Block book Bachelor (Year 2)

Project 2-2

Intelligent Traffic Control

Period 2.4, 2.5, and 2.6
05-02-2018 / 29-06-2018
Academic year 2017-2018
Data Science and Knowledge Engineering
Faculty of Humanities and Sciences
University Maastricht

Courses

Human-Computer Interaction (KEN2410)
Theoretical Computer Science (KEN2420
Mathematical Modeling (KEN2430)
Social Media (KEN2510)
Linear Programming (KEN2520)
Mathematical Simulation (KEN2530)

Project 2-2

The central topic of project 2-2 is intelligent traffic control. Next to designing and implementing a traffic simulator, the program should also allow the incorporation of various strategies to for instance reduce traffic jams and to have parameters that allow defining the traffic density at a specific road or crossroad.

1 Project description

Historical inner-cities, like the city of Maastricht, face a serious traffic problem. The traffic density leads to delays due to traffic jams. One way to cope with the economic and environmental consequences consists of the use of *intelligent traffic control*. In this project you will implement a traffic simulator, with graphical user interface, allowing simulating traffic for any city or traffic situation a user would like to design or experiment with. Therefore, your simulator should allow building any pattern of roads a user would like to test and save this information to a file in a smart way (e.g. using XML). Figures 1 and 2 provide, as an example, two different views of a visualization of a traffic model and its simulation.

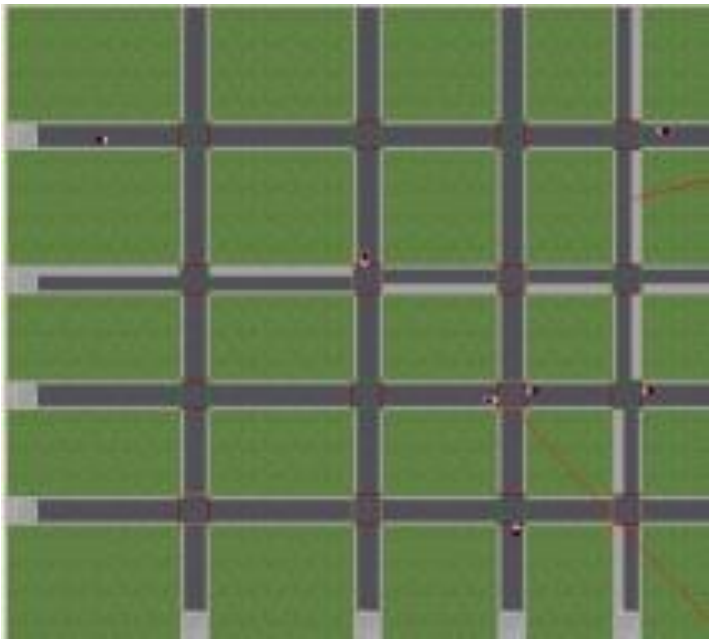

Figure 1: A general view of a traffic model.

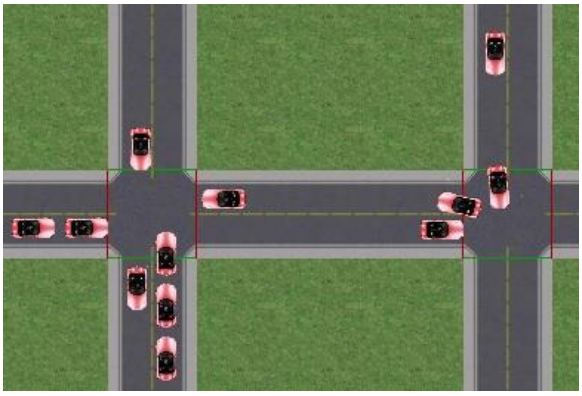

Figure 2: Zooming in on specific crossroads

As a case of particular interest, consider the scenario in Maastricht where the upper two tunnels are closed (in case the lower two are closed the traffic is simply send to the upper two, hence that is not very interesting). In that case, local traffic has to reroute through

the quarters Scharn, Wittevrouweveld and possibly Wyckerpoort. Here the roads will get congested.

Next to designing and implementing the simulator, your program should also allow the incorporation of various strategies to for instance reduce traffic jams and to have parameters that allow defining the traffic density at a specific road or crossroad. Such strategies might, for example, consist of: optimization to maximize the number of vehicles entering the system (using linear programming or integer linear programming), automatic traffic light control (using machine learning), changing intersections to roundabouts vice versa, heuristics (e.g. green wave), or plug in or delete traffic or flow control lights.
Additionally, you will develop user interfaces so that you can see the effects of certain predefined parameters or strategies (e.g. speed control, traffic density etc.) on the traffic flow. Have a look at the use of different machine learning techniques within this context. The assumption is made that drivers have a predetermined destination and are aware of the street plan, i.e. they know alternative roads when faced with congestion and might reroute depending on their personal preference.

Phase 1

In the first phase (period 2.4), literature research is performed on modeling and simulation approaches. Attempt to include enough dynamics in your model such that congestion etc. occurs. Furthermore, (preferably) realistic data of the traffic density or flow is collected. Given a certain street plan, and a list of departure times, points of origin and destinations of drivers, algorithms are designed that determine (dynamically) how to control the traffic and simulate how late each driver arrives. The output may contain measures such as the traveled distance and the amount of time that drivers have been waiting etc. At the end of phase 1 there should be at minimum a simple simulation environment, demonstrated by the case of special interest in a live demo, where only little to no dynamics and static control (e.g. a traffic light that cycles) are needed. Also, a draft introduction and literature review for the final report is delivered. Obviously, you are most welcome to do more. An overview needs to be provided of which group member contributed to what and to which extend.

Phase 2

In the second phase (period 2.5), the deliverables are at minimum: a fully operational simulation model with dynamics is defined and implemented including GUI. Next, a first traffic control strategy is defined and implemented and the simulation environment is validated. Furthermore, the draft introduction is updated. Once again, you are most welcome to do more. How interesting the simulation is, depends partly on the traffic setting. Think about flat roundabouts, flat intersections, highways, traffic lights etc. An overview should be provided of which group member contributed to what and to which extend.

Phase 3

During the project weeks, you further develop and implement the automatic traffic strategies. Try to incorporate (integer) linear programming to compute optimum traffic strategies (with respect to your goals), or to compute maximum flow of cars that can enter the system. Use the LP solver GUROBI. The collected data has to be used for validation purposes. You will run simulations to determine the relative performance of the strategies implemented and will use statistics to show which one is better (for a given scenario). Furthermore, a sensitivity analysis should be included, i.e., how robust are the predictions with respect to (small) changes in the input data and the parameters of the simulation. Instead of the standard project report, the results will be described in a scientific-article-like manner. An overview should be provided of which group member contributed to what and to which extend.

2 Reporting

The research will be described as a scientific article, and must contain:

- Abstract
- Introduction
  where problem is explained, the research in this report is placed in the existing literature and in terms of the state of the art, requiring a literature study. Furthermore, a problem statement is formulated and research questions are posed. Here you also sketch the structure of the report.
- Methods
  Here you describe your approach. If needed this can be spread over multiple sections.
- Experiments
  Describing what you want to find out and how and why you have designed your experiments
- Results
  A “dry“ exposé of the results of your experiments, including proper statistical analysis
- Discussion
  Here you interpret the results of your experiments and place them in terms of what is known from the literature.
- Conclusions
  You draw your conclusions from your research and answer your research questions
- References
  In your report you should always cite if you are using ideas, methodologies or software from others.

The article should be written in LaTeX, have a font size of 11 points and has a page limit of ten pages excluding appendices. The format should match the requirements for IEEE transactions http://ieeeauthorcenter.ieee.org/create-your-ieee-article/use-authoring-tools-and-ieee-article-templates/ieee-article-templates/templates-for-transactions/. Ensure that you have a uniform style of writing.

Examiners: Joël Karel, Matúš Mihálak

3 Project phases

The project assignment in block 2.4 is preparatory for project 2-2 which takes place in the sixth block.

In project work some stages can be discerned:
- the first weeks are meant for interpretation of the project assignment, looking for information and literature on the subject, making choices, formulating problem definitions and goals and making a work plan.
- in the next stage the problem definitions will be elaborated.
- in the completion of phase 1 each group will present her ideas, findings and possible results in an interim presentation. This interim presentation takes 20 minutes and is held per group. During the first 15 minutes, the lecturers and possible external clients are being informed about the results thus far. The last 5 minutes can be used to ask content related questions to the lecturers and vice versa. In this meeting, the examiners can correct the group if necessary. Each group also has to hand in a project plan. Minutes have to be taken of this meeting.

The interim presentations will be given on **Thursday March 29**. A schedule will be announced.

During the first 3 weeks of block 2.6 the students work full-time on the project. **Tuesday June 26 at 14:00** each group hands in four copies of the **scientific article** at the Education Office (Tapijn). At the same time, the source code is handed in on DVD or USB. The product, the report as well as the sheets of the presentation have to be placed on the productserver: (\\unimaas.nl\education\FHS_DKE). Finally, on **Wednesday June 27** a presentation of 20 minutes is given by each group. The audience consists of fellow students, the examiners, and the tutor. A time schedule, as well as location, will be announced.

4 Project presentation

March 29 each project group separately, will give an interim presentation. This presentation takes at the most 15 minutes. The public will consist of lecturers.
June 27 each group gives a presentation of at most 20 minutes. The audience consists of lecturers and fellow students. A time schedule as well as location will be announced.

5 Project assessment

The project period 1 will be concluded with a presentation of the results thus far. For the students this presentation means feedback on their interpretation of the project assignment, their conclusions and their planning for the next period. For the lecturers the presentations of period 1 enable them to judge if more information and tutoring is needed. At the end of period 3 the final presentation will take place in which the students communicate what their results and conclusions on the project assignment are. The presentations of the first and second phase and the final presentation have different weights in the total assessment of the block according to 1 : 1 : 4.

The final project result will be a group result unless decided otherwise by the examiners. When a student has not participated enough, the examiner can decide to give him or her an additional assignment. The examiner can, in individual cases, decide to deviate from the group result in a positive or negative direction.
Plagiarism is not allowed. If plagiarism is observed, sanctions will follow.
Students are allowed to be absent at 1 Project skills training per block. If more sessions are missed the project mark is decreased by 0.5 per block.

6 Project coordination

The examiners of project 2-2 are Joël Karel and Matúš Mihálak. Jan Paredis (j.paredis@maastrichtuniversity.nl) is coordinating the project and tutoring the groups. Every week he will have a meeting with each project group.
For questions and remarks regarding the computers you can mail to:
lo-fhs@ maastrichtuniversity.nl .

7 Courses

Human-Computer Interaction
Human-computer interaction (HCI) is the study of the interaction between people (users) and computers. It is often regarded as the intersection of computer science, behavioural sciences, design and several other fields of study. Interaction between users and computers occur at the user interface (or simply interface), which includes both software and hardware; for example, characters or objects displayed by software on a personal computer's monitor, input received from users via hardware peripherals such as keyboards and mice, and other user interactions with large-scale computerized systems such as aircraft and power plants

Theoretical Computer Science
This course explores the theoretical underpinnings of computingby investigating algorithms and programs casted as language recognition problems The influence of the theory on modern hardware and software design is demonstrated. The following subjects will be presented: mathematical foundations, alphabets and languages, finite automata and regular languages, Turing machines, languages and machines, acceptance and decidability, primitive and partial recursive functions, complexity, time complexity classes, NPproblems, NP-completeness.

Mathematical Modeling
Mathematical modelling is of great importance for solving practical problems by casting them into a form suitable for the use of mathematical techniques. In this course, a number of basic topics are discussed. First, attention is paid to a general methodology by means of the model cycle, which offers a systematic framework for mathematical modelling. Then we focus on some widely used model classes from engineering, in particular on the class of linear time-invariant dynamical models. These are described by linear difference equations (in discrete time) or linear differential equations (in continuous time). Alternative model descriptions that are discussed are transfer functions (in the frequency domain) obtained with the z-transform and the Laplace transform respectively; and state-space models, which may or may not involve canonical forms. Some further topics receiving attention are the concepts of stability, controllability and observability, Bode diagrams, the interconnection of subsystems, and the technique of pole placement by means of state feedback.
The subject matter is clarified through exercises and examples involving practical applications. Also, the software package Matlab and the control system toolbox are introduced, which offers a powerful instrument for analyzing linear dynamic models.

Project Skills 2.4
The subject of the training Interviewing is to formulate a goal for an interview. The students learn to transform this goal into different questions and to structure these questions into an interview in order to collect ideas or elicit knowledge. Different types of questions and interviews will be discussed and practised. The student will also reflect on nonverbal aspects of the interview situation. If possible, external clients will be interviewed and the information will be used for the project 2-2.

Social Media
With the development and popularization of digital technologies, various scholars started investigating how users interact with these media and how they become part of contemporary cultures. The course introduces core concepts and theories that have been suggested in social sciences, cultural and media studies in order to analyze the interactions between producers, users, and digital technologies. It will particularly focus on those technologies that have been labeled as 'social media'.
Starting from this umbrella term, students will discuss how new technologies have been praised as tools for user empowerment on the one hand, and criticized as means of exploitation (free labor), control and surveillance on the other hand. The course will focus on academic literature that emphasizes the role of users in digital environments.

The tutorials link back to the course Human Computer Interaction and Social Media: students will evaluate how interfaces chosen for social media may act as tools for participation, but may also define and limit user practices. Today, most Western societies face divided discourses about social media: they are presented as perfect tools to stay connected, as platform for sharing images, videos and music, and as a way to openly express (personal) thoughts, opinions, and ideas.
Likewise, social media are constructed as potential danger for our privacy and as instruments used for surveillance. These viewpoints are reflected in debates in newspapers, magazines, TV series (as for example the 1st episode of Black Mirror) or in fictional texts (e.g. Dave Egger's novel The Circle). Research from social sciences, media
and cultural studies discusses social media from similar points of view. Even though academic publications about social media are much more differentiated and do not only envision a black and-white scenario, we can discover a few similarities when comparing these discourses. Scholars point out social media's liberating potential to engage users and to offer new platforms for participation; at the same time, rather critical approaches question the exploitation of users as free labor, the control of users and their surveillance via governments, national security agencies or companies' marketing departments. In this course, students will investigate issues negotiated in these academic debates, form more nuanced opinions about social media and will learn to engage in related discussions.

Linear Programming

This course deals with one specific mathematical model: the linear programming model. This model has a wide range of practical applications, and is of interest to practitioners in operations research, statistics, economics, management and psychology. This, and the fact that good algorithms can solve huge linear programs, is reason for the considerable succes of this model. The theory of the course treats the simplex algorithm, duality theory, and sensitivity analysis. Many examples from practice illustrate the power of the model and teach the student the skill of modelling.

Mathematical Simulation

The area of mathematical simulation is concerned with studying processes and systems. Uncertainty can be an important factor and has to be modeled properly. After modeling a complex system, various scenarios can be simulated to gain insight. The results need to be properly interpreted and uncertainty has to be reduced. The modeling, implementation, analysis and technical aspects will be discussed as an introduction in this field. Emphasis will will be on discrete event simulation.

Project Skills 2.5

The subject of the project skills training is Argumentation and Rhetoric. Several topics will be highlighted like logistics, argumentation for example critical reasoning and genres. The aims of logistics are to learn different techniques in building arguments, to identify applications across different genres, to write examples and to expand writing abilities. Furthermore, students learn to discover different types of argumentation and to review literature by several methods.

Appendices

Appendix A Project Evaluation Assessment Form

Date:	Project: 2-2
Student:	ID-number:
Project coordinator: J. Paredis	Number of the group:
Evaluator: J. Karel	Evaluator:
Evaluator: M. Mihalak	
Evaluator:	

Assessment Product	factor x mark	Score
Form	1 x	
Contents	2 x	
Product mark		A =

Assessment Report	factor x mark	Score
Form	1 x	
Contents	2 x	
mark		B =

Assessment Presentation	factor x mark	Score
Form	1 x	
Contents	2 x	
Presentation mark		C =

GROUP MARK 2.6	(2A + 2B + C)/5	
FINAL MARK 2-2	(2.4 + 2.5 + 4x2.6)/6	

Attendance P-meetings	Sufficient?	Yes / No

Individual mark	
Signature Examiner: Date:	

Appendix B Criteria for assessing projects

Product

form

well-structured, clarity, easy to read
user-friendly, easy input of data and parameters, good use of graphical possibilities, help facility, robustness (e.g. against deficient input)
manual, demo and/or other documentation

contents

functionality (has the solution been found?), efficiency (computational time needed)
range of applicability of the method(s) used
originality

form

cover, title page, table of contents, preface
abstract
list of figures, list of abbreviations and symbols
problem description
structure of chapters and paragraphs, use of (sub) titles
introduction, conclusion
lay-out and spelling
references

contents

abstract
introduction, problem description, structure
relevancy and complete reference of sources
background, history and importance of the problem
theoretical basis of the method, explanation of the theory used, description of alternative approaches, motivation for the chosen approach
program design
work plan
system validation, description of the test situation, test results, conclusions of the tests, final conclusions
overview of operational costs
adequate use of figures, tables, correct and adequate use of mathematics
explain abstract issues using simple illustrative examples
coherence of the arguments, well-written for the target audience

Presentation

form

introduction, title, names of project members, announcement of the structure of the presentation
contact with the public, audibility, attitude and behaviour
adequate use of audio-visual support

contents

problem statement, objectives of the project team, description of the problem
method of dealing with the problem
theoretical approach
explanation of experiments
results and conclusions
comprehensibility, quality of the argument(s), correct en adequate use of mathematics

Appendix C Project groups, tutors and lecturers

Here you will find an overview of the different roles and functions of those involved with project centred learning.

Student:
Personal characteristics: autonomous, willing to take initiatives, adaptability, flexibility, capacity for improvisation, willing to cooperate.
Skills: oral presentation techniques, skills to negotiate, social skills; planning, organizing and coordinating activities and competent to apply knowledge.

Tasks:
There are several tasks within a project group.
Project leader:
monitors the process / progress
updates the planning
external communication
responsible for handing in the and product

Editor:
responsible for the
checks texts written by other team members
gives writing assignments
puts together the individual contributions resulting in a complete and coherent
administer of the literature for the

Presentation co-ordinator:
responsible for the presentation
tests the hardware used for the presentation
ensures coherence of the sheets and slides

Product co-ordinator:
assigns tasks with respect to the creation of the product
links the different modules of the product
manages the documentation, manual(s), diagrams
finishing touch
monitors progress of the product according to the design

Besides the functions above, students are assigned the responsibility for the input of the contents of the courses in the project.

The project groups, in the end, are responsible for the final results and the products. With each project general and specific learning goals can be discerned. The general goals are the same for each project to come. However, each time a higher level is expected. The following general goals are formulated by the educational board:

- Ability to apply knowledge and skills
- Ability to elicit relevant information in an efficient way
- Being able to cooperate in a project group
- Being able to structure meeting
- Being able to deliberate and negotiate with an external client
- Making and adjusting a planning and schedule
- Able to work under time pressure

- Able to give a presentation
- Able to write a project

The lecturers who are responsible for a specific project formulate the level of these more general goals by stating clear criteria.

The more specific goals are different for each project. These goals are content related and related to other educational activities in the block. The specific goals are formulated by those lecturers involved in the block. These goals are for example the application of specific theories, and methods and techniques on behalf of the project.

The role of a tutor is to keep a group on the right track in a non-directive way. He or she observes the process and progress of a group and may give suggestions to encourage the group.

The project coordinator
The project coordinator is responsible for the ins and outs of a project. Every week the coordinator has a meeting with each project group. Besides the project examiner the lecturers, involved in a block, also assess product, and presentation of each project group.

The lecturers are responsible for the professional knowledge. They will be available for consultation by the students during a project. Since the lecturers may act as a client for a project assignment, it is very important to approach them with your questions and ideas. The lecturers are being expected to question the students during their final presentations on domain related issues.

Appendix D Project meetings

The aim of a project meeting is to continuously track the state of the art of the project by looking backward and forward. Appointments made are checked, new appointments are made. Moreover, the feasibility of the planning will be checked. In case of deviations, an analysis of the situation will be made in order to trace the causes. Project meetings normally are scheduled on a fixed date and time. An agenda is available on each meeting. The chairman and secretary put up the agenda. Of each meeting minutes will be taken.

The agenda below can be seen as a standard agenda. This agenda, of course, can be changed, influenced by the project or specific situation.

1. Opening
2. Announcements
   a. by the group members
   b. by the tutor
3. Incoming/outgoing post or mail
4. Minutes last meeting (mention date of meeting)
5. State of the courses
6. State of the project
   a. planning
   b. correction of the planning
   c. discussion on the log book
   d. discussion on the results of a brainstorm session or of a sub group
7. Cooperation
8. Appointments
   a. tasks to be done
   b. organization of the work
   c. chairman and secretary next meeting; monitoring the log book
9. Any other business

The project leader is chairman. He or she takes care that everybody can participate, that the atmosphere in the group is safe and open, and that conclusions are drawn and decisions are made. Summarizing is an important skill for a chairman.

The secretary takes care of the minutes. He/she sends them at last one day before the next meeting to every group member and the tutor. The minutes have to be provided with date, group number and the names of those present and absent.