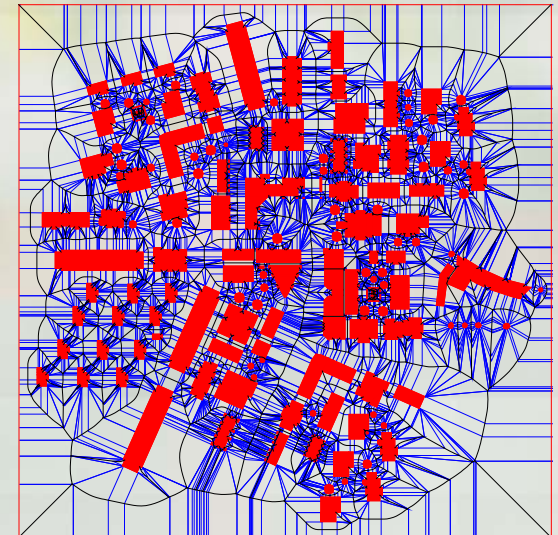




# Knowledge utilization with crowd simulation software

Roland Geraerts

31-03-2016



# Social relevance of simulation

- Big-scale exercises (>500 people) are impractical
  - Has big impact on environment and surroundings
  - Costs considerable amount of time
  - Tests only a few scenarios
- Crowd simulation is needed for
  - Simulations of the real world
    - Improving crowd flow, predicting crowd pressures, planning evacuation routes
  - Improving the immersion/realism in virtual worlds



Game world



Rebuilding of train station



Love Parade, Duisburg, 2010  
*21 deaths*  
*510 injuries*



Evacuation in sports stadiums

[Faculteit Bètawetenschappen  
Informatica]



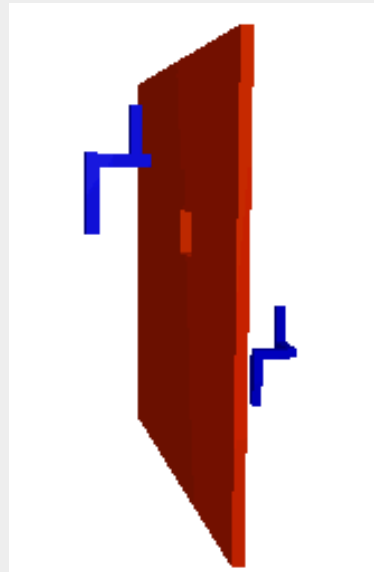
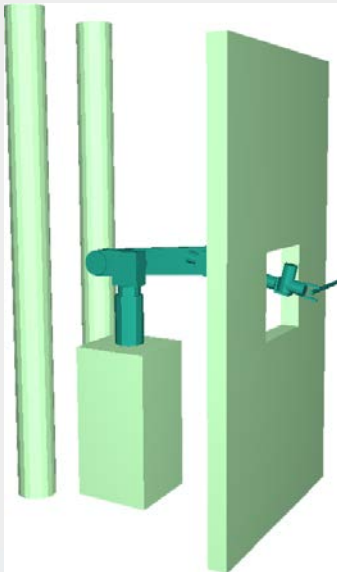
Universiteit Utrecht

# A long path...



■ 2004

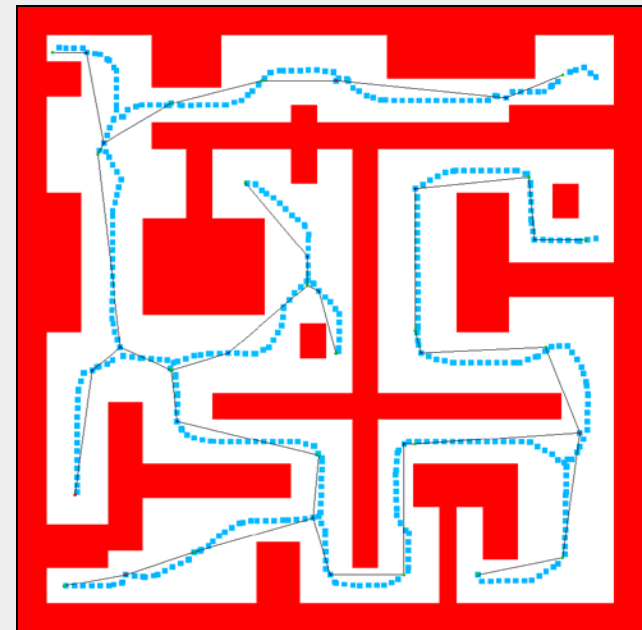
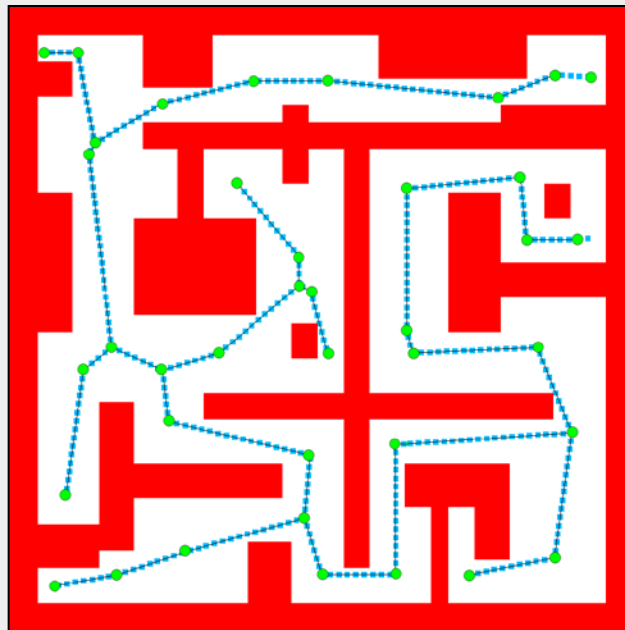
- Studied motion planning problems in high-dimensional spaces
- Experimenting with space representations



# A long path...

■ 2005

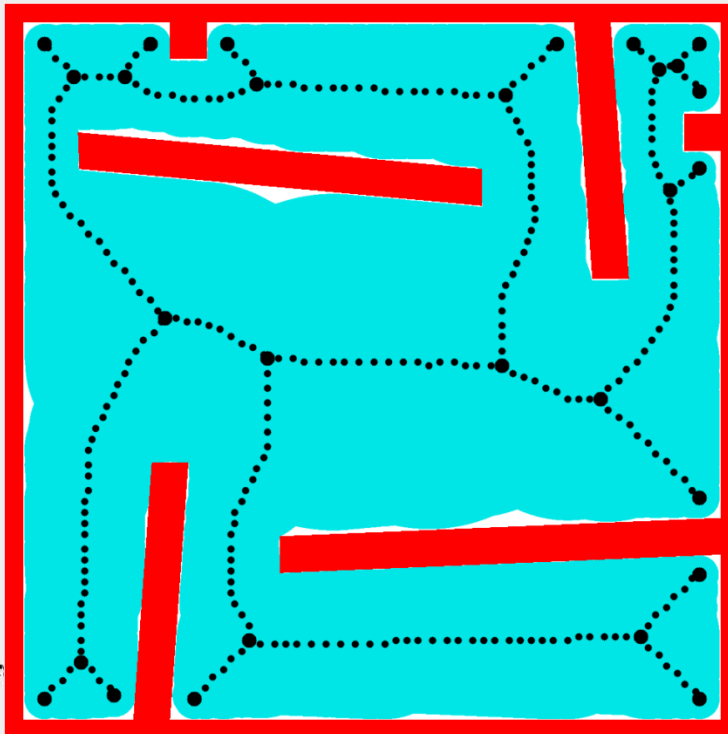
- Creating of graphs for high-dimensional problems
- Sampling-based approach



# A long path...

■ 2007

- First homebrew version, approximates medial axis using imaging techniques
- Transition from 1D curves to 2D surfaces



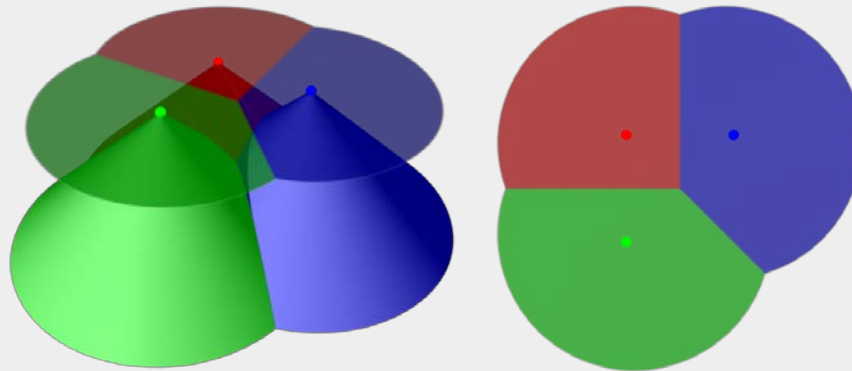
Univer

[Faculteit Bètawetenschappen  
Informatica]

# A long path...

■ 2008

- Shift focus on 2D path planning
- Approximation of the 2D Voronoi Diagram on the GPU
- Software: Corridor Map (CM)

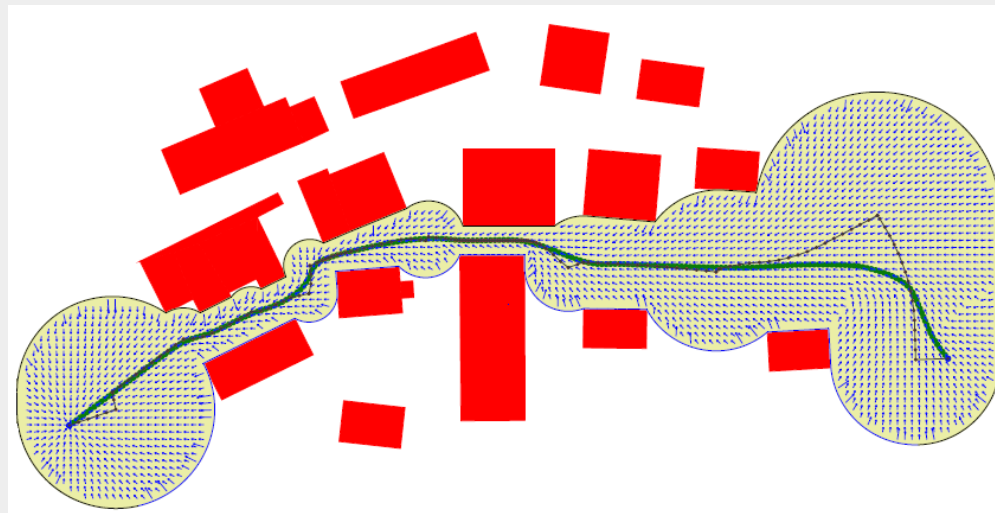


# A long path...

## ■ 2009

### ■ First focus on crowds

- Each agent follows a route with some noise
- Characters avoid collisions
- Obviously, this doesn't yield realistic crowds



# A long path...

■ 2009

■ Conference: Foundations of Digital games

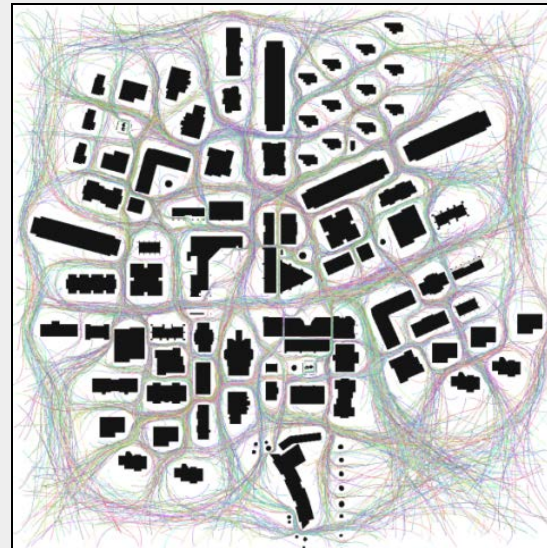
- Discussions with lead AI programmer of EA games
- Big challenge: path planning in a 3D, dynamic environment



# A long path...

## ■ 2009

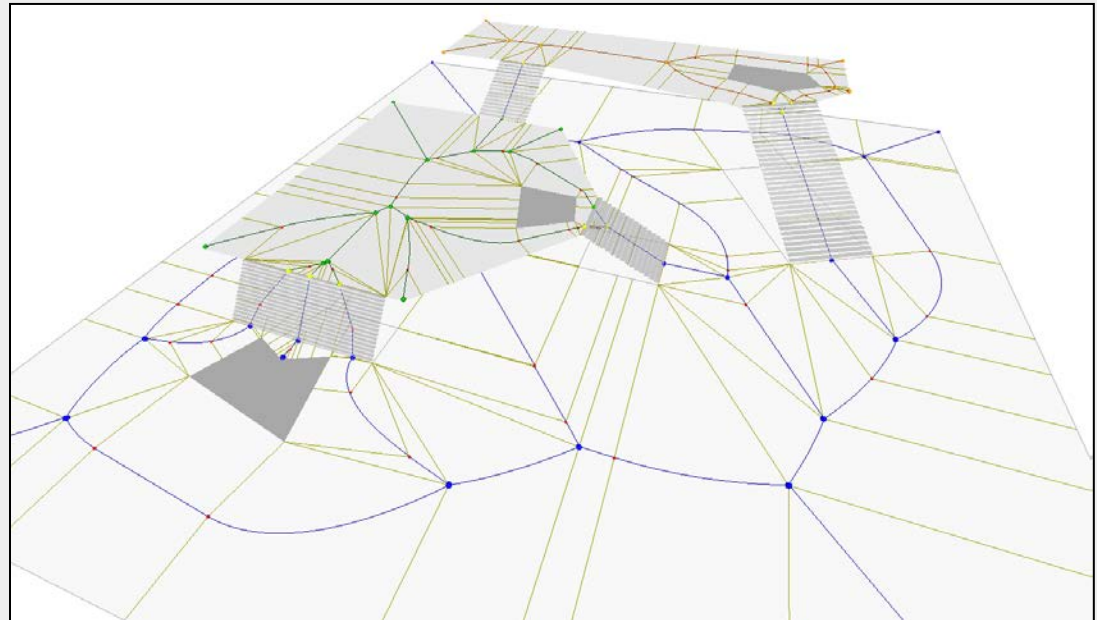
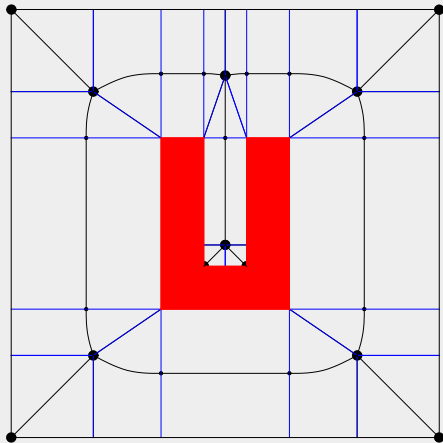
- First software demo of 'crowd simulation' at the GATE symposium
- Yielded contacts with companies
  - GreenDino (Car simulators)
  - VSTEP (training in virtual environments)
  - InControl (Pedestrian dynamics)



# A long path...

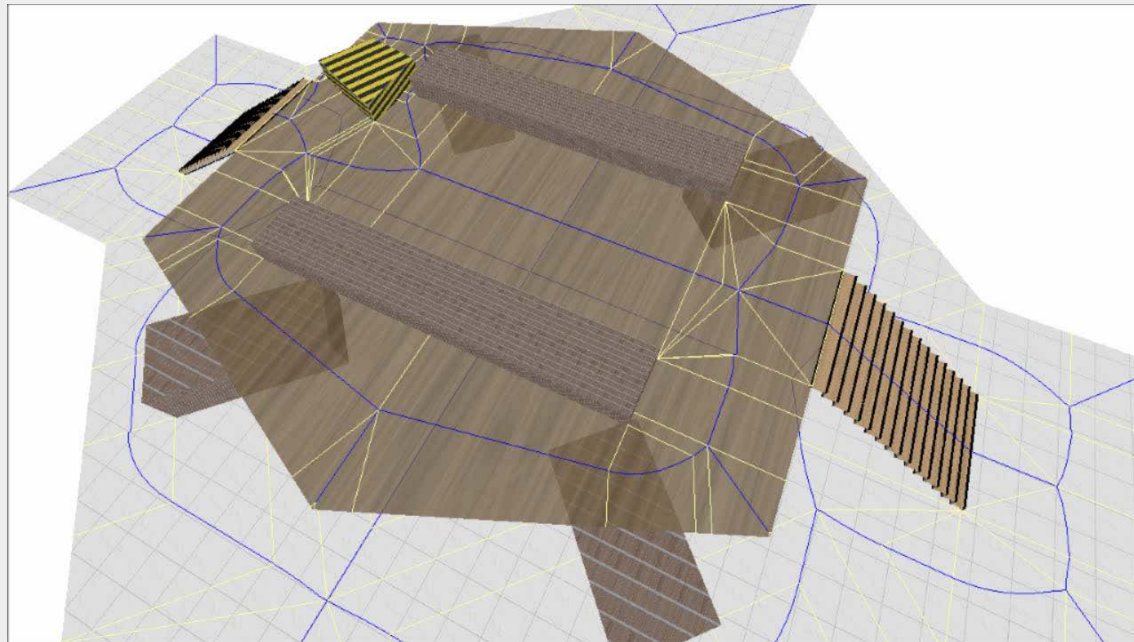
## ■ 2010

- Improvement of representation of the environment
  - Navigation mesh based on medial axis
- MSc project with Wouter van Toll at InControl
- Extension from 2D to multi-layered environments...



# A long path...

- 2010
- ...and dynamic environments.



*...due to Wouter van Toll.*



# A long path...



## ■ 2010

- Student project with VSTEP
  - Conclusion: our software is in an too early stage
- More MSc projects with InControl

## ■ 2011

- Software package was integrated in EU project in Second Life
  - ITEA Achievement Award 2011 (Silver)
- By InControl's invitation
  - Partner in EU project (was rejected)
- GATE Knowledge Transfer project with GreenDino
  - Accepted: 96K euro
  - Many papers, but our software is in an too early stage



# A long path...



## ■ 2012

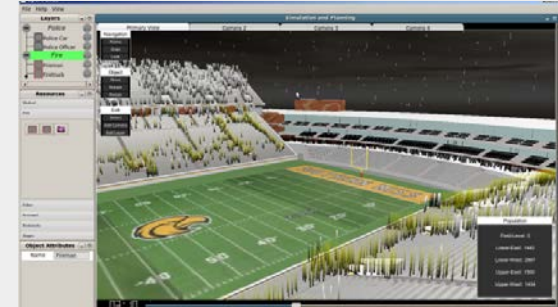
- Small business innovation research project with InControl
  - Accepted: 400K euro
  - Led to new product: Pedestrian dynamics
- New PhD student: Wouter van Toll
  - Contributed a lot to the project

## ■ 2013

- First license agreement with InControl
  - 15K euro
  - From hindsight: our software is in an too early stage
- First contact with 'end users'
  - Client day Efteling organized by InControl
- Internal software project
  - Crowd simulation framework & editor for Unity3D
    - From hindsight: our software is in an too early stage



# A long path...



## ■ 2014

- Software projects
  - Tools for crowd simulation (yielded a nice editor)
  - Walking, jumping & climbing in complex virtual worlds
- Project proposal with E-semble and InControl for the Hague Security Delta (almost accepted)
- Our software gets more and more scientific users
- Visit by delegation of USA Homeland Security delegates
  - Yielded product for Homeland Security/NCS4: SportEvac
- Many invited talks, e.g.
  - Keynote on Conference on Pedestrian and Evacuation Dynamics, best Dutch/Belgium CS thesis NGI/NGM (Arne Hillebrand)
- Movie on crowd simulation by Faculty of Sciences
- Many demo's given to companies / research institutes



# A long path...

■ 2015

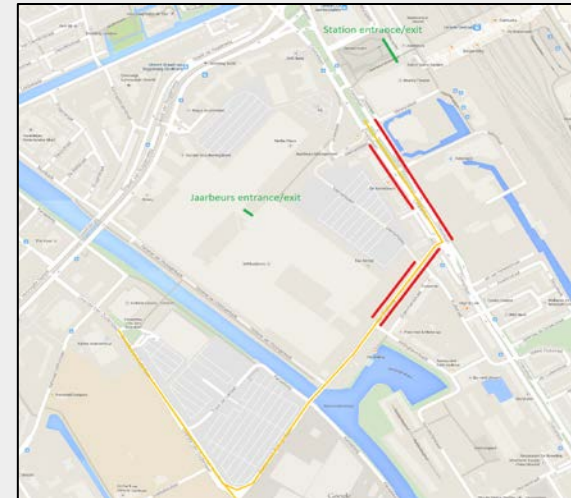
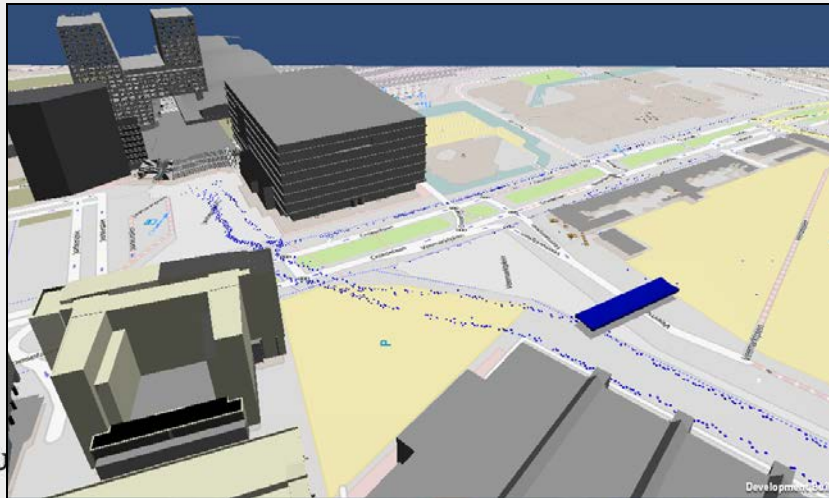
- Experiments performed during Festival deBeschaving
- Led to TV interviews (NPO2, RTVUtrecht)



# A long path...

## ■ 2015

- Simulations for preparations of the Grand Départ of the Tour de France
  - Together with Movares and city of Utrecht
  - Led to massive attention from the media
    - Press releases, TV (NOS, RTL4, RTVUtrecht, NPO2), news papers, magazines, radio (radio 5, BNR), websites, scheurkalender.
    - Followed by 'expert' interviews: NRC fact check, interview Belgium radio

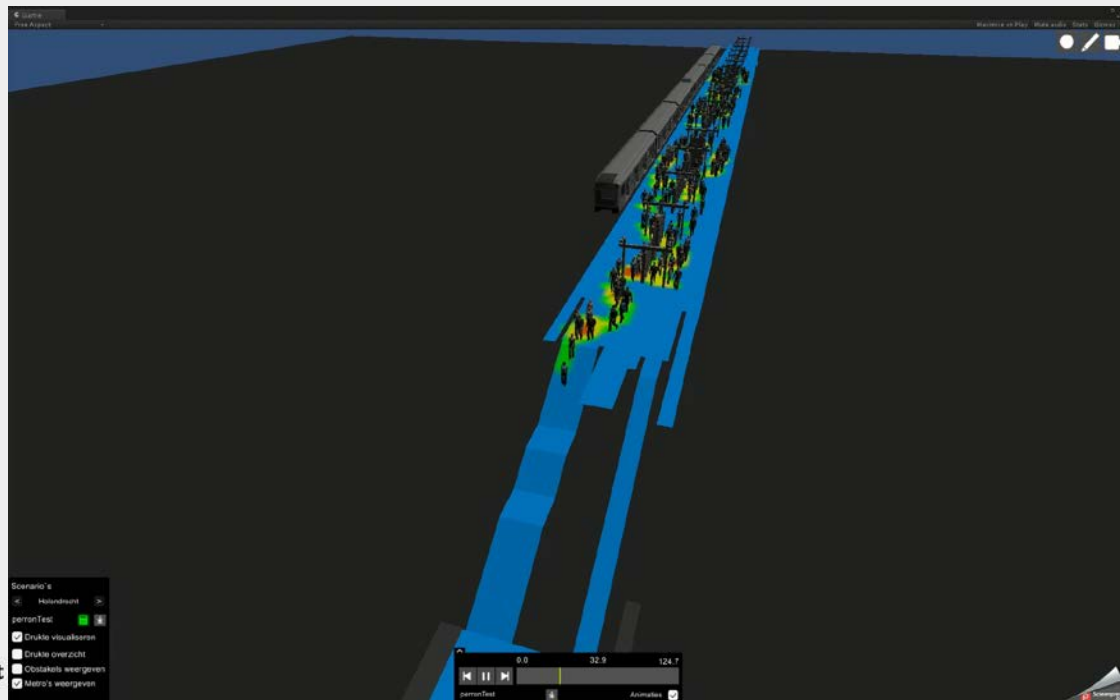


# A long path...

■ 2015

■ Won a project with company Movares

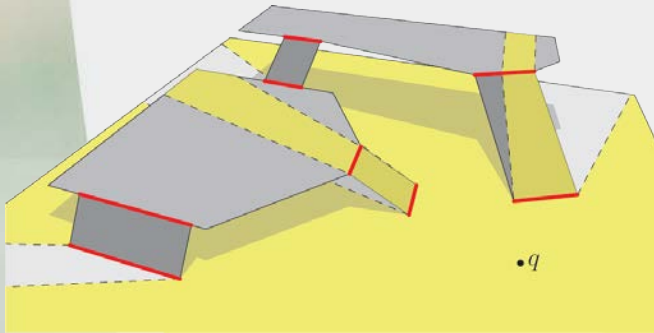
- Evacuation studies in metro stations of the Noord/Zuidlijn (Ams)
- 12KEuro (7.5K license, rest: payment for hours)



# A long path...

## ■ 2015

- STW Demonstrator project: The crowd simulation engine
  - 150K euro, 2.5 FTE scientific programmers
    - Addition of: Angelos Kremyzas, Wouter van Toll, Mihai Polak
  - Goal: to make the software market ready
- STW invited me for
  - Yearly report
  - Demo/pitch at the Euro case conference on smart cities
- Preparations of visit of all EU-ambassadors to Utrecht
  - Webke Kingma (was very enthusiastic about crowd simulation)
  - 12K euro by the board of the University for a software project on Crowd prediction
  - 20 May 2016



# A long path...

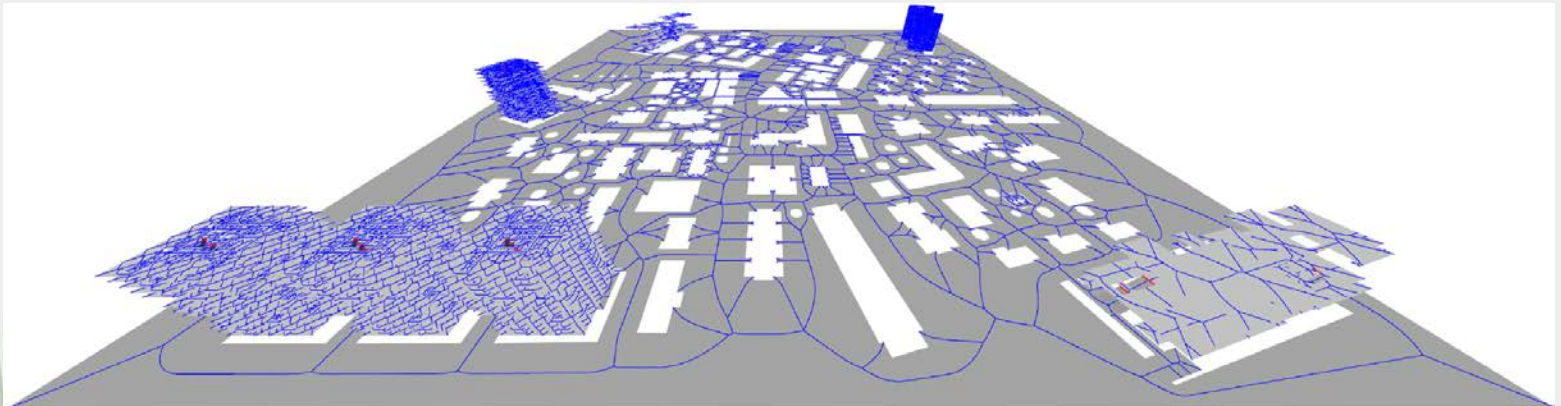
## ■ 2015

### ■ Many invited talks, e.g.

- University day, NHTV, Seminar Noldes, workshop Emergence in networks, control conference,...

### ■ Many demo's, e.g.

- Board of the university
- Open days
- Companies and research institutes



# A long path...

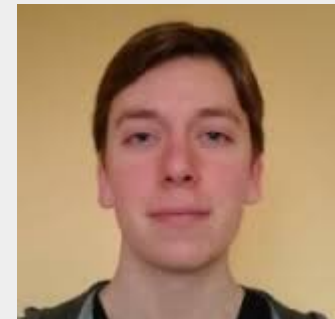
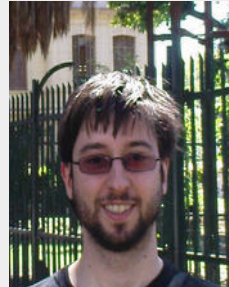
## ■ 2016

- Participate in STW Perspective project proposal on crowds
  - 4 universities, budget >3 million, now in phase 3 ☺
- Won 1<sup>st</sup> prize of NWO' *Meet the demo* at ICT.OPEN 2016
- More simulation projects with Movares
  - Oostlijn, Apenheul, ...
- We're in the process of formalizing our collaboration
  - Integral license for 2016, PhD student next year (hopefully), ...



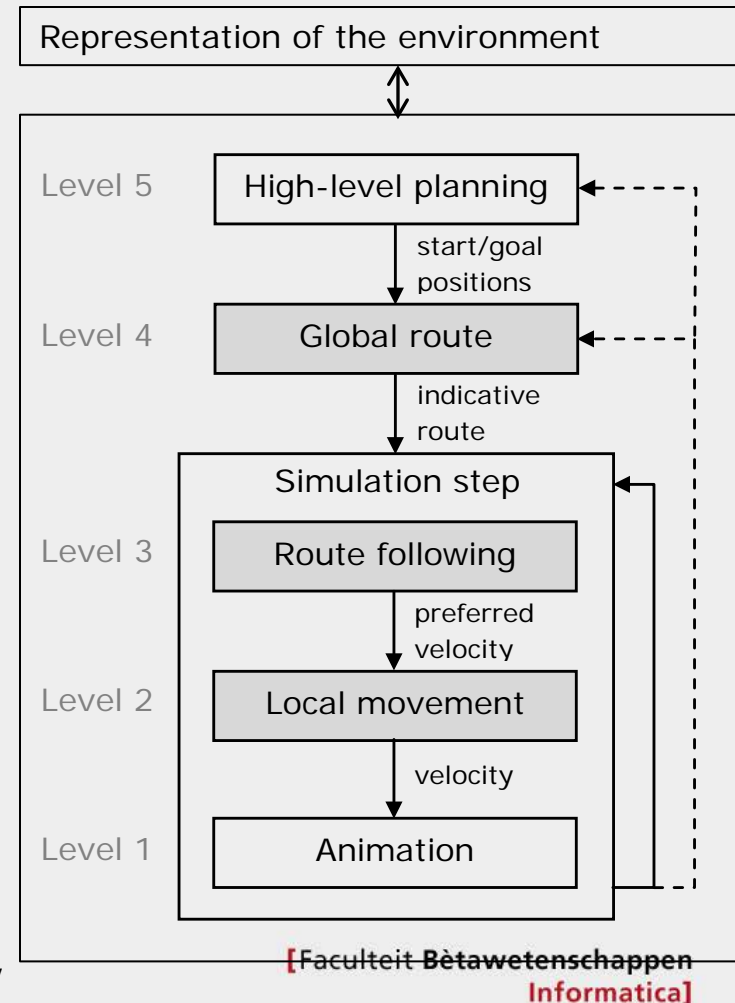
# It's teamwork

- Computer Science
  - Board Secretary ICS
  - Head of department
  - Researcher (me)
  - 3 PhD, 3 programmers, and many MSc students
- Utrecht VC
  - Business developer
- Utrecht Holdings BV
  - Company lawyer



# Software

- Version control system
  - Mercurial (open source)
  - Backup and all versions
  - Only a few persons can add code to the main repositories
- Platform independent
  - 32/64 bit code
- Maintainability: API's and DLLs
- Documentation on all levels
- Simple demo projects
  - Also to ensure compatibility between different components
- Plugin for game engine Unity3D
- We integrate most of our research into our library



# Licenses, IP, and contracts

## ■ Arrange license/IP as soon as possible

- UU is owner software
- Standard distribution
  - 25% for the researcher
  - 25% for Utrecht Holdings
  - 50% for the department

## ■ Contracts

- Must be personalized
- Costs a lot of work
- The university cannot be hold responsible
- There is no standard support for features and bugs
- Make sure
  - that the contract is signed before the software is used by the company;
  - that the existing IP stays with you.



# Collaboration with companies

- Commercial potential must be clear
  - They must be able to make money
  - Make clear what you can offer
- Building up trust
  - Show that you are an expert
  - Know what they want and show that
  - Start with MSc student
  - Let them try the software
  - Give demo's
- Make expectations clear
- Have a good team
  - Distribute responsibilities
  - Researcher: scientific part



## Lessons learnt

# Don't provide your software too early

but when it is really finished, you're too late.



# Lessons learnt

- There is no free lunch: “research is payed by tax money”
  - Less budget by government, so find others ways of funding
  - Illegal, so use market-based prices
- Don't ask for too much cash money
  - SME's don't have much liquidity, so small royalty fee works better
- Short term goals versus long term goals
  - Combine MSc projects with longer term projects
- Liability of software and results
  - Clarify that the UU will not be responsible for bugs etc.
  - Use verified models
- Royalties build up gradually
  - Accept uncertainty (e.g. pay for 1 year of PhD or post-doc)
- What if the researcher leaves?



# Valorization: YES/NO

## ■ Pros

- New and relevant research questions
- Debugging/testing of the code
  - Higher quality experimental research
- Integration of research into framework
  - May lead to new papers
- Budget to expand the team
- Additional income for the institute and researcher
- New contacts and visibility lead to new project proposals
- Additional publicity and PR

## ■ Cons

- You've to have much patience (it may take several years)
- Other activities may be valued more / indirect effect
  - e.g. writing research proposals



# Future steps

- Make software market-ready (should be ready in 1 year)
- Start spin-off, or find an entrepreneur
- Ensure long term life
  - Investment in scientific programmer
  - Additional software project
- Plugin in Unity3D
  - Sell it on Steam to reach the big game industry
- Website
- Develop better long term strategies
- Add research
  - Validation
  - Prediction
  - Bicycles and interaction
  - ...



# List of contributors

## ■ Staff

- Roland Geraerts
- Marjan van den Akker
- Han Hoogeveen
- Frank van der Stappen
- Mark Overmars
- Marc van Kreveld

## ■ PhD students

- Wouter van Toll
- Arthur van Goethem
- Norman Jaklin
- Ioannis Karamouzas
- Arne Hillebrand

## ■ MSc students

- Angelos Kremyzas
- Peter Prins
- Simon Rosman
- Marijn van der Zwan
- Mihai Polak

## ■ Scientific programmers

- Angelos Kremyzas
- Mihai Polak
- Wouter van Toll

## ■ Companies

- Movares
- GreenDino
- InControl



# Contact

- Roland Geraerts
- BBL 4.18
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- <http://www.staff.science.uu.nl/~gerae101/>



# Discussion points

- It should be possible to build up reserves
  - Money comes in small batches
- Money should flow back to researchers to invest in their own (or groups') research
- Researchers that are promising or good at knowledge utilization should get some time for that (in change for education duties)

