1531	33.3333	30.7688	26.0004	0.000142964	0.00922454	0.283519
126	250	1	946	25	20.8307	12.0015	0.00107758	0.00841037	0.175185
127	300	1	395	25	21.4277	14.0006	0.000579637	0.00341358	0.0731481
128	600	1	1455	25	23.0751	26.0021	0.000849187	0.0116938	0.269444
129	1400	1	2628	16.6667	16.2776	86.0078	0.00143744	0.0300647	0.486667
130	190	1	528	25	19.7898	9.60089	0.000900321	0.00496881	0.0977778
131	400	1	206	16.6667	15.3843	26.0006	0.000628788	0.00248519	0.0381481
132	400	1	189	25	22.2219	18.0002	0.000321254	0.001575	0.035
133	1400	1	106	25	24.1379	58.0001	0.000114387	0.000813228	0.0196296
134	1500	1	105	25	24.1935	62.0001	0.000112492	0.000803704	0.0194444
135	359	1	92	25	21.9436	16.3601	0.000226148	0.000775818	0.017037
136	400	1	809	25	22.2207	18.0012	0.000755695	0.00674676	0.149815
137	250	1	1086	25	20.8304	12.0017	0.00107944	0.00966	0.201111
138	800	3	894	25	23.5291	34.0004	0.000185263	0.00705069	0.165556
139	500	1	156	25	22.727	22.0002	0.000290168	0.00127111	0.0288889
140	1400	3	1918	33.3333	31.8178	44.0005	0.000119181	0.0111866	0.355185
141	1400	3	1053	33.3333	31.818	44.0003	0.000102035	0.00614749	0.195
142	400	1	1357	25	22.2198	18.002	0.000946056	0.0113194	0.251296
143	750	3	664	33.3333	30.612	24.5002	9.94334e-05	0.00402864	0.122963
144	700	1	4741	25	23.3268	30.0084	0.00323185	0.0378418	0.877963
145	350	2	1180	25	21.8738	16.0009	0.000478098	0.00999947	0.218519
146	350	2	535	25	21.8744	16.0004	0.000329685	0.00452963	0.0990741
147	450	1	327	25	22.4994	20.0005	0.000468639	0.00269383	0.0605556
148	525	2	1634	16.6667	15.6704	33.5026	0.000832352	0.0193302	0.302593
149	800	2	1623	25	23.5286	34.0011	0.000364057	0.0128155	0.300556
150	750	3	5847	33.3333	30.61	24.5018	0.000643226	0.0355072	1.08278
151	700	1	4890	25	23.3267	30.0085	0.00325663	0.0390526	0.905556
152	1200	3	986	33.3333	31.5787	38.0003	0.000103324	0.0058	0.182593
153	1200	3	995	33.3333	31.5787	38.0003	0.000109153	0.00585355	0.184259
154	700	1	357	33.3333	30.4344	23.0003	0.00025444	0.00217407	0.0661111
155	1000	3	626	33.3333	31.2498	32.0002	8.48824e-05	0.00371259	0.115926
156	700	1	395	33.3333	30.4344	23.0003	0.000239579	0.00240714	0.0731481
157	600	1	103	33.3333	29.9999	20.0001	0.000138658	0.000640432	0.0190741
158	700	2	758	33.3333	30.4344	23.0003	0.000179199	0.00462513	0.14037
159	1000	3	607	33.3333	31.2498	32.0002	8.92373e-05	0.00360593	0.112407
160	700	1	278	33.3333	30.4345	23.0002	0.00019115	0.00169153	0.0514815
161	3100	3	718	33.3333	32.6315	95.0002	5.39709e-05	0.00411362	0.132963
162	1300	3	716	33.3333	31.7072	41.0002	8.68927e-05	0.00419601	0.132593
163	3100	3	887	33.3333	32.6315	95.0002	6.72032e-05	0.00504982	0.164259

164	450	1	202	25	22.4997	20.0003	0.00032814	0.00166296	0.0374074
165	196	1	0	25	0	0	0	0	0
166	400	1	541	25	22.2212	18.0008	0.000586489	0.0045162	0.100185
167	200	1	33	25	20	10	0	0.000305556	0.00611111
168	200	1	503	25	19.9984	10.0008	0.000832206	0.00465926	0.0931481
169	300	1	234	16.6667	14.9994	20.0007	0.000766341	0.00288951	0.0433333
170	1500	1	339	16.6667	16.3042	92.001	0.000386262	0.00388012	0.0627778
171	1100	1	382	25	23.9128	46.0005	0.000270614	0.00298232	0.0707407
172	1000	1	351	25	23.8092	42.0005	0.000279698	0.00274389	0.065
173	450	1	361	25	22.4994	20.0005	0.000443437	0.00297119	0.0668519
174	1100	2	455	16.6667	16.1763	68.0007	0.000299845	0.00522003	0.0842593
175	1000	2	717	25	23.8093	42.0005	0.000202571	0.00559019	0.132778
176	700	2	745	27.7778	25.7349	27.2004	0.000217539	0.00537513	0.137963
177	230	2	1090	25	20.5341	11.2009	0.000594703	0.00983333	0.201852
178	294	2	1173	16.6667	14.9679	19.642	0.00103935	0.0145446	0.217222
179	495	1	1002	16.6667	15.6135	31.7033	0.00152229	0.0119005	0.185556
180	700	1	1285	16.6667	15.9076	44.0041	0.00141222	0.0149918	0.237963
181	500	1	1422	16.6667	15.6228	32.0046	0.00196915	0.0168819	0.263333
182	500	1	912	16.6667	15.6236	32.0029	0.00133294	0.0108348	0.168889
183	400	1	1421	16.6667	15.3818	26.0047	0.00215318	0.0171148	0.263148
184	400	1	916	16.6667	15.3829	26.0029	0.00149553	0.0110407	0.16963
185	327	1	1356	16.6667	15.1217	21.6245	0.00216538	0.016614	0.251111
186	1000	1	201	16.6667	16.1289	62.0006	0.000362551	0.00230778	0.0372222
187	2150	1	80	16.6667	16.4122	131	0.00016053	0.000910939	0.0148148
188	2000	1	254	25	24.3901	82.0003	0.000168415	0.00192852	0.047037
189	2183	1	180	25	24.4401	89.3202	0.00013499	0.0013634	0.0333333
190	97	1	277	16.6667	12.4025	7.82098	0.00149238	0.00415044	0.0512963
191	2200	1	91	16.6667	16.4179	134	0.000153	0.00104217	0.0168519
192	700	1	11	25	23.3333	30	9.70856e-05	0.00009	0.00203704
193	234	1	11	25	20.5986	11.36	0	0.00009	0.00203704
194	669	1	909	16.6667	15.8746	42.1427	0.00111109	0.0106261	0.168333
195	300	1	835	16.6667	14.998	20.0027	0.00149207	0.0103179	0.15463
196	208	2	2846	16.6667	14.3599	14.4848	0.00168316	0.0367192	0.527037
197	73	2	3622	16.6667	11.4281	6.38774	0.00367353	0.0588153	0.670741
198	173	2	1360	16.6667	13.9715	12.3823	0.00125572	0.0180572	0.251852
199	82	2	2161	16.6667	11.842	6.92452	0.00268426	0.0338098	0.400185
200	1300	2	709	25	24.0739	54.0005	0.000196606	0.00548319	0.131296
201	200	4	1153	16.6667	14.2847	14.001	0.000565811	0.0149472	0.213519
202	196	1	567	16.6667	14.2424	13.7618	0.00139439	0.00737717	0.105
203	800	2	662	16.6667	15.9997	50.001	0.000426769	0.00769398	0.122593
204	1400	1	368	16.6667	16.2788	86.0012	0.000535114	0.00421005	0.0681481
205	525	2	698	25	22.8256	23.0005	0.000302668	0.00566914	0.129259

206	1300	2	1643	25	24.0736	54.0011	0.000305702	0.0127004	0.304259
207	360	1	1307	16.6667	15.2514	23.6043	0.00194011	0.0158945	0.242037
208	360	1	1448	16.6667	15.2513	23.6046	0.00193255	0.0176116	0.268148
209	600	2	754	25	23.0765	26.0005	0.00029028	0.00605895	0.13963
210	650	2	865	25	23.2138	28.0006	0.000278934	0.00692849	0.160185
211	411	2	1598	16.6667	15.4149	26.6625	0.00094511	0.0192575	0.295926
212	338	2	1260	16.6667	15.1692	22.282	0.000901627	0.0154021	0.233333
213	434	2	1040	25	22.4165	19.3608	0.000391632	0.00862818	0.192593
214	700	2	397	33.3333	30.4346	23.0002	0.000113618	0.0024172	0.0735185
215	650	2	1571	25	23.2134	28.0011	0.000365428	0.0125393	0.290926
216	600	2	1613	25	23.0759	26.0011	0.000393765	0.0129497	0.298704
217	523	2	446	33.3333	29.5644	17.6902	0.000149066	0.00279796	0.0825926
218	300	1	504	16.6667	14.9988	20.0017	0.00123874	0.00622901	0.0933333
219	2300	2	819	33.3333	32.3942	71.0003	0.000109845	0.00469597	0.151667
220	1500	2	1603	33.3333	31.9145	47.0006	0.000165454	0.00932617	0.296852
221	800	2	1413	25	23.5287	34.001	0.000333026	0.0111435	0.261667
222	1300	2	720	19.4444	18.8795	68.8579	0.000257264	0.00709786	0.133333
223	500	2	717	19.4444	18.0407	27.7151	0.000452059	0.00737667	0.132778
224	118	1	91	25	17.559	6.72022	0.000597668	0.000954175	0.0168519
225	4462	1	626	25	24.7228	180.481	0.000247786	0.00475053	0.115926
226	800	1	508	16.6667	15.9995	50.0016	0.000781625	0.00588773	0.0940741
227	720	1	805	16.6667	15.9283	45.2025	0.00101651	0.00937114	0.149074
228	720	1	538	16.6667	15.9286	45.2017	0.000814668	0.00627135	0.0996296
229	950	1	801	16.6667	16.101	59.0024	0.000872219	0.00923411	0.148333
230	950	1	541	16.6667	16.1012	59.0017	0.000721408	0.00626862	0.100185
231	300	1	0	25	0	0	0	0	0
232	556	1	467	16.6667	15.7233	35.3615	0.000794981	0.00550226	0.0864815
233	2700	1	844	25	24.5452	110.001	0.00025954	0.00639218	0.156296
234	1900	1	711	25	24.3587	78.0009	0.000290411	0.00542339	0.131667
235	100	1	1153	16.6667	12.4933	8.00428	0.0032303	0.0170981	0.213519
236	1100	1	1221	16.6667	16.1756	68.0036	0.000956174	0.0140522	0.226111
237	750	1	866	16.6667	15.9566	47.0026	0.00092545	0.0100617	0.16037
238	250	1	864	16.6667	14.7034	17.0028	0.0016186	0.0108911	0.16
239	300	1	863	16.6667	14.9979	20.0028	0.00146899	0.0106562	0.159815
240	300	1	1080	16.6667	14.9974	20.0035	0.00165111	0.0133451	0.2
241	1050	2	721	25	23.8634	44.0005	0.000216459	0.00561605	0.133519
242	4462	1	489	25	24.7229	180.481	0.00018331	0.0037098	0.0905556
243	556	2	550	16.6667	15.7236	35.3608	0.000409124	0.00649281	0.101852
244	338	2	914	16.6667	15.1696	22.2814	0.000700513	0.0111708	0.169259
245	411	2	905	16.6667	15.4155	26.6614	0.000728722	0.0109034	0.167593
246	500	2	1078	19.4444	18.0404	27.7156	0.000577182	0.0110752	0.19963
247	1300	2	1200	19.4444	18.8793	68.8585	0.000397991	0.0118105	0.222222

248	800	2	811	19.4444	18.5427	43.1438	0.000361202	0.00812361	0.150185
249	1500	2	876	33.3333	31.9147	47.0003	0.000118733	0.00510123	0.162222
250	2300	2	565	33.3333	32.3943	71.0002	8.26909e-05	0.0032467	0.10463
251	300	1	580	16.6667	14.9986	20.0018	0.00117312	0.00716914	0.107407
252	300	1	541	16.6667	14.9987	20.0017	0.0011421	0.00668704	0.100185
253	250	1	540	16.6667	14.7044	17.0017	0.00124798	0.00680963	0.1
254	750	1	538	16.6667	15.9569	47.0016	0.000718853	0.00625407	0.0996296
255	1100	1	879	16.6667	16.1758	68.0026	0.00080805	0.010117	0.162778
256	100	1	633	16.6667	12.4963	8.00239	0.0024089	0.00938333	0.117222
257	1900	1	317	25	24.3588	78.0004	0.000200204	0.00242281	0.0587037
258	2700	1	320	25	24.5454	110	0.000181693	0.00245048	0.0592593
259	50	1	823	16.6667	9.99185	5.00408	0.00444625	0.0152778	0.152407
260	500	1	819	16.6667	15.6238	32.0026	0.00116202	0.00973889	0.151667
261	50	2	819	16.6667	9.99595	5.00202	0.00221266	0.0151741	0.151667
262	800	1	570	16.6667	15.9994	50.0018	0.000804617	0.00660255	0.105556
263	150	1	2172	16.6667	13.6267	11.0078	0.00358348	0.0295284	0.402222
264	150	1	2727	16.6667	13.6244	11.0097	0.00426369	0.0371086	0.505
265	450	1	2268	16.6667	15.5134	29.0072	0.00211336	0.0271189	0.42
266	450	1	2717	16.6667	15.5127	29.0084	0.00231282	0.0324918	0.503148
267	344	1	3042	16.6667	15.1878	22.6498	0.00286414	0.0371748	0.563333
268	261	1	3174	16.6667	14.7704	17.6705	0.00359837	0.0398858	0.587778
269	182	1	2282	16.6667	14.078	12.9279	0.0036424	0.0300387	0.422593
270	184	1	2278	16.6667	14.1019	13.0479	0.00360917	0.0299145	0.421852
271	114	1	2621	16.6667	12.8814	8.84996	0.00509296	0.0376917	0.48537
272	557	1	2540	16.6667	15.7221	35.4279	0.00219969	0.0299794	0.47037
273	85	2	2396	16.6667	11.9635	7.10492	0.00282671	0.0370871	0.443704
274	108	1	1634	16.6667	12.7265	8.48622	0.00379191	0.0238289	0.302593
275	241	1	1158	16.6667	14.6382	16.4638	0.00204463	0.0146727	0.214444
276	62	1	401	16.6667	10.8355	5.72194	0.00304926	0.00685185	0.0742593
277	50	2	1223	16.6667	9.99445	5.00278	0.00251016	0.0226741	0.226481
278	50	2	600	16.6667	9.99714	5.00143	0.00195015	0.0111111	0.111111
279	650	2	1216	16.6667	15.853	41.0018	0.000562229	0.0142393	0.225185
280	650	2	760	16.6667	15.8532	41.0012	0.000465507	0.00888519	0.140741
281	600	1	79	16.6667	15.7893	38.0003	0.00039304	0.000926543	0.0146296
282	600	1	79	16.6667	15.7893	38.0003	0.00039304	0.000926543	0.0146296
283	600	2	79	16.6667	15.7894	38.0001	0.000196517	0.000926543	0.0146296
284	315	2	1264	16.6667	15.0703	20.902	0.000879744	0.0155456	0.234074
285	327	1	676	16.6667	15.1233	21.6223	0.00134851	0.0082835	0.125185
286	700	1	739	16.6667	15.9083	44.0023	0.000943472	0.00863148	0.136852
287	495	1	483	16.6667	15.6144	31.7015	0.000891934	0.00576506	0.0894444
288	294	2	802	16.6667	14.9685	19.6413	0.000773272	0.00991371	0.148519
289	300	1	615	16.6667	14.9984	20.0021	0.00139223	0.00759321	0.113889

290	669	1	487	16.6667	15.8751	42.1415	0.000811635	0.00573825	0.0901852
291	208	2	1140	16.6667	14.3627	14.4819	0.00109588	0.014692	0.211111
292	82	2	969	16.6667	11.8463	6.92202	0.00187246	0.0151445	0.179444
293	173	2	987	16.6667	13.9722	12.3817	0.00121869	0.0130647	0.182778
294	73	3	926	16.6667	11.4397	6.38131	0.00125004	0.0150482	0.171481
295	78	3	2192	16.6667	11.6712	6.6831	0.00186646	0.0347745	0.405926
296	61	1	838	16.6667	10.7703	5.66371	0.00375058	0.0143898	0.155185
297	180	1	42	16.6667	14.0624	12.8001	0.000415996	0.000557613	0.00777778
298	105	1	144	16.6667	12.6497	8.3006	0.00118798	0.00210758	0.0266667
299	250	1	868	16.6667	14.7035	17.0028	0.00166903	0.0109415	0.160741
300	50	1	867	11.1111	7.68249	6.5083	0.00765082	0.0209222	0.160556
301	75	1	1478	11.1111	8.55959	8.76211	0.00790835	0.0320815	0.273704
302	85	1	1477	16.6667	11.9622	7.10573	0.00417697	0.0228497	0.273519
303	40	2	1477	16.6667	9.08296	4.40385	0.00347366	0.030125	0.273519
304	165	2	395	16.6667	13.8648	11.9007	0.000701185	0.00529854	0.0731481
305	295	1	16	16.6667	14.9746	19.7001	0.00021357	0.000207156	0.00296296
306	105	1	914	16.6667	12.6454	8.30342	0.00293467	0.0133968	0.169259
307	100	1	913	11.1111	9.08495	11.0072	0.00538479	0.0186111	0.169074
308	50	1	161	11.1111	7.69041	6.5016	0.00353514	0.00389259	0.0298148
309	250	1	161	16.6667	14.7054	17.0006	0.000729111	0.00202741	0.0298148
310	175	2	918	16.6667	13.9983	12.5015	0.00108894	0.0121429	0.17
311	80	1	402	16.6667	11.7619	6.80165	0.00211463	0.00637963	0.0744444
312	60	1	2059	16.6667	10.697	5.60902	0.00611864	0.0356667	0.381296
313	25	1	1168	16.6667	7.12729	3.50765	0.0085146	0.0302963	0.216296
314	25	1	1559	16.6667	7.12154	3.51048	0.0105083	0.040763	0.288704
315	35	1	1083	16.6667	8.52362	4.10624	0.00680351	0.0234656	0.200556
316	45	1	1308	16.6667	9.56096	4.70664	0.00610468	0.0253333	0.242222
317	60	2	435	16.6667	10.7127	5.60084	0.00133956	0.00752778	0.0805556
318	270	1	607	13.8889	12.5916	21.4428	0.00170517	0.00893141	0.112407
319	60	1	646	16.6667	10.7088	5.60289	0.00349866	0.011216	0.11963
320	150	3	1027	16.6667	13.6348	11.0013	0.000855266	0.0139481	0.190185
321	320	1	0	16.6667	0	0	0	0	0
322	80	1	25	16.6667	11.7643	6.80025	0.000872768	0.000393519	0.00462963
323	90	2	435	16.6667	12.1608	7.40082	0.00104061	0.00661728	0.0805556
324	155	2	287	16.6667	13.7163	11.3004	0.000610576	0.00388172	0.0531481
325	100	2	285	16.6667	12.4993	8.00047	0.000793614	0.00422407	0.0527778
326	165	4	285	16.6667	13.8653	11.9002	0.000281825	0.00380247	0.0527778
327	140	4	2886	16.6667	13.4576	10.403	0.00133543	0.0398108	0.534444
328	200	2	1082	16.6667	14.2838	14.0018	0.0010876	0.0140472	0.20037
329	140	2	1001	16.6667	13.4592	10.4018	0.00125286	0.0138188	0.18537
330	165	2	999	16.6667	13.8635	11.9018	0.00116153	0.0133625	0.185
331	100	3	999	16.6667	12.498	8.0013	0.00103624	0.0148019	0.185

332	155	3	28	16.6667	13.7168	11.3	0.000142139	0.000379928	0.00518519
333	90	3	28	16.6667	12.1621	7.40007	0.000244823	0.000425926	0.00518519
334	239	2	99	16.6667	14.6266	16.3401	0.000239254	0.00124748	0.0183333
335	239	3	760	16.6667	14.6259	16.3409	0.000561293	0.0096366	0.140741
336	75	2	99	16.6667	11.5382	6.50017	0.000509021	0.00159012	0.0183333
337	130	2	190	16.6667	13.2648	9.80038	0.000612299	0.0026453	0.0351852
338	315	2	199	16.6667	15.0715	20.9004	0.000390934	0.00244503	0.0368519
339	130	2	114	16.6667	13.265	9.8002	0.000455489	0.00158547	0.0211111
340	75	2	113	16.6667	11.538	6.50027	0.000694726	0.00184198	0.0209259
341	185	1	734	16.6667	14.1193	13.1027	0.00197618	0.00962863	0.135926
342	300	1	648	16.6667	14.9984	20.0021	0.00136639	0.008	0.12
343	185	2	399	16.6667	14.1214	13.1007	0.00070303	0.00524124	0.0738889
344	105	2	733	16.6667	12.6484	8.30147	0.00130934	0.0107213	0.135741
345	70	2	1726	16.6667	11.2836	6.20367	0.00253886	0.028381	0.31963
346	85	2	1376	16.6667	11.9672	7.10273	0.00198268	0.0213115	0.254815
347	120	2	883	16.6667	13.0412	9.20158	0.00127582	0.012534	0.163519
348	344	1	2699	16.6667	15.1886	22.6486	0.00256717	0.0329253	0.499815
349	85	1	2128	16.6667	11.9573	7.10861	0.0049711	0.0329956	0.394074
350	557	1	2195	16.6667	15.7226	35.4268	0.00171279	0.025912	0.406481
351	114	2	2174	16.6667	12.89	8.84408	0.00209393	0.0312736	0.402593
352	184	1	2725	16.6667	14.1002	13.0495	0.00355633	0.0358072	0.50463
353	182	1	2721	16.6667	14.0764	12.9295	0.00356811	0.0358262	0.503889
354	261	1	3101	16.6667	14.7706	17.6702	0.00333236	0.038913	0.574259
355	120	2	2056	16.6667	13.0381	9.20383	0.002057	0.0292623	0.380741
356	85	2	2055	16.6667	11.9647	7.10421	0.00251921	0.0317712	0.380556
357	70	2	2047	16.6667	11.2823	6.20443	0.00282466	0.0335873	0.379074
358	105	1	1049	16.6667	12.6443	8.30415	0.00322291	0.0153457	0.194259
359	62	2	58	16.6667	10.8391	5.72004	0.000266994	0.000997611	0.0107407
360	241	1	1648	16.6667	14.6366	16.4656	0.0024737	0.0208399	0.305185
361	108	1	1459	16.6667	12.7273	8.4857	0.00370536	0.0212569	0.270185
362	130	1	357	16.6667	13.2635	9.80136	0.00165421	0.0049886	0.0661111
363	50	2	357	16.6667	9.99816	5.00092	0.00154059	0.00661111	0.0661111
364	203	1	44	16.6667	14.3158	14.1801	0.000398571	0.000566502	0.00814815
365	92	1	32	16.6667	12.2338	7.52017	0.000673982	0.000487118	0.00592593
366	50	1	12	16.6667	10	5	0	0.000222222	0.00222222
367	42	2	12	16.6667	9.29204	4.52	0	0.000246914	0.00222222
368	196	1	810	16.6667	14.2413	13.7628	0.00182571	0.0105801	0.15
369	150	3	1687	16.6667	13.634	11.0019	0.000989037	0.0229321	0.312407
370	95	1	1027	16.6667	12.331	7.70416	0.00345949	0.0154327	0.190185
371	850	1	4655	16.6667	16.0335	53.0139	0.0024496	0.0539996	0.862037
372	450	1	640	16.6667	15.5161	29.0021	0.00121746	0.00764733	0.118519
373	450	1	3840	16.6667	15.5109	29.0119	0.00292086	0.0459099	0.711111

374	1400	1	462	16.6667	16.2788	86.0015	0.000618648	0.00530357	0.0855556
375	600	1	828	25	23.0759	26.0012	0.000622536	0.00665525	0.153333
376	134	1	3607	16.6667	13.3293	10.0531	0.00515868	0.0501009	0.667963
377	95	1	819	16.6667	12.3328	7.70304	0.00266438	0.0123138	0.151667
378	243	1	1923	16.6667	14.6505	16.5864	0.00259987	0.0243759	0.356111
379	520	1	789	16.6667	15.6615	33.2024	0.00106015	0.00934651	0.146111
380	520	1	100	16.6667	15.6625	33.2003	0.000365109	0.00118162	0.0185185
381	610	1	788	19.4444	18.2781	33.3732	0.000775108	0.00798543	0.145926
382	610	1	100	19.4444	18.279	33.3716	0.000266775	0.00101366	0.0185185
383	750	1	304	19.4444	18.4856	40.5721	0.000456358	0.00305432	0.0562963
384	750	1	75	19.4444	18.4858	40.5716	0.000184837	0.000750864	0.0138889
385	2170	1	312	25	24.4368	88.8004	0.000194357	0.00237216	0.0577778
386	2170	1	1230	25	24.4365	88.8016	0.000425732	0.00939555	0.227778
387	2300	1	204	25	24.468	94.0003	0.000121351	0.00155483	0.0377778
388	152	1	0	25	0	0	0	0	0
389	340	1	513	16.6667	15.1774	22.4017	0.00121199	0.00625545	0.095
390	350	1	118	16.6667	15.2172	23.0003	0.00045813	0.00143598	0.0218519
391	350	1	1084	16.6667	15.215	23.0035	0.0016746	0.0132302	0.200741
392	400	1	756	19.4444	17.7201	22.5732	0.00102374	0.00789907	0.14
393	400	1	1147	19.4444	17.7193	22.5742	0.0013159	0.0119898	0.212407
394	2750	1	744	25	24.5534	112.001	0.00028314	0.00564808	0.137778
395	2750	1	1149	25	24.5532	112.002	0.000366948	0.00872283	0.212778
396	1400	2	873	25	24.1377	58.0006	0.000204266	0.00672222	0.161667
397	2100	2	840	25	24.4184	86.0006	0.000179144	0.00642196	0.155556
398	176	2	962	25	19.4673	9.0408	0.000603837	0.00917088	0.178148
399	340	1	1462	16.6667	15.1754	22.4046	0.00186355	0.0178851	0.270741
400	453	2	702	25	22.5143	20.1205	0.000321912	0.00577753	0.13
401	1900	1	204	16.6667	16.3792	116.001	0.000247645	0.00232856	0.0377778
402	2800	1	25	16.6667	16.4706	170	7.47597e-05	0.000281085	0.00462963
403	295	1	1685	16.6667	14.9705	19.7055	0.00219785	0.020838	0.312037
404	148	1	1684	16.6667	13.5954	10.886	0.00317172	0.0229154	0.311852
405	70	1	193	16.6667	11.2887	6.20088	0.00179385	0.00316138	0.0357407
406	70	2	924	16.6667	11.2867	6.20198	0.00185645	0.0151614	0.171111
407	55	2	920	16.6667	10.3731	5.30215	0.00214076	0.0164613	0.17037
408	60	1	825	16.6667	10.707	5.60379	0.00387732	0.0142531	0.152778
409	95	1	802	16.6667	12.3326	7.70317	0.00289704	0.0120643	0.148519
410	600	1	140	25	23.0768	26.0002	0.000209137	0.00112346	0.0259259
411	365	1	37	25	21.9878	16.6001	0.000212541	0.000309488	0.00685185
412	365	1	13	25	21.988	16.6	0	0.000110604	0.00240741
413	1200	1	2	16.6667	16.2162	74	0	0.00002	0.00037037
414	531	1	6	16.6667	15.6822	33.86	0	0.00007	0.00111111
415	1000	1	40	16.6667	16.129	62.0001	0.000158226	0.000459259	0.00740741

416	1000	1	760	16.6667	16.1285	62.0022	0.000723375	0.00874741	0.140741
417	453	2	1106	25	22.514	20.1208	0.000429171	0.0091125	0.204815
418	983	1	735	16.6667	16.1195	60.9821	0.000779426	0.0084686	0.136111
419	155	1	714	16.6667	13.7138	11.3025	0.00203406	0.0096356	0.132222
420	172	1	0	25	0	0	0	0	0
421	1400	1	0	16.6667	0	0	0	0	0
422	2000	1	274	16.6667	16.3933	122.001	0.000341217	0.00312481	0.0507407
423	2000	1	10	16.6667	16.3934	122	3.98447e-05	0.000112963	0.00185185
424	1000	1	428	16.6667	16.1287	62.0013	0.00060523	0.00491407	0.0792593
425	1000	1	326	16.6667	16.1288	62.0011	0.000649144	0.00376037	0.0603704
426	1600	1	179	16.6667	16.3264	98.0005	0.000292698	0.00206262	0.0331481
427	1600	1	31	16.6667	16.3265	98.0001	0.000136057	0.00035162	0.00574074
428	3300	1	146	16.6667	16.5	200	0.000198868	0.00164108	0.027037
429	172	1	0	25	0	0	0	0	0
430	3300	1	35	16.6667	16.5	200	8.70399e-05	0.000392817	0.00648148
431	400	1	147	25	22.222	18.0002	0.000286935	0.001225	0.0272222
432	3900	1	47	25	24.6835	158	4.69112e-05	0.000352612	0.0087037
433	700	1	429	16.6667	15.9086	44.0013	0.000727624	0.00499392	0.0794444
434	700	1	84	16.6667	15.909	44.0003	0.000295049	0.000978571	0.0155556
435	700	1	20	16.6667	15.9091	44	0.000110807	0.000232804	0.0037037
436	1500	1	82	16.6667	16.3043	92.0003	0.000169549	0.000938395	0.0151852
437	1200	1	0	16.6667	0	0	0	0	0
438	700	1	0	16.6667	0	0	0	0	0
439	1500	1	11	16.6667	16.3043	92	0	0.000124938	0.00203704
440	1000	1	108	16.6667	16.1289	62.0004	0.000385907	0.00124	0.02
441	1000	1	0	16.6667	0	0	0	0	0
442	531	1	0	16.6667	0	0	0	0	0
443	800	1	117	16.6667	15.9999	50.0003	0.000277256	0.00135417	0.0216667
444	1000	1	0	16.6667	0	0	0	0	0
445	1000	1	88	16.6667	16.129	62.0002	0.000232128	0.00101278	0.0162963
446	800	1	254	16.6667	15.9998	50.0008	0.000539947	0.00295278	0.047037
447	400	1	7	25	22.2221	18.0001	0.000158749	0.00005	0.0012963
448	600	1	168	25	23.0767	26.0002	0.000220435	0.00134815	0.0311111
449	3900	1	0	25	0	0	0	0	0
450	106	1	188	16.6667	12.6786	8.36054	0.00114279	0.00276555	0.0348148
451	400	1	165	16.6667	15.3844	26.0004	0.000487119	0.00198611	0.0305556
452	700	1	0	16.6667	0	0	0	0	0
453	700	1	0	16.6667	0	0	0	0	0
454	400	1	117	16.6667	15.3844	26.0004	0.00051771	0.00142037	0.0216667
455	106	1	168	16.6667	12.6786	8.36052	0.00102224	0.00246331	0.0311111
456	500	1	0	16.6667	0	0	0	0	0
457	300	1	109	16.6667	14.9997	20.0004	0.000619521	0.00134568	0.0201852

458	1200	1	0	16.6667	0	0	0	0	0
459	1200	1	0	16.6667	0	0	0	0	0
460	900	1	0	16.6667	0	0	0	0	0
461	900	1	0	16.6667	0	0	0	0	0
462	1500	1	51	16.6667	16.3043	92.0001	0.000152893	0.000579259	0.00944444
463	250	1	182	16.6667	14.7053	17.0006	0.0008229	0.00229185	0.0337037
464	250	1	116	16.6667	14.7056	17.0003	0.000551677	0.00146074	0.0214815
465	750	1	114	16.6667	15.9573	47.0003	0.000314156	0.00133185	0.0211111
466	750	1	182	16.6667	15.9573	47.0006	0.000481156	0.0021121	0.0337037
467	300	1	73	16.6667	14.9998	20.0003	0.000465514	0.000901235	0.0135185
468	500	1	0	16.6667	0	0	0	0	0
469	1500	1	7	16.6667	16.3043	92	6.34981e-05	0.00008	0.0012963
470	200	1	51	13.8889	12.195	16.4001	0.000410588	0.000776852	0.00944444
471	200	1	7	13.8889	12.1951	16.4	0	0.000105556	0.0012963
472	2800	1	70	16.6667	16.4706	170	0.000199531	0.000800992	0.012963
473	400	1	216	16.6667	15.3842	26.0008	0.000711054	0.00261204	0.04
474	2300	1	102	16.6667	16.4285	140	0.000262011	0.00116449	0.0188889
475	2300	1	250	16.6667	16.4285	140.001	0.000350427	0.00282907	0.0462963
476	400	1	454	16.6667	15.3838	26.0014	0.000880781	0.00546574	0.0840741
477	155	1	0	25	0	0	0	0	0
478	600	1	38	16.6667	15.7895	38	0.000114777	0.000445679	0.00703704
479	600	1	269	16.6667	15.7892	38.0008	0.000521617	0.00315494	0.0498148
480	600	1	13	16.6667	15.7895	38	0.000116488	0.000152469	0.00240741
481	1000	1	348	16.6667	16.1288	62.0011	0.000561514	0.00400796	0.0644444
482	200	1	914	16.6667	14.2826	14.0031	0.00190346	0.0118537	0.169259
483	500	1	325	16.6667	15.6245	32.001	0.000718108	0.00386704	0.0601852
484	300	1	428	16.6667	14.9989	20.0014	0.00115924	0.00528395	0.0792593
485	300	1	428	16.6667	14.9989	20.0014	0.00115924	0.00528395	0.0792593
486	124	1	443	16.6667	13.1333	9.44162	0.00181254	0.00625747	0.082037
487	350	1	358	16.6667	15.2166	23.0012	0.00094905	0.00435661	0.0662963
488	300	1	452	16.6667	14.9989	20.0015	0.00124939	0.00559259	0.0837037
489	148	1	3249	16.6667	13.5885	10.8916	0.00456568	0.0442505	0.601667
490	295	1	2173	16.6667	14.9693	19.707	0.00240141	0.0269278	0.402407
491	600	1	694	16.6667	15.7886	38.0022	0.00106292	0.0081787	0.128519
492	500	1	0	16.6667	0	0	0	0	0
493	600	1	1304	16.6667	15.7878	38.004	0.00142986	0.0153349	0.241481
494	900	1	1052	16.6667	16.0705	56.0032	0.00103989	0.0121658	0.194815
495	1500	1	318	16.6667	16.3042	92.001	0.000383743	0.00365864	0.0588889
496	1000	1	350	16.6667	16.1288	62.001	0.000489107	0.00403278	0.0648148
497	900	1	2162	16.6667	16.0696	56.0065	0.00139892	0.0250897	0.40037
498	600	1	3260	16.6667	15.7854	38.0099	0.00208585	0.038384	0.603704
499	1500	1	317	16.6667	16.3042	92.0009	0.00036981	0.00360951	0.0587037

500	400	1	57	16.6667	15.3845	26.0001	0.000250839	0.000686111	0.0105556
501	700	1	90	16.6667	15.909	44.0003	0.000345186	0.00105794	0.0166667
502	1500	1	217	16.6667	16.3042	92.0006	0.000292319	0.00248988	0.0401852
503	1500	1	54	16.6667	16.3043	92.0001	0.000138638	0.000625802	0.01
504	700	1	48	16.6667	15.909	44.0002	0.000245838	0.000563757	0.00888889
505	400	1	132	16.6667	15.3843	26.0005	0.000511019	0.00159444	0.0244444
506	1400	1	0	16.6667	0	0	0	0	0
507	983	1	0	16.6667	0	0	0	0	0
508	2000	1	519	16.6667	16.3932	122.002	0.000514361	0.00592778	0.0961111
509	1900	1	147	16.6667	16.3793	116	0.000208096	0.00167232	0.0272222
510	2000	1	19	16.6667	16.3934	122	7.52555e-05	0.000218611	0.00351852
511	3000	1	25	16.6667	16.4835	182	6.26725e-05	0.000287222	0.00462963
512	3000	1	193	16.6667	16.4835	182.001	0.000186465	0.00219327	0.0357407
513	140	2	0	16.6667	0	0	0	0	0
514	100	2	427	16.6667	12.4988	8.00078	0.000975307	0.00634074	0.0790741
515	80	2	14	16.6667	11.7647	6.8	0	0.000222222	0.00259259
516	85	2	14	16.6667	11.9718	7.1	0	0.000215686	0.00259259
517	80	2	1306	16.6667	11.7601	6.80264	0.00211016	0.0205347	0.241852
518	260	2	1842	16.6667	14.7702	17.603	0.00127579	0.023109	0.341111
519	140	1	1658	16.6667	13.4537	10.4061	0.0033546	0.0228069	0.307037
520	95	1	208	16.6667	12.3361	7.70094	0.00154004	0.00311696	0.0385185
521	60	2	202	16.6667	10.7131	5.60061	0.00110707	0.00350926	0.0374074
522	55	2	253	16.6667	10.3762	5.30061	0.00116695	0.00453199	0.0468519
523	70	3	252	16.6667	11.2896	6.20039	0.000698504	0.00412169	0.0466667
524	110	2	1626	16.6667	12.7861	8.6031	0.0019364	0.0235892	0.301111
525	115	2	20	16.6667	12.9213	8.90005	0.000245034	0.000281804	0.0037037
526	115	1	992	16.6667	12.9159	8.90378	0.00287422	0.0142013	0.183704
527	107	1	1272	16.6667	12.7004	8.42491	0.00339654	0.0185497	0.235556
528	107	1	956	16.6667	12.7024	8.42358	0.00300959	0.0139702	0.177037
533	35	1	221	16.6667	8.53386	4.10131	0.00295528	0.00479894	0.0409259
536	105	1	1174	16.6667	12.6438	8.3045	0.0032342	0.0172099	0.217407
537	95	2	1158	16.6667	12.334	7.70228	0.0016963	0.0174152	0.214444
538	95	2	1141	16.6667	12.334	7.70229	0.00173402	0.0171754	0.211296
539	210	1	181	16.6667	14.3828	14.6007	0.000993637	0.00232187	0.0335185
540	100	1	1114	16.6667	12.4932	8.00434	0.00322078	0.0165167	0.206296
541	35	1	237	16.6667	8.53316	4.10165	0.00345091	0.0051164	0.0438889
542	85	1	274	16.6667	11.9696	7.10131	0.00207617	0.00424401	0.0507407
543	84	1	265	16.6667	11.9296	7.0413	0.00203425	0.00411376	0.0490741
544	84	1	1165	16.6667	11.9237	7.04477	0.00369151	0.0181107	0.215741
545	80	1	245	16.6667	11.7624	6.80135	0.00215611	0.00386574	0.0453704
546	222	1	233	16.6667	14.49	15.3209	0.00105818	0.00298215	0.0431481
547	67	1	134	16.6667	11.1283	6.0207	0.00161083	0.00223051	0.0248148

548	213	1	91	16.6667	14.411	14.7804	0.000612419	0.00116849	0.0168519
549	153	1	134	16.6667	13.6847	11.1803	0.00070198	0.0018228	0.0248148
550	63	1	220	16.6667	10.8979	5.78095	0.00205717	0.00373016	0.0407407
551	92	1	158	16.6667	12.2331	7.52056	0.00130393	0.00239533	0.0292593
552	73	1	116	16.6667	11.4409	6.3806	0.00159735	0.00188483	0.0214815
553	78	1	116	16.6667	11.6756	6.68059	0.00151421	0.00183523	0.0214815
554	72	1	109	16.6667	11.3915	6.32051	0.00133373	0.00177726	0.0201852
555	213	1	1056	16.6667	14.4079	14.7836	0.00208904	0.013562	0.195556
556	67	1	518	16.6667	11.1253	6.02233	0.00293848	0.00863737	0.0959259
557	222	1	431	16.6667	14.4895	15.3214	0.00127915	0.00551218	0.0798148
558	80	2	452	16.6667	11.763	6.80097	0.00122678	0.00712731	0.0837037
559	78	2	545	16.6667	11.6745	6.68123	0.00139057	0.00870608	0.100926
560	79	1	1288	16.6667	11.7115	6.74549	0.00410966	0.0203962	0.238519
561	99	1	1287	16.6667	12.4604	7.94516	0.00359537	0.0191246	0.238333
562	100	1	1192	16.6667	12.4925	8.00478	0.00349328	0.0176815	0.220741
563	100	1	1282	16.6667	12.492	8.0051	0.00357397	0.0190148	0.237407
564	78	1	96	16.6667	11.6761	6.68034	0.00119452	0.00152659	0.0177778
565	73	1	96	16.6667	11.4414	6.38036	0.00127654	0.0015449	0.0177778
566	92	1	0	16.6667	0	0	0	0	0
567	63	1	0	16.6667	0	0	0	0	0
568	153	1	828	16.6667	13.6815	11.183	0.0021899	0.0112128	0.153333
569	100	1	1131	16.6667	12.4932	8.00437	0.00321897	0.016763	0.209444
570	99	1	571	16.6667	12.4648	7.94234	0.00242062	0.0085073	0.105741
571	79	3	580	16.6667	11.7196	6.74087	0.000944017	0.00911861	0.107407
572	1000	1	0	13.8889	0	0	0	0	0
573	180	1	2677	16.6667	14.0499	12.8114	0.00469473	0.0353807	0.495741
574	2100	1	268	16.6667	16.4061	128.001	0.000309402	0.00306614	0.0496296
575	400	1	324	16.6667	15.384	26.001	0.000736133	0.0039	0.06
576	800	1	1013	16.6667	15.9991	50.003	0.000832458	0.0117579	0.187593
577	213	1	2359	16.6667	14.4035	14.788	0.00326186	0.0303669	0.436852
578	1600	1	0	16.6667	0	0	0	0	0
579	90	2	904	16.6667	12.1592	7.40179	0.00157259	0.0138333	0.167407
580	300	1	676	16.6667	14.9982	20.0024	0.00151467	0.00836975	0.125185
581	900	1	238	16.6667	16.0712	56.0007	0.000429126	0.0027428	0.0440741
582	160	1	47	16.6667	13.793	11.6001	0.0003214	0.00062963	0.0087037
583	105	2	1481	16.6667	12.6463	8.30281	0.0018332	0.0216931	0.274259
584	74	1	1012	16.6667	11.4827	6.44447	0.00399599	0.0162988	0.187407
585	272	2	111	16.6667	14.847	18.3202	0.000316579	0.00138957	0.0205556
586	2500	1	1	16.6667	16.4474	152	-nan	0.00001	0.000185185
587	2500	1	0	16.6667	0	0	0	0	0
588	2100	1	92	16.6667	16.4062	128	0.000164242	0.00104083	0.017037
589	1000	1	216	16.6667	16.1289	62.0006	0.000453972	0.00250426	0.04

590	1000	1	60	16.6667	16.129	62.0002	0.000192423	0.000689074	0.0111111
591	600	1	62	16.6667	15.7894	38.0002	0.00025745	0.000738889	0.0114815
592	1100	1	257	16.6667	16.1763	68.0007	0.000388047	0.00294815	0.0475926
593	600	1	33	16.6667	15.7894	38.0001	0.000164505	0.000394136	0.00611111
594	700	1	178	16.6667	15.9089	44.0005	0.000405673	0.00207196	0.032963
595	700	1	109	16.6667	15.909	44.0004	0.000368113	0.00126878	0.0201852
596	600	1	67	16.6667	15.7894	38.0001	0.000201323	0.00079321	0.0124074
597	1100	1	285	16.6667	16.1763	68.0009	0.000513823	0.00328064	0.0527778
598	600	1	36	16.6667	15.7894	38.0001	0.000203572	0.000422222	0.00666667
599	80	1	289	13.8889	10.3073	7.76149	0.00239167	0.00518287	0.0535185
600	80	1	285	13.8889	10.3075	7.76134	0.00225904	0.00513194	0.0527778
601	500	1	326	16.6667	15.6245	32.001	0.000667955	0.00387852	0.0603704
602	500	1	323	16.6667	15.6245	32.001	0.000776562	0.00384	0.0598148
603	220	1	326	16.6667	14.4727	15.2011	0.00103471	0.0041734	0.0603704
604	220	1	324	16.6667	14.4727	15.2011	0.00115086	0.00414562	0.06
605	300	1	129	16.6667	14.9997	20.0004	0.000639829	0.00159259	0.0238889
606	300	1	32	16.6667	14.9999	20.0001	0.000248773	0.000399383	0.00592593
607	250	1	30	16.6667	14.7059	17	0.000184047	0.000377778	0.00555556
608	250	1	21	16.6667	14.7058	17	0.000219978	0.000264444	0.00388889
609	250	1	29	16.6667	14.7059	17	0.000187193	0.000368148	0.00537037
610	250	1	21	16.6667	14.7058	17	0.000219978	0.000264444	0.00388889
611	1800	1	374	16.6667	16.3635	110.001	0.000509513	0.00423508	0.0692593
612	400	1	116	16.6667	15.3844	26.0004	0.000445698	0.00142361	0.0214815
613	450	1	538	16.6667	15.5163	29.0018	0.0010351	0.00642263	0.0996296
614	1800	1	235	16.6667	16.3635	110.001	0.000354645	0.00266893	0.0435185
615	450	1	628	16.6667	15.5162	29.002	0.00121324	0.00749959	0.116296
616	51	1	240	16.6667	10.0767	5.0612	0.00252249	0.00441903	0.0444444
617	400	1	74	16.6667	15.3845	26.0002	0.000413241	0.000890741	0.0137037
618	51	1	179	16.6667	10.0771	5.061	0.00212396	0.00329339	0.0331481
619	450	1	162	16.6667	15.5169	29.0006	0.00055812	0.00193333	0.03
620	450	1	148	16.6667	15.517	29.0005	0.000606983	0.00177366	0.0274074
621	950	1	159	16.6667	16.1016	59.0005	0.00039198	0.00185302	0.0294444
622	950	1	149	16.6667	16.1016	59.0005	0.0003818	0.00172359	0.0275926
623	99	1	395	16.6667	12.4663	7.9414	0.00181411	0.00587355	0.0731481
624	99	1	217	16.6667	12.4671	7.94089	0.00158276	0.00322858	0.0401852
625	2100	1	0	16.6667	0	0	0	0	0
626	1000	1	0	13.8889	0	0	0	0	0
627	700	1	545	16.6667	15.9085	44.0017	0.000817979	0.0063672	0.100926
628	550	1	1023	13.8889	13.2197	41.6045	0.00151397	0.0143572	0.189444
629	700	1	1065	16.6667	15.9079	44.0032	0.00106474	0.012432	0.197222
630	2000	1	45	16.6667	16.3934	122	0.000116546	0.000524722	0.00833333
631	87	1	564	16.6667	12.0461	7.22225	0.00243352	0.0086739	0.104444

632	2000	1	21	16.6667	16.3934	122	7.52995e-05	0.000237222	0.00388889
633	87	1	1109	16.6667	12.0425	7.22443	0.00364078	0.0170775	0.20537
634	300	1	591	16.6667	14.9985	20.002	0.0012586	0.0073179	0.109444
635	800	1	82	16.6667	15.9999	50.0002	0.000290994	0.000949074	0.0151852
636	1100	1	488	16.6667	16.1761	68.0015	0.000587198	0.00560101	0.0903704
637	1700	1	53	16.6667	16.3461	104	0.000145247	0.000600436	0.00981481
638	400	1	1106	16.6667	15.3827	26.0033	0.00141649	0.013319	0.204815
639	1100	1	77	16.6667	16.1764	68.0002	0.000218267	0.000881481	0.0142593
640	900	1	96	16.6667	16.0714	56.0002	0.000244608	0.00111132	0.0177778
641	1700	1	8	16.6667	16.3462	104	5.24092e-05	0.00009	0.00148148
642	900	1	172	16.6667	16.0713	56.0005	0.000423749	0.00198189	0.0318519
643	1200	1	82	16.6667	16.2162	74.0002	0.000180741	0.000954784	0.0151852
644	2100	1	18	16.6667	16.4062	128	7.3884e-05	0.000203175	0.00333333
645	600	1	133	16.6667	15.7893	38.0004	0.000390481	0.00155988	0.0246296
646	800	1	0	16.6667	0	0	0	0	0
647	600	1	0	16.6667	0	0	0	0	0
648	800	1	0	16.6667	0	0	0	0	0
649	700	1	13	16.6667	15.9091	44	9.98469e-05	0.000151323	0.00240741
650	700	1	32	16.6667	15.9091	44.0001	0.000169536	0.000382804	0.00592593
651	1200	1	41	16.6667	16.2162	74.0001	0.000161837	0.000474846	0.00759259
652	300	1	41	16.6667	15	20.0001	0.000221478	0.000506173	0.00759259
653	300	1	57	16.6667	14.9999	20.0002	0.000380245	0.000711728	0.0105556
654	1000	1	40	16.6667	16.129	62.0001	0.000158226	0.000464444	0.00740741
655	600	1	319	16.6667	15.7891	38.001	0.000681793	0.00375216	0.0590741
656	450	1	52	16.6667	15.5172	29.0002	0.000279161	0.000620576	0.00962963
657	450	1	0	16.6667	0	0	0	0	0
658	94	1	319	16.6667	12.3013	7.64149	0.00205666	0.0047695	0.0590741
659	94	1	52	16.6667	12.3034	7.64015	0.000631468	0.000782112	0.00962963
660	1000	1	6	16.6667	16.129	62	0	0.00007	0.00111111
661	1000	1	129	16.6667	16.1289	62.0003	0.000254343	0.00148111	0.0238889
662	800	1	77	16.6667	15.9999	50.0002	0.000258603	0.000902315	0.0142593
663	300	1	1076	16.6667	14.9975	20.0033	0.0016049	0.0132883	0.199259
664	1000	1	173	16.6667	16.1289	62.0005	0.000425696	0.00199111	0.032037
665	800	1	39	16.6667	16	50.0001	0.00016406	0.000451389	0.00722222
666	1700	1	63	16.6667	16.3461	104	0.000132357	0.000727451	0.0116667
667	1700	1	61	16.6667	16.3461	104	0.000132496	0.000691068	0.0112963
668	700	1	7	16.6667	15.9091	44	0	0.00008	0.0012963
669	700	1	140	16.6667	15.9089	44.0004	0.000440122	0.00163042	0.0259259
670	800	1	247	16.6667	15.9998	50.0007	0.000442807	0.00286597	0.0457407
671	90	1	1199	16.6667	12.1547	7.40454	0.00356944	0.0182819	0.222037
672	800	1	131	16.6667	15.9999	50.0003	0.000267687	0.00152269	0.0242593
673	600	1	770	16.6667	15.7884	38.0025	0.00108291	0.00905031	0.142593

674	800	1	5	16.6667	16	50	0	0.00005	0.000925926
675	600	1	1195	16.6667	15.788	38.0035	0.00109703	0.0140358	0.221296
676	900	1	50	16.6667	16.0714	56.0001	0.000189738	0.000576132	0.00925926
677	700	1	1298	16.6667	15.9077	44.0038	0.00126509	0.0151709	0.24037
678	1000	1	296	16.6667	16.1288	62.0009	0.000475452	0.00342519	0.0548148
679	700	1	923	16.6667	15.908	44.0029	0.00105088	0.0107677	0.170926
680	350	1	948	16.6667	15.2154	23.003	0.00145319	0.0115508	0.175556
681	1000	1	45	16.6667	16.129	62.0001	0.000157151	0.000516667	0.00833333
682	800	1	380	16.6667	15.9996	50.0011	0.00060416	0.00442755	0.0703704
683	1800	1	225	16.6667	16.3635	110.001	0.000295363	0.00255617	0.0416667
684	800	1	1271	16.6667	15.9988	50.0038	0.00117629	0.0147792	0.23537
685	800	1	364	16.6667	15.9996	50.0012	0.000660521	0.00421296	0.0674074
686	300	1	0	16.6667	0	0	0	0	0
687	1600	1	0	16.6667	0	0	0	0	0
688	1800	1	130	16.6667	16.3636	110	0.000215529	0.00148601	0.0240741
689	1200	1	0	16.6667	0	0	0	0	0
690	1200	1	82	16.6667	16.2162	74.0002	0.000217366	0.000941358	0.0151852
691	320	1	83	16.6667	15.0941	21.2003	0.000538845	0.0010191	0.0153704
692	320	1	62	16.6667	15.0942	21.2002	0.000412982	0.000758681	0.0114815
693	100	1	0	16.6667	0	0	0	0	0
694	125	2	1433	16.6667	13.1542	9.50264	0.00165949	0.0201719	0.26537
695	145	1	492	16.6667	13.5493	10.7017	0.00164051	0.00671264	0.0911111
696	50	1	0	16.6667	0	0	0	0	0
697	40	1	3	16.6667	9.09091	4.4	0	0.00006	0.000555556
698	95	1	0	16.6667	0	0	0	0	0
699	120	1	652	16.6667	13.04	9.20245	0.002298	0.00928086	0.120741
700	95	1	148	16.6667	12.3366	7.70066	0.00123349	0.00221248	0.0274074
701	80	1	251	8.33333	6.89461	11.6033	0.00462985	0.00674537	0.0464815
702	130	1	1366	8.33333	7.37878	17.6181	0.00844368	0.0343689	0.252963
703	105	1	601	16.6667	12.647	8.30235	0.00236378	0.00878836	0.111296
704	50	1	428	16.6667	9.99606	5.00197	0.00303344	0.00792593	0.0792593
705	125	1	173	16.6667	13.1569	9.50073	0.0012309	0.00242815	0.032037
706	40	1	993	16.6667	9.08028	4.40515	0.00580026	0.0203056	0.183889
707	140	1	820	16.6667	13.4577	10.403	0.00242033	0.0112989	0.151852
708	170	1	681	16.6667	13.9318	12.2023	0.00189141	0.00905773	0.126111
709	205	1	1485	16.6667	14.3306	14.3051	0.00246861	0.0192051	0.275
710	50	1	2317	16.6667	9.97746	5.01129	0.0075776	0.0430481	0.429074
711	240	1	31	16.6667	14.6341	16.4001	0.000315587	0.000392747	0.00574074
712	240	1	98	16.6667	14.6338	16.4003	0.00055601	0.00123457	0.0181481
713	78	1	2630	16.6667	11.6526	6.69379	0.00651076	0.0418281	0.487037
714	78	1	18	16.6667	11.6766	6.68	0	0.000287274	0.00333333
715	180	1	78	16.6667	14.0622	12.8003	0.000599515	0.00101955	0.0144444

716	75	1	2792	16.6667	11.5128	6.51448	0.00686003	0.0450346	0.517037
717	150	1	5	16.6667	13.6364	11	0	0.00007	0.000925926
718	62	1	311	16.6667	10.8361	5.72161	0.00276104	0.00528973	0.0575926
719	90	1	0	16.6667	0	0	0	0	0
720	95	1	311	16.6667	12.3355	7.70136	0.00204424	0.00467446	0.0575926
721	105	1	4	16.6667	12.6506	8.3	0	0.00005	0.000740741
722	35	1	127	16.6667	8.53505	4.10074	0.00219867	0.0027672	0.0235185
723	150	1	41	16.6667	13.6363	11.0001	0.000366451	0.00055679	0.00759259
724	50	1	91	16.6667	9.99911	5.00044	0.0016237	0.00168519	0.0168519
725	50	1	0	16.6667	0	0	0	0	0
726	30	1	29	16.6667	7.89474	3.8	0	0.000685185	0.00537037
727	30	1	0	16.6667	0	0	0	0	0
728	90	1	0	16.6667	0	0	0	0	0
729	195	2	194	8.33333	7.67683	25.4011	0.00109202	0.00467996	0.0359259
730	170	1	29	16.6667	13.9344	12.2001	0.000275306	0.000384532	0.00537037
731	50	1	0	8.33333	0	0	0	0	0
732	30	1	1484	16.6667	7.87598	3.80905	0.00861043	0.0349444	0.274815
733	30	1	0	16.6667	0	0	0	0	0
734	120	1	0	8.33333	0	0	0	0	0
735	150	1	0	16.6667	0	0	0	0	0
736	225	1	318	16.6667	14.5152	15.501	0.00104727	0.00406337	0.0588889
737	245	1	1155	16.6667	14.6673	16.7038	0.00202562	0.0145745	0.213889
738	120	1	0	8.33333	0	0	0	0	0
739	115	1	258	16.6667	12.9201	8.90085	0.00133467	0.00370048	0.0477778
740	65	1	1160	11.1111	8.2691	7.86059	0.00784533	0.025963	0.214815
741	95	1	1177	11.1111	8.99671	10.5594	0.00606224	0.0242437	0.217963
742	70	1	254	11.1111	8.43138	8.30232	0.00333487	0.00556614	0.047037
743	100	1	273	11.1111	9.08879	11.0026	0.0030576	0.00556852	0.0505556
744	45	1	526	11.1111	7.43158	6.05524	0.00672795	0.0130864	0.0974074
745	294	1	918	11.1111	10.3278	28.4668	0.00320153	0.0165029	0.17
746	162	1	62	11.1111	9.77052	16.5805	0.00104688	0.00117284	0.0114815
747	169	1	0	8.33333	0	0	0	0	0
748	161	1	7	16.6667	13.8079	11.66	0	0.00009	0.0012963
749	142	1	230	16.6667	13.4969	10.5209	0.00127163	0.00316771	0.0425926
750	161	1	96	16.6667	13.8074	11.6604	0.000850005	0.00128479	0.0177778
751	90	1	72	16.6667	12.1615	7.40039	0.000975627	0.00109053	0.0133333
752	169	1	4	11.1111	9.81987	17.21	0	0.00007	0.000740741
753	162	1	0	11.1111	0	0	0	0	0
754	21	1	62	11.1111	5.39724	3.89088	0.00393146	0.00210758	0.0114815
755	21	1	4	11.1111	5.39846	3.89	0	0.000141093	0.000740741
756	102	1	21	11.1111	9.12329	11.1802	0.000809016	0.000430283	0.00388889
757	149	1	84	11.1111	9.66861	15.4107	0.00132716	0.00161074	0.0155556

758	102	1	11	11.1111	9.12343	11.18	0	0.000225127	0.00203704
759	117	1	188	16.6667	12.97	9.02079	0.00127707	0.00268281	0.0348148
760	56	1	645	16.6667	10.4419	5.36301	0.00346303	0.0114683	0.119444
761	149	1	16	16.6667	13.6195	10.9402	0.00057779	0.000218742	0.00296296
762	117	1	2	16.6667	12.9712	9.02	0	0.00002	0.00037037
763	92	1	182	16.6667	12.2325	7.52096	0.0016236	0.00274758	0.0337037
764	272	1	1	16.6667	14.8472	18.32	-nan	0.00001	0.000185185
765	56	1	64	16.6667	10.4469	5.36042	0.0015493	0.00113095	0.0118519
766	99	1	691	16.6667	12.4642	7.94274	0.0025855	0.0102694	0.127963
767	213	1	9	16.6667	14.4112	14.7801	0.000394403	0.000117371	0.00166667
768	99	1	0	16.6667	0	0	0	0	0
769	448	1	489	16.6667	15.5116	28.8815	0.00100972	0.00585028	0.0905556
770	74	1	2356	16.6667	11.4726	6.45013	0.00607089	0.0380455	0.436296
771	207	1	1009	16.6667	14.3516	14.4234	0.00209373	0.0130515	0.186852
772	51	1	2378	16.6667	10.0563	5.07146	0.00752345	0.0438126	0.44037
773	51	1	2411	16.6667	10.0553	5.07193	0.00794775	0.0444154	0.446481
774	420	1	83	16.6667	15.441	27.2003	0.000389775	0.00100838	0.0153704
775	420	1	57	16.6667	15.4411	27.2002	0.000315763	0.000684744	0.0105556
776	87.5	1	83	16.6667	12.0683	7.25038	0.000982986	0.00128042	0.0153704
777	402.5	1	71	16.6667	15.3919	26.1502	0.000310206	0.000851162	0.0131481
778	385	1	638	16.6667	15.3374	25.1021	0.00124149	0.00771188	0.118148
779	385	1	57	16.6667	15.3385	25.1002	0.000339367	0.000686869	0.0105556
780	402.5	1	53	16.6667	15.3919	26.1502	0.000328357	0.000639061	0.00981481
781	87.5	1	55	16.6667	12.0686	7.25021	0.00075521	0.00085291	0.0101852
782	175	1	2	16.6667	14	12.5	0	0.00002	0.00037037
783	140	1	2	16.6667	13.4615	10.4	0	0.00002	0.00037037
784	140	1	12	16.6667	13.4615	10.4	0	0.000162698	0.00222222
785	87.5	1	560	16.6667	12.0651	7.25231	0.00259047	0.00862011	0.103704
786	297.5	1	569	16.6667	14.9859	19.852	0.0013843	0.00705135	0.10537
787	297.5	1	4	16.6667	14.9874	19.85	0	0.00005	0.000740741
788	87.5	1	2	16.6667	12.069	7.25	0	0.00002	0.00037037
789	1715	1	115	13.8889	13.6675	125.48	0.000254747	0.00159583	0.0212963
790	1715	1	34	13.8889	13.6675	125.48	0.00012862	0.000460425	0.0062963
791	35	1	136	13.8889	7.74194	4.52083	0.00255855	0.00324339	0.0251852
792	35	1	16	13.8889	7.74336	4.52	0	0.000391534	0.00296296
793	35	1	16	13.8889	7.74336	4.52	0	0.00037037	0.00296296
794	35	1	55	13.8889	7.74336	4.52	0	0.00132275	0.0101852
795	437.5	1	119	13.8889	13.0595	33.5005	0.000611799	0.0016927	0.022037
796	437.5	1	0	13.8889	0	0	0	0	0
797	700	1	0	13.8889	0	0	0	0	0
798	700	1	0	13.8889	0	0	0	0	0
799	2362.5	1	16	13.8889	13.7275	172.1	9.31122e-05	0.000215795	0.00296296

800	2362.5	1	55	13.8889	13.7275	172.1	0.000191879	0.000741917	0.0101852
801	472.5	1	16	16.6667	15.5684	30.35	0	0.00019126	0.00296296
802	472.5	1	35	16.6667	15.5683	30.3501	0.000172165	0.000415834	0.00648148
803	122.5	1	0	16.6667	0	0	0	0	0
804	297.5	2	801	16.6667	14.9864	19.8513	0.000808298	0.0098836	0.148333
805	122.5	1	20	16.6667	13.1016	9.35	0	0.000281179	0.0037037
806	542.5	2	764	16.6667	15.7013	34.5512	0.000579427	0.00903055	0.141481
807	420	2	763	16.6667	15.4405	27.2012	0.000671853	0.00914859	0.141296
808	420	1	557	16.6667	15.4402	27.2017	0.00105088	0.00670944	0.103148
809	542.5	1	535	16.6667	15.7011	34.5517	0.000889433	0.0063219	0.0990741
810	297.5	1	549	16.6667	14.986	19.8518	0.0012611	0.00679427	0.101667
811	700	1	168	13.8889	13.3586	52.4008	0.000602985	0.00233016	0.0311111
812	700	1	131	13.8889	13.3586	52.4006	0.000509298	0.00183519	0.0242593
813	297.5	2	432	25	21.4023	13.9003	0.000323871	0.00373669	0.08
814	122.5	2	600	25	17.7522	6.90055	0.000589641	0.00625397	0.111111
815	3185	2	906	25	24.6135	129.401	0.00016578	0.00684424	0.167778
816	3185	2	597	25	24.6135	129.4	0.00011734	0.00453329	0.110556
817	122.5	2	231	25	17.7531	6.90019	0.000345206	0.00242328	0.0427778
818	297.5	2	97	25	21.4028	13.9001	0.00012565	0.000837846	0.017963
819	1767.5	1	341	16.6667	16.358	108.051	0.000403682	0.00386809	0.0631481
820	1767.5	1	389	16.6667	16.358	108.051	0.000438548	0.0044127	0.072037
821	297.5	1	43	13.8889	12.7027	23.4203	0.000547563	0.000640523	0.00796296
822	1767.5	1	0	13.8889	0	0	0	0	0
823	2450	1	7	13.8889	13.7332	178.4	4.66516e-05	0.00009	0.0012963
824	2450	1	7	13.8889	13.7332	178.4	4.66516e-05	0.00009	0.0012963
825	1767.5	1	0	13.8889	0	0	0	0	0
826	297.5	1	128	13.8889	12.7026	23.4205	0.000698542	0.00186804	0.0237037
827	980	1	135	13.8889	13.506	72.5606	0.000374844	0.00185072	0.025
828	1785	1	128	13.8889	13.676	130.521	0.000282666	0.00173275	0.0237037
829	1785	1	43	13.8889	13.676	130.52	0.00018901	0.000582218	0.00796296
830	980	1	50	13.8889	13.506	72.5602	0.000268575	0.000685563	0.00925926
831	577.5	1	7	13.8889	13.2515	43.58	0	0.00009	0.0012963
832	577.5	1	7	13.8889	13.2515	43.58	0	0.00009	0.0012963
833	1067.5	1	409	16.6667	16.1617	66.0512	0.000515136	0.0047057	0.0757407
834	1732.5	1	227	16.6667	16.3519	105.951	0.000339222	0.00258222	0.042037
835	472.5	1	438	25	22.607	20.9006	0.000492231	0.00359005	0.0811111
836	665	1	440	25	23.2512	28.6006	0.00041699	0.00352158	0.0814815
837	665	1	711	25	23.251	28.6009	0.000472495	0.0056714	0.131667
838	472.5	1	699	25	22.6066	20.901	0.000596738	0.00575113	0.129444
839	1732.5	1	152	16.6667	16.352	105.95	0.000250631	0.00173427	0.0281481
840	1067.5	1	253	16.6667	16.1618	66.0508	0.000516253	0.00290155	0.0468519
841	1155	1	46	16.6667	16.1991	71.3001	0.000163962	0.000525573	0.00851852

842	1155	1	44	16.6667	16.1991	71.3001	0.000163618	0.000505211	0.00814815
843	2485	1	177	16.6667	16.446	151.101	0.00021438	0.00200775	0.0327778
844	2485	1	102	16.6667	16.446	151.1	0.000240671	0.0011486	0.0188889
845	60	1	2095	16.6667	10.6967	5.6092	0.00627779	0.036321	0.387963
846	80	1	292	16.6667	11.7625	6.80127	0.00199391	0.00459954	0.0540741
847	60	1	739	16.6667	10.7079	5.60335	0.00356076	0.0127284	0.136852
848	25	1	1466	16.6667	7.12232	3.51009	0.0103255	0.0381185	0.271481
849	25	1	1946	16.6667	7.11637	3.51303	0.0115966	0.0506667	0.36037
850	35	1	1438	16.6667	8.51906	4.10844	0.00805053	0.031381	0.266296
851	45	1	951	16.6667	9.56486	4.70472	0.00529018	0.0184239	0.176111
852	10	1	2052	16.6667	3.80459	2.6284	0.0303643	0.0997222	0.38
853	10	1	1336	16.6667	3.81818	2.61905	0.0239408	0.0642963	0.247407
854	10	1	232	16.6667	3.8421	2.60274	0.0088639	0.0109444	0.042963
855	10	1	907	16.6667	3.82959	2.61124	0.0178237	0.0438333	0.167963
856	10	1	725	16.6667	3.8323	2.6094	0.015203	0.0349815	0.134259
857	10	1	2034	16.6667	3.80598	2.62744	0.0287714	0.0987593	0.376667
858	10	1	1168	16.6667	3.82321	2.6156	0.0209368	0.0565	0.216296
859	10	1	278	16.6667	3.84052	2.60381	0.010156	0.0136852	0.0514815
860	10	1	1479	16.6667	3.818	2.61917	0.0231015	0.0717778	0.273889
861	10	1	441	16.6667	3.83854	2.60516	0.0112811	0.0212593	0.0816667
862	10	1	980	16.6667	3.8255	2.61403	0.0201184	0.0471296	0.181481
863	10	1	998	16.6667	3.82736	2.61277	0.0188827	0.0485741	0.184815
864	10	1	850	16.6667	3.83041	2.61069	0.0179138	0.0410741	0.157407
865	10	1	1488	16.6667	3.81788	2.61925	0.0224539	0.0722593	0.275556
866	30	1	1476	13.8889	7.19073	4.17204	0.0107971	0.0380062	0.273333
867	1000	3	46	16.6667	16.129	62.0001	8.28974e-05	0.000537593	0.00851852
868	1000	3	232	16.6667	16.129	62.0002	0.000148894	0.00266593	0.042963
869	1000	3	260	16.6667	16.129	62.0003	0.00015227	0.00302481	0.0481481
870	1000	3	50	16.6667	16.129	62.0001	8.13883e-05	0.000574074	0.00925926
871	1000	3	93	16.6667	16.129	62.0001	8.86434e-05	0.00106778	0.0172222
872	1000	3	1059	16.6667	16.1288	62.0011	0.000298391	0.0122133	0.196111
873	1000	3	165	16.6667	16.129	62.0002	0.000119859	0.00191778	0.0305556
874	1000	3	126	16.6667	16.129	62.0001	0.000113196	0.00146241	0.0233333
875	1000	3	754	16.6667	16.1288	62.0008	0.000263629	0.00869185	0.13963
876	1000	3	159	16.6667	16.129	62.0002	0.000115437	0.00183167	0.0294444
877	1000	3	766	16.6667	16.1288	62.0008	0.000276848	0.00884352	0.141852
878	1000	3	17	16.6667	16.129	62	2.78969e-05	0.000195185	0.00314815
879	1000	3	493	16.6667	16.1289	62.0005	0.000207751	0.00568759	0.0912963
880	1000	3	944	16.6667	16.1288	62.0009	0.000282435	0.0108967	0.174815
881	1000	3	104	16.6667	16.129	62.0001	8.11891e-05	0.00119407	0.0192593
882	1000	3	3	16.6667	16.129	62	0	0.00003	0.000555556
883	1000	3	17	16.6667	16.129	62	3.30081e-05	0.000195185	0.00314815

884	582.5	1	39	16.6667	15.7645	36.9501	0.00022921	0.000458115	0.00722222
885	582.5	1	103	16.6667	15.7644	36.9503	0.000323712	0.0012103	0.0190741
886	558	2	1117	19.4444	18.1768	30.6984	0.000554435	0.0114251	0.206852
887	44	1	60	16.6667	9.48198	4.64038	0.00144382	0.00115741	0.0111111
888	56	1	1057	19.4444	11.4665	4.88381	0.00396909	0.0170635	0.195741
889	12	1	93	13.8889	4.1875	2.86567	0.00641144	0.00405864	0.0172222
890	10	1	70	13.8889	3.67464	2.72135	0.00643933	0.00364815	0.012963
891	13	1	382	13.8889	4.42044	2.94088	0.0101253	0.0159402	0.0707407
892	32	1	263	13.8889	7.4317	4.30588	0.00405338	0.00652778	0.0487037
893	18	1	1727	13.8889	5.42965	3.31513	0.018203	0.0587243	0.319815
894	12	1	3374	13.8889	4.1156	2.91573	0.0398082	0.151698	0.624815
895	11	1	2006	13.8889	3.8951	2.82406	0.031118	0.0953872	0.371481
896	360	1	3	11.1111	10.4651	34.4	0	0.00006	0.000555556
897	11	1	990	13.8889	3.91854	2.80717	0.0202225	0.0470202	0.183333
898	10	1	1031	13.8889	3.65525	2.73579	0.0221216	0.0519444	0.190926
899	16	1	2942	13.8889	5.01793	3.18857	0.0272574	0.108391	0.544815
900	7	1	2931	13.8889	2.71026	2.58278	0.0759836	0.200503	0.542778
901	25	1	2036	13.8889	6.54763	3.81817	0.0143559	0.0576074	0.377037
902	6	1	1697	13.8889	2.4219	2.4774	0.0588405	0.129506	0.314259
903	5	1	1233	13.8889	2.08239	2.40109	0.0610242	0.109667	0.228333
904	15	1	29	13.8889	4.86901	3.08071	0.00381483	0.00107407	0.00537037
905	30	2	4623	13.8889	7.179	4.17885	0.00947357	0.119235	0.856111
906	20	1	103	13.8889	5.81195	3.44119	0.00410983	0.00325926	0.0190741
907	9	1	121	13.8889	3.39616	2.65005	0.00830771	0.00650206	0.0224074
908	430	2	195	16.6667	15.4675	27.8003	0.000276714	0.00233678	0.0361111
909	400	2	4605	16.6667	15.3803	26.0073	0.00159305	0.0555699	0.852778
910	370	1	1954	13.8889	12.9149	28.6491	0.00285959	0.0280626	0.361852
911	517.5	1	0	13.8889	0	0	0	0	0
912	517.5	1	2022	13.8889	13.1783	39.2691	0.00239948	0.0285264	0.374444
913	24	1	0	13.8889	0	0	0	0	0
914	24	1	0	13.8889	0	0	0	0	0
915	280	1	1809	13.8889	12.6305	22.1686	0.00304648	0.0265635	0.335
916	280	1	116	13.8889	12.6351	22.1605	0.000658799	0.00169709	0.0214815
917	752.5	1	327	13.8889	13.3941	56.1815	0.000768153	0.0045419	0.0605556
918	752.5	1	4	13.8889	13.3944	56.18	0	0.00005	0.000740741
919	14	1	1387	13.8889	4.6272	3.02559	0.0188676	0.0556349	0.256852
920	22	1	905	13.8889	6.12443	3.59217	0.0102206	0.0273316	0.167593
921	7	1	552	13.8889	2.78364	2.5147	0.0234672	0.0366667	0.102222
922	17	1	3994	13.8889	5.19789	3.27056	0.0299211	0.142549	0.73963
923	7	1	284	13.8889	2.78904	2.50982	0.0155591	0.0190741	0.0525926
924	23	1	2992	13.8889	6.24286	3.68421	0.0193379	0.088913	0.554074
925	16	1	2029	13.8889	5.03813	3.17578	0.0222776	0.0746412	0.375741

926	22	1	1267	13.8889	6.11821	3.59582	0.0122697	0.0382912	0.23463
927	6	1	2958	13.8889	2.36926	2.53244	0.117141	0.231543	0.547778
928	82	1	15	11.1111	8.74172	9.38031	0.00119098	0.000325203	0.00277778
929	360	1	15	11.1111	10.4651	34.4001	0.000271118	0.000265432	0.00277778
930	392	2	4722	16.6667	15.356	25.5274	0.00169634	0.0570356	0.874444
931	466	2	1315	16.6667	15.553	29.962	0.000784222	0.0156807	0.243519
932	22	1	3	8.33333	4.74138	4.64	0	0.000117845	0.000555556
933	60	1	3	8.33333	6.52174	9.2	0	0.00008	0.000555556
934	86	2	4738	13.8889	10.4813	8.20511	0.00490862	0.0838286	0.877407
935	20	2	4736	13.8889	5.77341	3.46416	0.0137065	0.152093	0.877037
936	25	1	708	13.8889	6.568	3.80634	0.00893545	0.0200741	0.131111
937	12	1	1300	13.8889	4.16374	2.88203	0.0231328	0.0577778	0.240741
938	172	1	74	13.8889	11.9574	14.3844	0.000957057	0.00115418	0.0137037
939	210	1	815	19.4444	16.4035	12.8021	0.00152558	0.00921164	0.150926
940	146	2	871	13.8889	11.6669	12.5141	0.00147912	0.0138318	0.161296
941	36	1	504	13.8889	7.83387	4.59543	0.00510118	0.0117901	0.0933333
942	12	1	2570	13.8889	4.13435	2.90251	0.0338997	0.115648	0.475926
943	6	1	3197	13.8889	2.36372	2.53837	0.107602	0.249938	0.592037
944	28	2	5267	13.8889	6.93365	4.03828	0.0113557	0.140754	0.97537
945	15	1	762	13.8889	4.85484	3.0897	0.0148581	0.0290494	0.141111
946	8	1	1837	13.8889	3.05866	2.61552	0.0442481	0.112361	0.340185
947	60	1	29	13.8889	9.49341	6.32017	0.000936998	0.000564815	0.00537037
948	1700	1	97	13.8889	13.6655	124.4	0.000294006	0.0013183	0.017963
949	87.5	1	29	13.8889	10.542	8.30012	0.000642115	0.00050582	0.00537037
950	87.5	1	276	13.8889	10.5403	8.30148	0.00220321	0.00484233	0.0511111
951	132	1	222	13.8889	11.4732	11.5051	0.00155289	0.00359007	0.0411111
952	216	1	0	13.8889	0	0	0	0	0
953	60	1	153	13.8889	9.49233	6.32089	0.00217575	0.00298765	0.0283333
954	3150	1	25	13.8889	13.7675	228.8	7.29011e-05	0.000336273	0.00462963
955	3150	1	5	13.8889	13.7675	228.8	4.29325e-05	0.00006	0.000925926
956	105	1	6	13.8889	10.9833	9.56	0	0.000102293	0.00111111
957	105	1	273	13.8889	10.9817	9.56136	0.00188238	0.0046261	0.0505556
958	16	1	2339	13.8889	5.03281	3.17914	0.0234975	0.0858912	0.433148
959	280	1	1	13.8889	12.6354	22.16	-nan	0.00001	0.000185185
960	10	1	4718	13.8889	3.56223	2.80723	0.0589098	0.244981	0.873704
961	16	1	2574	13.8889	5.02813	3.1821	0.0242779	0.0947338	0.476667
962	12	1	2077	13.8889	4.14651	2.894	0.0279911	0.0924383	0.38463
963	14	1	693	13.8889	4.64069	3.01679	0.0160181	0.0276455	0.128333
964	36	1	2300	13.8889	7.81151	4.60858	0.0113837	0.0543776	0.425926
965	10	1	5492	13.8889	3.53949	2.82527	0.067712	0.287944	1.01704
966	7	1	1579	13.8889	2.75682	2.53915	0.0417531	0.10672	0.292407
967	10	1	5747	13.8889	3.53128	2.83183	0.0709117	0.300481	1.06426

968	6	1	2394	13.8889	2.39812	2.50196	0.0770884	0.185463	0.443333
969	18	1	3351	13.8889	5.40032	3.33314	0.0255592	0.115319	0.620556
970	8	1	2865	13.8889	3.03128	2.63915	0.0575381	0.174005	0.530556
971	26	1	2561	13.8889	6.67621	3.89443	0.0159486	0.0709829	0.474259
972	110	1	1026	13.8889	11.0825	9.92559	0.00401643	0.0171566	0.19
973	170	1	118	13.8889	11.9377	14.2406	0.00103157	0.00182898	0.0218519
974	595	1	272	13.8889	13.2691	44.8412	0.000711308	0.00380237	0.0503704
975	595	1	5	13.8889	13.2694	44.84	0	0.00007	0.000925926
976	35	1	1073	13.8889	7.72943	4.52815	0.0083042	0.0256455	0.198704
977	740	1	1133	13.8889	13.3852	55.2851	0.00164673	0.0157593	0.209815
978	562	1	772	13.8889	13.2337	42.4675	0.00145885	0.0108412	0.142963
979	562	1	1075	13.8889	13.2333	42.4686	0.0015724	0.0150636	0.199074
980	5	1	1561	13.8889	2.06705	2.4189	0.0891999	0.14137	0.289074
981	140	1	3096	16.6667	13.4471	10.4112	0.00459369	0.0426548	0.573333
982	140	1	3183	16.6667	13.4466	10.4116	0.00495698	0.0438095	0.589444
983	18	1	4576	11.1111	4.87662	3.69108	0.041983	0.173549	0.847407
984	18	1	2869	11.1111	4.91244	3.66417	0.0318482	0.108621	0.531296
985	18	1	4487	11.1111	4.87827	3.68983	0.0406948	0.170545	0.830926
986	250	1	2442	16.6667	14.6989	17.0081	0.00291947	0.0307933	0.452222
987	250	1	2296	16.6667	14.6994	17.0074	0.00281179	0.0289622	0.425185
988	175	1	562	16.6667	13.9977	12.502	0.00176074	0.00745503	0.104074
989	18	1	3433	11.1111	4.90002	3.67346	0.0363556	0.1293	0.635741
990	1015	1	1859	16.6667	16.1353	62.9055	0.00121767	0.0214612	0.344259
991	10	1	1647	16.6667	3.81298	2.62262	0.0256421	0.080537	0.305
992	10	1	1649	16.6667	3.81293	2.62265	0.0254612	0.080463	0.30537
993	21	1	2405	11.1111	5.35263	3.9233	0.0247578	0.0830952	0.44537
994	17	1	2436	11.1111	4.76303	3.56915	0.0317388	0.0947386	0.451111
995	17	1	2407	11.1111	4.76418	3.56829	0.0301895	0.0932462	0.445741
996	43.75	1	1028	11.1111	7.356	5.94752	0.00911207	0.0259005	0.19037
997	10	1	1336	11.1111	3.41378	2.92931	0.0346365	0.0723519	0.247407
998	10	1	2325	11.1111	3.38328	2.95571	0.0511278	0.127056	0.430556
999	105	1	2194	11.1111	9.15596	11.4679	0.00876093	0.0444303	0.406296
1000	10	1	1727	11.1111	3.40255	2.93897	0.0409134	0.0937963	0.319815
1001	10	1	1242	11.1111	3.41616	2.92726	0.0332245	0.0673148	0.23
1002	35	1	842	11.1111	6.78443	5.15887	0.0100033	0.0230317	0.155926
1003	10	1	1968	11.1111	3.3933	2.94698	0.0477337	0.107519	0.364444
1004	90	2	1335	11.1111	8.90618	10.1053	0.00329256	0.0278045	0.247222
1005	30	2	2328	11.1111	6.36408	4.71396	0.00956389	0.0677654	0.431111
1006	35.75	2	1818	11.1111	6.83922	5.2272	0.00707437	0.0492152	0.336667
1007	10	1	1458	11.1111	3.40982	2.9327	0.0360713	0.079537	0.27
1008	25	2	2027	11.1111	5.86466	4.26282	0.010001	0.0640741	0.37537
1009	25	2	1323	11.1111	5.8711	4.25815	0.0080508	0.0417185	0.245

1010	25	2	2177	11.1111	5.86413	4.26321	0.0101589	0.0688889	0.403148
1011	17	1	515	11.1111	4.80556	3.53757	0.0130617	0.0199891	0.0953704
1012	17	1	405	11.1111	4.80788	3.53586	0.0109194	0.0156645	0.075
1013	17	1	849	11.1111	4.79936	3.54214	0.0170066	0.032963	0.157222
1014	17	1	701	11.1111	4.80202	3.54017	0.0152885	0.0268845	0.129815
1015	10	1	747	11.1111	3.42862	2.91663	0.0251426	0.0403704	0.138333
1016	15	1	647	11.1111	4.46376	3.36039	0.0162538	0.0271852	0.119815
1017	10	1	415	11.1111	3.43735	2.90922	0.0191777	0.0221296	0.0768519
1018	10	1	261	11.1111	3.44198	2.90531	0.0139839	0.0140185	0.0483333
1019	10	1	498	11.1111	3.43661	2.90984	0.0196759	0.0268889	0.0922222
1020	15	1	410	11.1111	4.46956	3.35603	0.0122298	0.0169383	0.0759259
1021	10	1	271	11.1111	3.44204	2.90525	0.0139127	0.014537	0.0501852
1022	15	1	438	11.1111	4.4697	3.35593	0.0114093	0.0181481	0.0811111
1023	10	1	242	11.1111	3.44128	2.9059	0.0151096	0.013	0.0448148
1024	10	1	192	11.1111	3.44437	2.90329	0.0109339	0.0102778	0.0355556
1025	15	1	980	11.1111	4.45512	3.36692	0.0216031	0.040642	0.181481
1026	10	1	734	11.1111	3.42796	2.91719	0.0273623	0.0393889	0.135926
1027	262.5	1	0	16.6667	0	0	0	0	0
1028	262.5	1	0	16.6667	0	0	0	0	0
1029	20	1	772	11.1111	5.24866	3.8105	0.01403	0.0272778	0.142963
1030	6	1	1163	11.1111	2.3189	2.58743	0.0694833	0.0931481	0.21537
1031	17	1	1162	11.1111	4.79008	3.549	0.0206711	0.044902	0.215185
1032	7	1	191	11.1111	2.65816	2.6334	0.0137959	0.0132011	0.0353704
1033	30	1	703	11.1111	6.37162	4.70838	0.0101975	0.0204383	0.130185
1034	15	1	1631	11.1111	4.44078	3.37779	0.0269694	0.0679012	0.302037
1035	15	1	1673	11.1111	4.4398	3.37853	0.027016	0.0701111	0.309815
1036	15	1	726	11.1111	4.46068	3.36272	0.0185582	0.030284	0.134444
1037	15	1	722	11.1111	4.4611	3.3624	0.0186665	0.0297407	0.133704
1038	30	1	1656	11.1111	6.35679	4.71937	0.0160528	0.048321	0.306667
1039	23	1	1108	11.1111	5.63104	4.0845	0.0158429	0.0364251	0.205185
1040	23	1	5841	11.1111	5.52406	4.1636	0.0457478	0.196103	1.08167
1041	23	1	5654	11.1111	5.52772	4.16085	0.0433581	0.189187	1.04704
1042	23	1	705	11.1111	5.63842	4.07916	0.0122114	0.023132	0.130556
1043	20	1	77	16.6667	6.24741	3.20133	0.00444256	0.00228704	0.0142593
1044	20	1	1108	16.6667	6.23422	3.2081	0.00970429	0.0328241	0.205185
1045	20	1	2890	11.1111	5.20689	3.84106	0.0285549	0.102944	0.535185
1046	20	1	1856	11.1111	5.22666	3.82653	0.0232386	0.0657963	0.343704
1047	20	1	1219	11.1111	5.2392	3.81737	0.0185896	0.0429537	0.225741
1048	20	1	891	11.1111	5.24647	3.81209	0.0154195	0.0316204	0.165
1049	20	1	1536	11.1111	5.23417	3.82105	0.0202283	0.054287	0.284444
1050	10	1	0	11.1111	0	0	0	0	0
1051	1000	3	0	16.6667	0	0	0	0	0

1052	1000	3	0	16.6667	0	0	0	0	0
1053	1000	3	0	16.6667	0	0	0	0	0
1054	1000	3	0	16.6667	0	0	0	0	0
1055	50	1	0	13.8889	0	0	0	0	0
1056	50	1	0	13.8889	0	0	0	0	0
1057	100	1	0	13.8889	0	0	0	0	0
1058	100	1	0	13.8889	0	0	0	0	0
1059	100	1	0	13.8889	0	0	0	0	0
1060	100	1	0	13.8889	0	0	0	0	0
1061	110	2	3	13.8889	11.0887	9.92	0	0.00005	0.000555556
1062	17	1	1435	11.1111	4.78485	3.55288	0.0223291	0.0555338	0.265741
1063	34	1	780	11.1111	6.70757	5.0689	0.0104576	0.0215577	0.144444
1064	17	1	736	11.1111	4.80105	3.54089	0.0154028	0.0286601	0.136296
1065	10	1	386	13.8889	3.66935	2.72528	0.0132129	0.0193889	0.0714815
1066	10	1	1331	13.8889	3.64542	2.74317	0.0293589	0.0673704	0.246481
1067	10	1	2305	13.8889	3.62153	2.76126	0.0385218	0.118074	0.426852
1068	10	1	779	13.8889	3.65977	2.73241	0.0202251	0.039463	0.144259
1069	10	1	507	13.8889	3.6652	2.72836	0.0160419	0.0257407	0.0938889
1070	10	1	1086	13.8889	3.65226	2.73803	0.0235827	0.0549074	0.201111
1071	14	1	1811	11.1111	4.25108	3.29328	0.0319459	0.0790079	0.33537
1072	14	1	866	11.1111	4.27513	3.27476	0.0202106	0.0374074	0.16037
1073	30	1	2391	11.1111	6.34454	4.72848	0.0188592	0.0697593	0.442778
1074	17	1	2316	11.1111	4.76713	3.56609	0.0294339	0.0903595	0.428889
1075	22	1	2104	11.1111	5.48879	4.00817	0.0225297	0.0710101	0.38963
1076	22	1	2042	11.1111	5.49032	4.00705	0.0219065	0.0688889	0.378148
1077	11	1	1526	11.1111	3.63855	3.02318	0.0352693	0.0776599	0.282593
1078	10	1	1988	13.8889	3.63291	2.75261	0.0324665	0.100981	0.368148
1079	10	1	2465	13.8889	3.61886	2.7633	0.0414924	0.126481	0.456481
1080	10	1	1724	13.8889	3.6384	2.74846	0.029664	0.0877963	0.319259
1081	10	1	2682	13.8889	3.6118	2.7687	0.0441926	0.137963	0.496667
1082	10	1	2029	13.8889	3.62984	2.75494	0.0357097	0.103685	0.375741
1083	10	1	508	13.8889	3.66616	2.72765	0.0153998	0.0257963	0.0940741
1084	10	1	1236	13.8889	3.64997	2.73975	0.0251054	0.0623704	0.228889
1085	10	1	1325	13.8889	3.64871	2.74069	0.0248726	0.0673148	0.24537
1086	14	1	2026	11.1111	4.24759	3.29599	0.0318431	0.0883333	0.375185
1087	20	1	2766	11.1111	5.20853	3.83986	0.0286827	0.0983426	0.512222
1088	20	1	3419	11.1111	5.19504	3.84983	0.0320431	0.12163	0.633148
1089	10	1	2690	11.1111	3.37509	2.96288	0.0530925	0.147648	0.498148
1090	374	1	21	13.8889	12.9285	28.9283	0.000540987	0.000301545	0.00388889