Geogame Design lab: Agent-based Simulation

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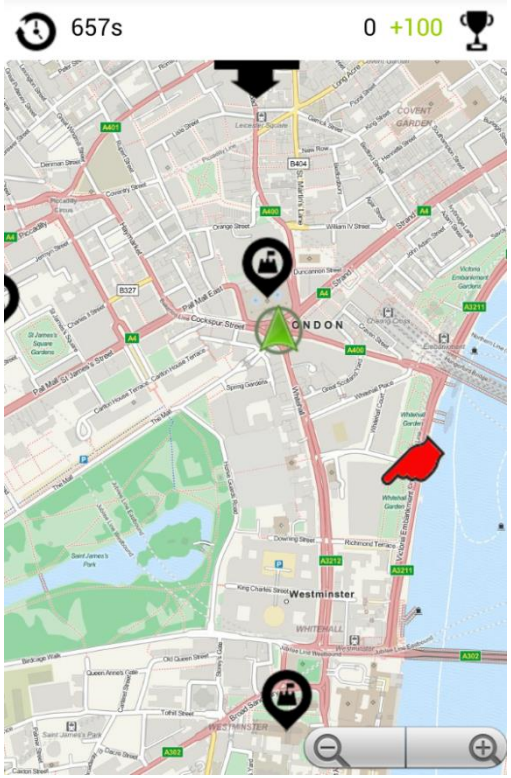
What to Expect from the Lab

- **Part I: Places of Game Play**
  - **Learn to identify issues of POG data management**
  - **Create a relocation of the Guesstimate game**
- Part II: Game Balancing through Spatial Analysis
  - Learn to model game elements
  - Balance games through spatio-temporal mechanics
- Part III: Simulation
  - Learn when to use agent-based simulation
  - Model a game strategy for a software player

Places of Game Play

A first game Mechanics

- Game Mode
  - Singleplayer
- Game experience
  - Provides a (almost) random exploration experience of an urban environment
  - See Geo-Art from Débord: Dérive (1956)
  - Hou Je Bek(2001): Algorithmic Walking



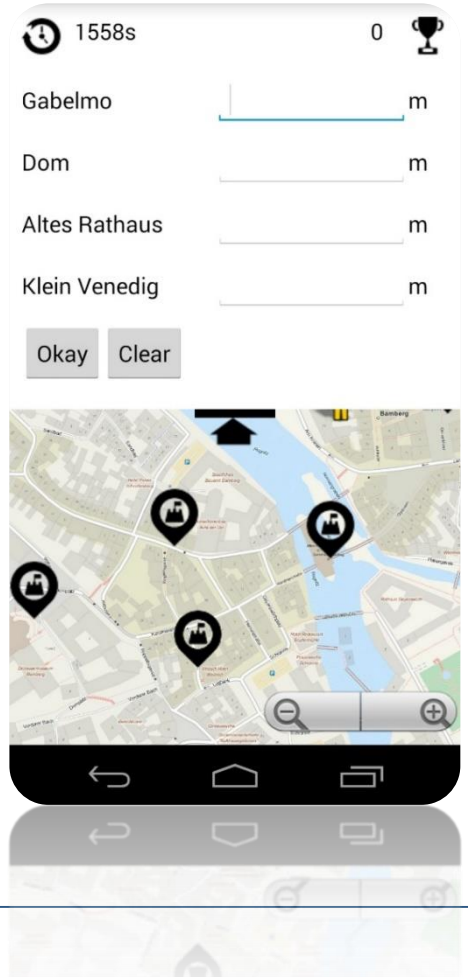
Guesstimate Narrative

- **Pizza PepeDroni Delivery Service**
  - Incredible: the best pizza in town is delivered on campus by super fast drones!
  - Just indicate your location by specifying your distance to four landmarks. The drone determines where to find you and, once landed, shows its location on the map.
  - If your distance guesses are inaccurate, you may have to walk a few steps to collect your pizza.
  - Try to guess the distances as accurately as possible to obtain a maximum number of pizzas during the next 20 minutes

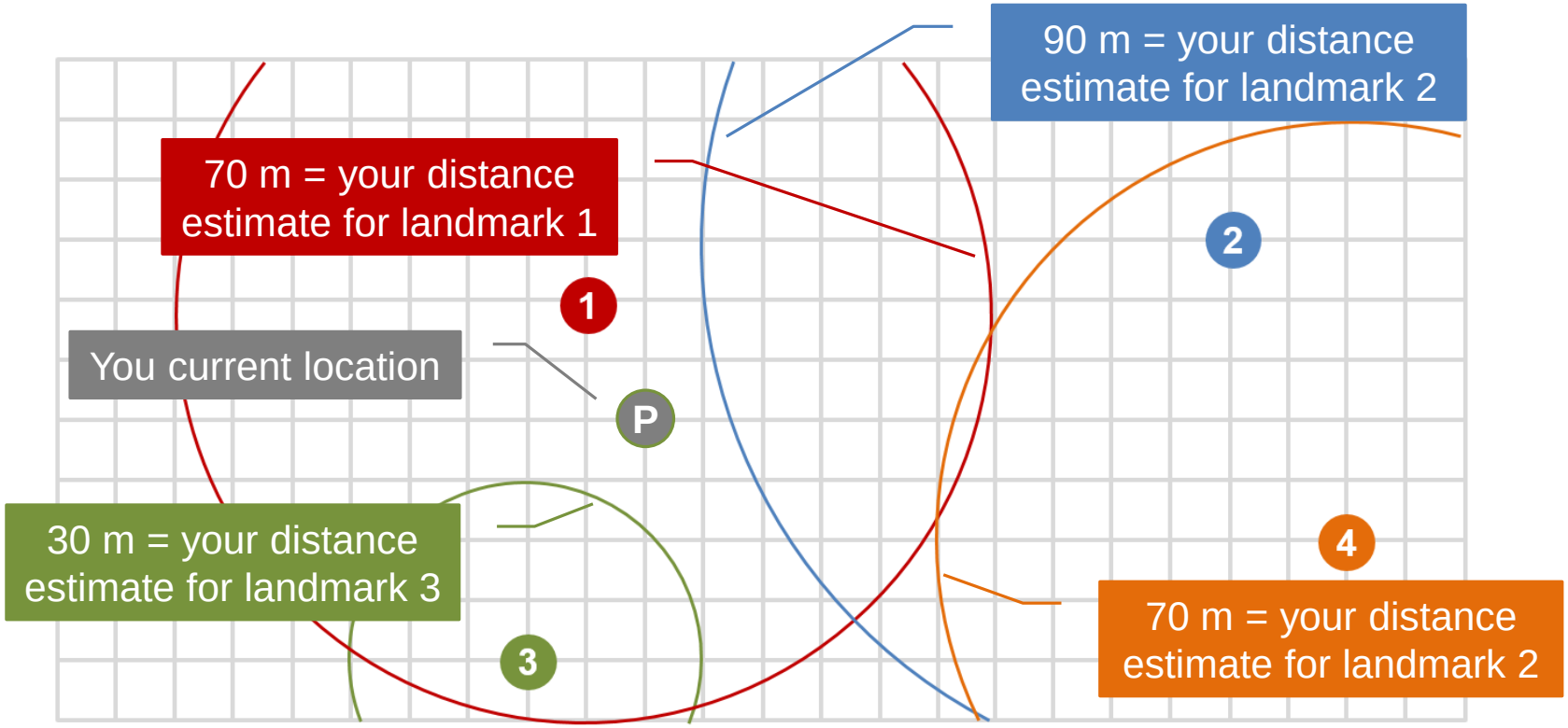
Guesstimating spatial distances

Spatial Task

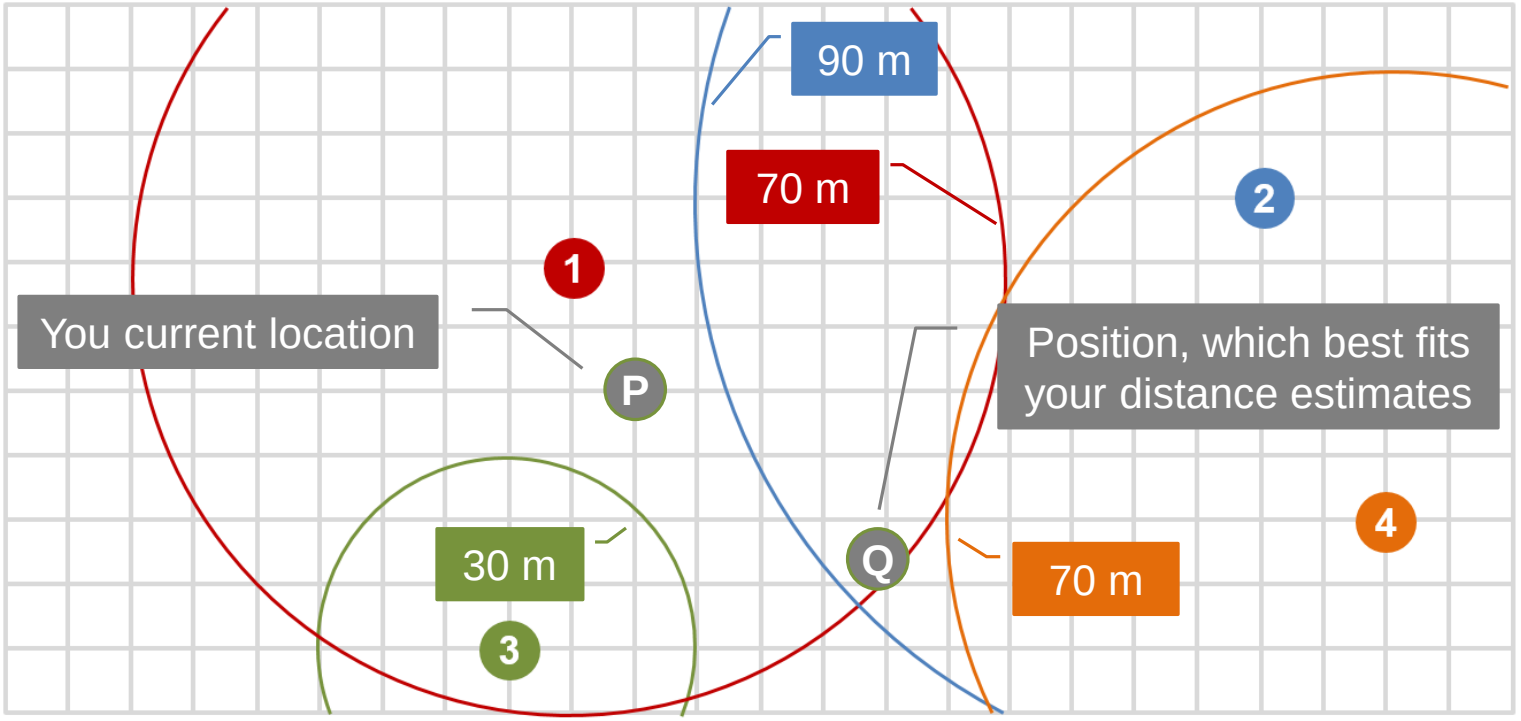
- 4 landmark locations on screen map
- Guesstimate the distance to your current position



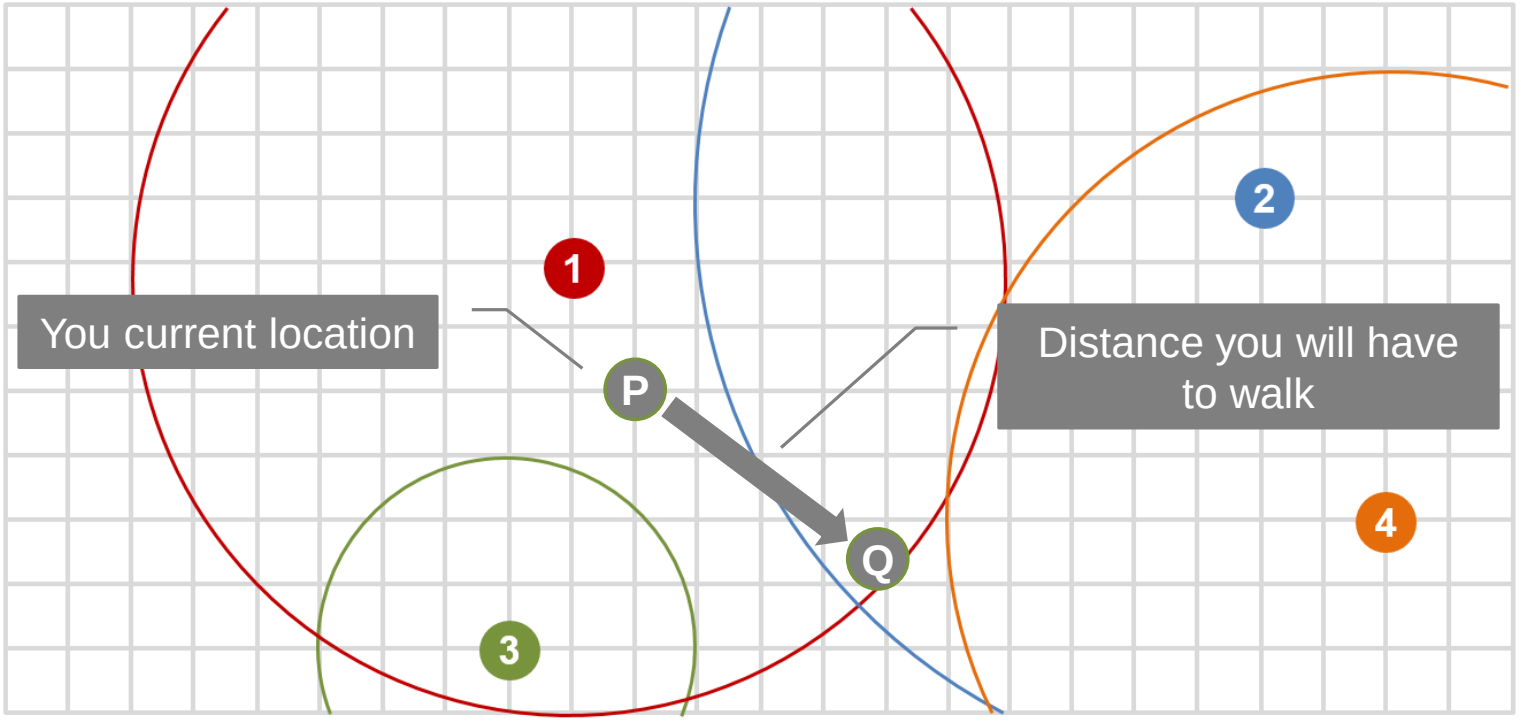
Input: Guesstimation Data



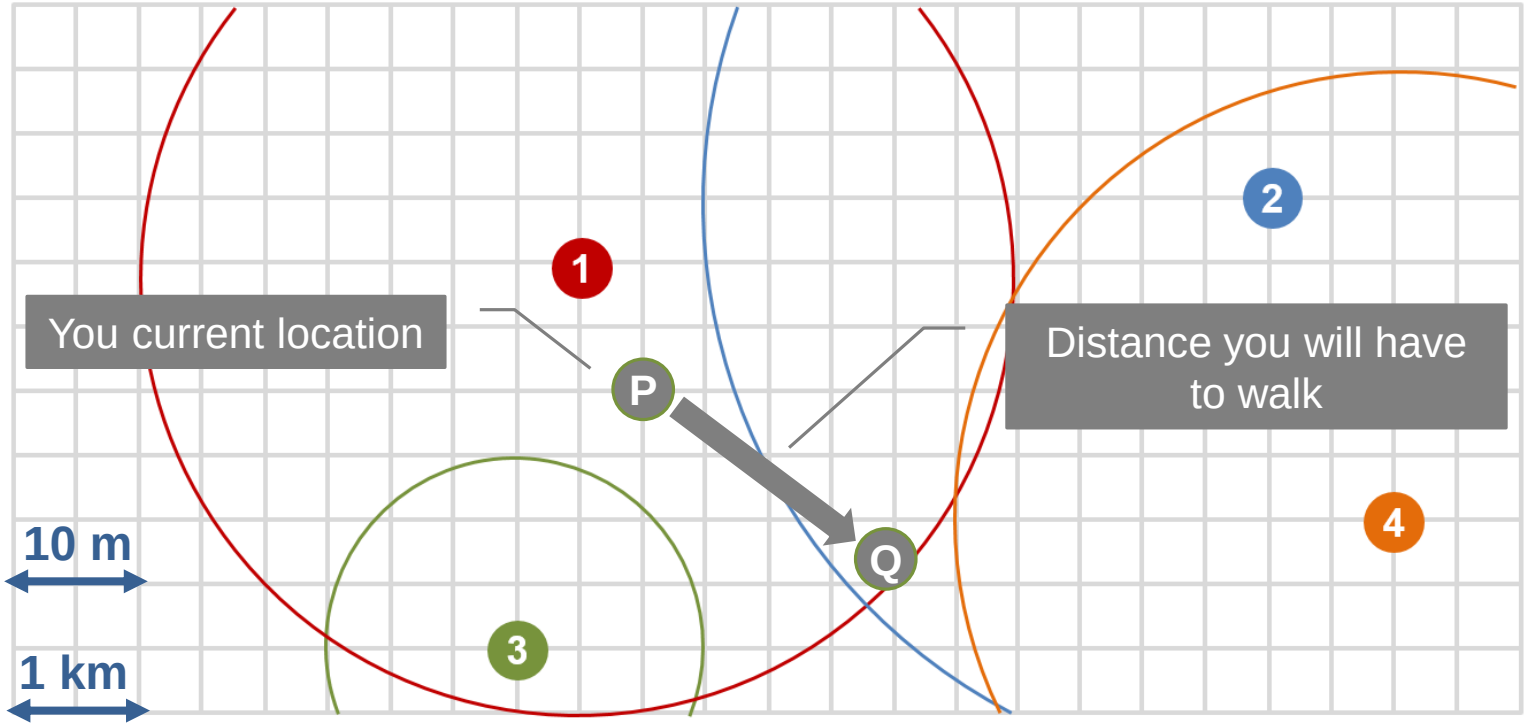
Output: Best Fit Position



Physical Scoring Mechanism



Scale Matters



Task:

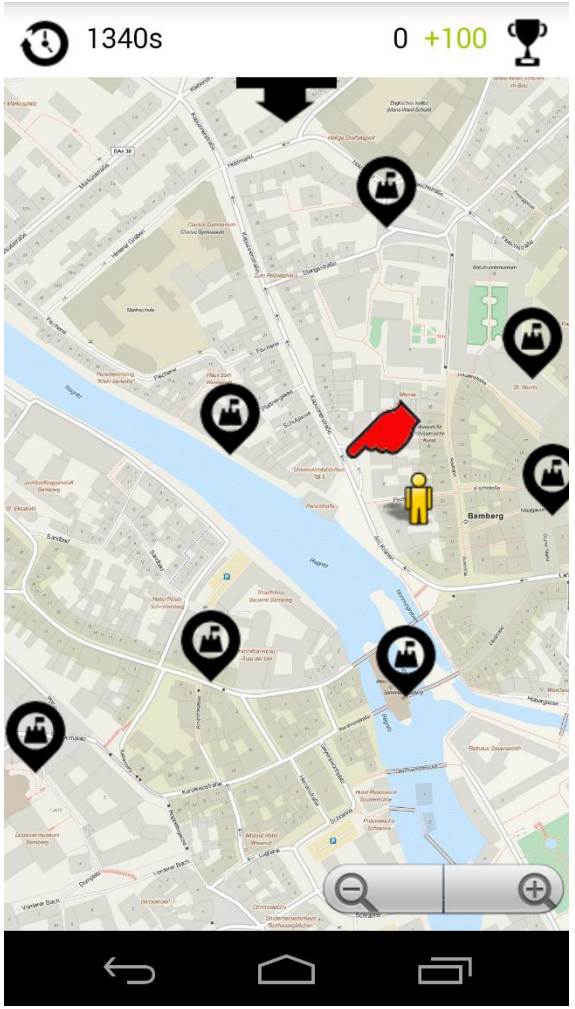
Determine Game Field Parameters

- Task
  - Does the size of the game field (bounding circle) influence the course of the game?
  - In what way?

Task:

Think as a Designer

- Task
  - The game should be played for 30 min and consist of roughly about 6 rounds
  - What radius would you choose for the bounding circle of the landmarks

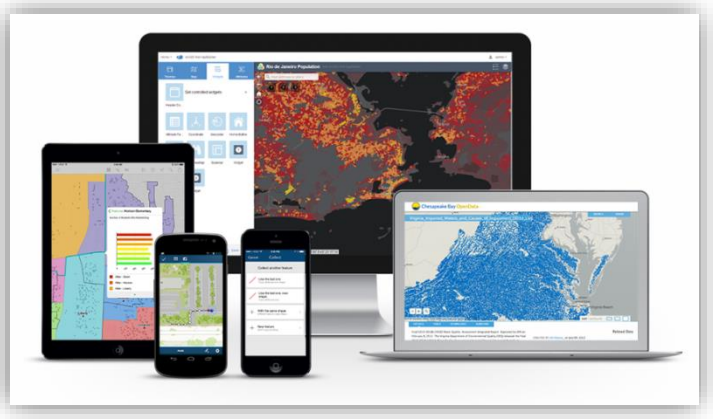


Places of Gameplay

- Landmarks
  - Worst case: Bounding circle with radius R meter
  - Rule of thumb: Walking distance: 0,5 * R
  - Or some other empirical grounded magic formula
- Game Duration
  - Example 30 min
  - Expected Number of walks: 5
  - Time for each round: 6 min = 5 min walking
  - 5 min at 1 m/s: 5 min * 60 * 1 m/s = 300m

Content Creation for Geogames

- Geodata has to be collected and stored
- Suitable software for..
  - Data gathering
    - Web Mapping + Editor
    - GIS Software
  - Data storage
    - Configuration Files
    - (Spatial) Database



http://www.arcgis.com/features/features.html

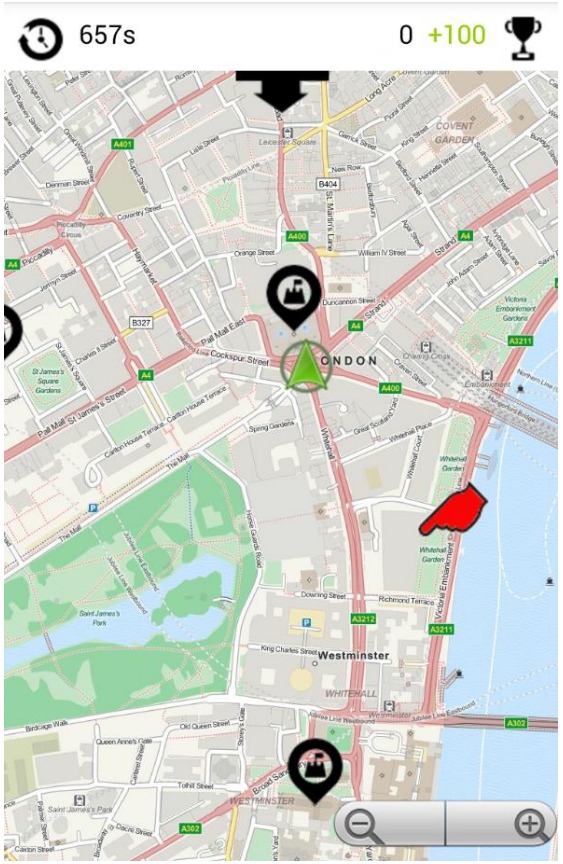
Task:

Create Your Own Guesstimate Game Field

- Create a Guesstimate game field for Helsinki or your home town
- Use the Guesstimate Editor:

  http://www.geogames-team.org/guesstimate/editor/
- Add at least 12 Features to your map
- Download the Android game at:

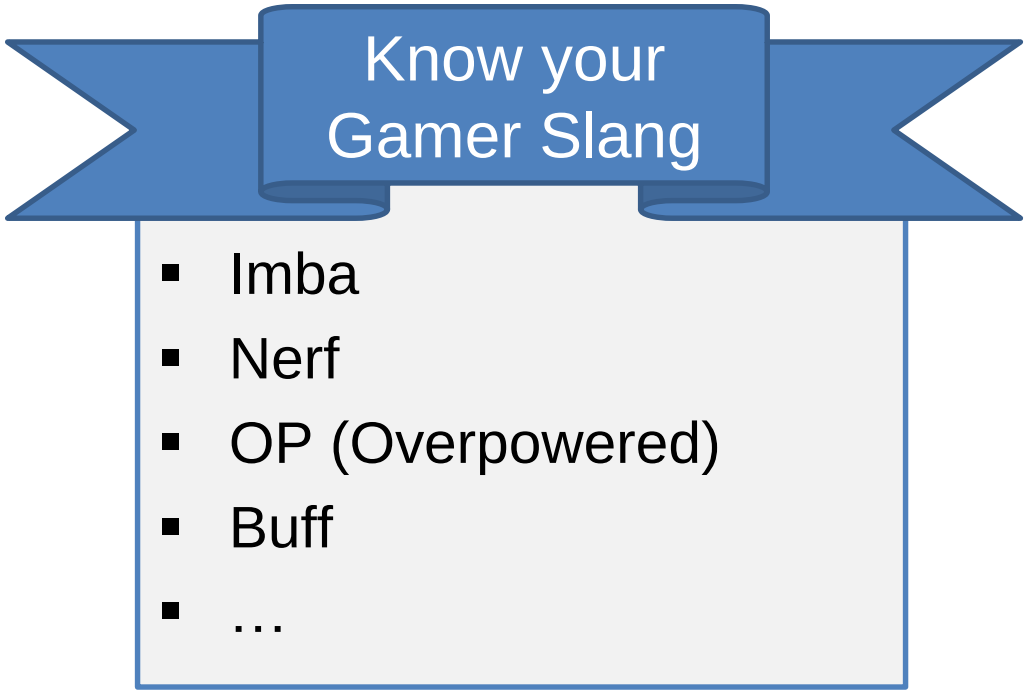
  http://www.geogames-team.org/files/guesstimate.apk



Game Balancing

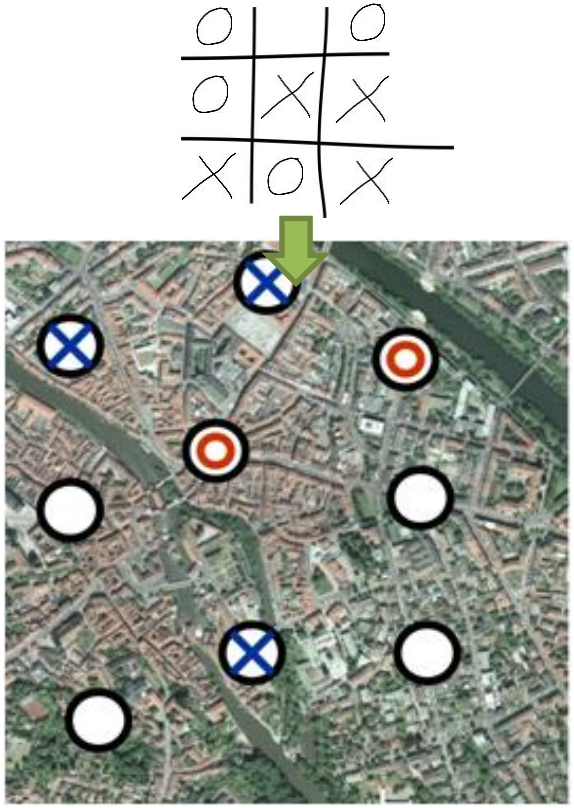
From Singleplayer to Multiplayer

- Imbalanced games are not fun to play
- Methods of balancing
  - Symmetry of forces
  - Negative Feedback loops



Example Geogame: GeoTicTacToe

- 9 geographic positions serve as game board
- A player places her or his token by physically moving to that position
- The player that first places three token in a row wins

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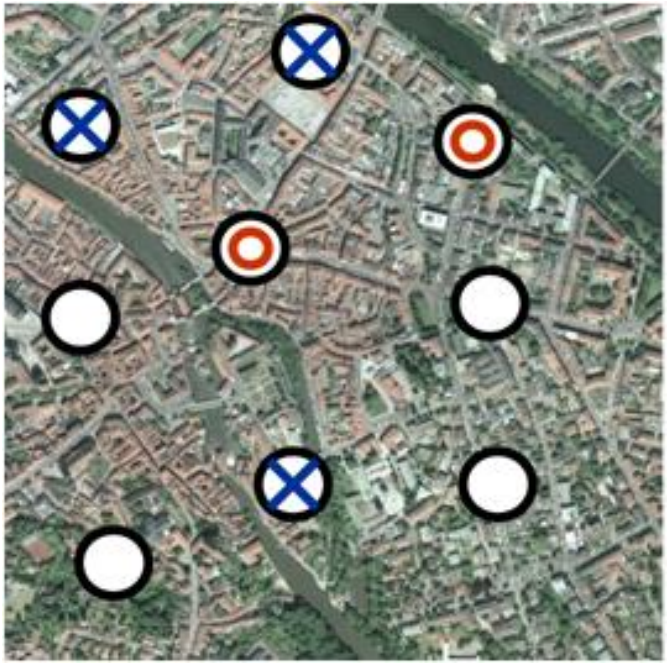
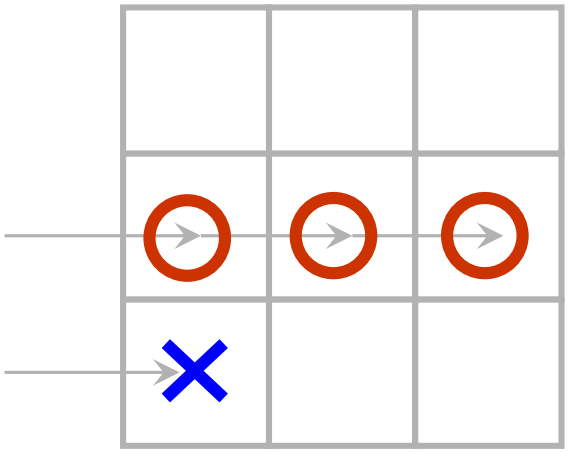
Questions



- Both players are playing on the same game field. Is that enough balancing?
- Brainstorm a suitable strategy for GeoTicTacToe.

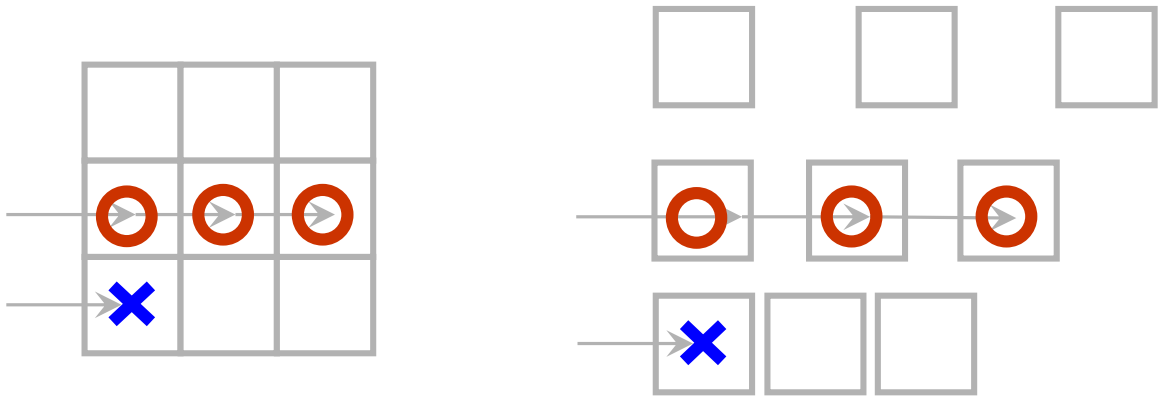
Why it does not work

- Problem
  - Simply mapping a game board into the geographic space leads to trivial games!
  - Without turns, the sequence of moves depends only on the speed whith which the players move



A trivial winning strategy:
„Be faster than your opponent!“

A spatial solution?



Balancing speed differences by spatially distorting the game board

A temporal solution!

- Basic idea
  - The players wait at the geograpic game positions for a determined (=computed) period of time.
  - The Bamberg Geogames team explores this idea in research since 2004

Geogames as a race game

- Locomotion
  - The sportive element is present in any challenging Geogame
- Extreme version (1)
  - „100-meter sprint“
  - The Geogame is played as a pure race game with synchronization time = 0 s

GeoTicTacToe

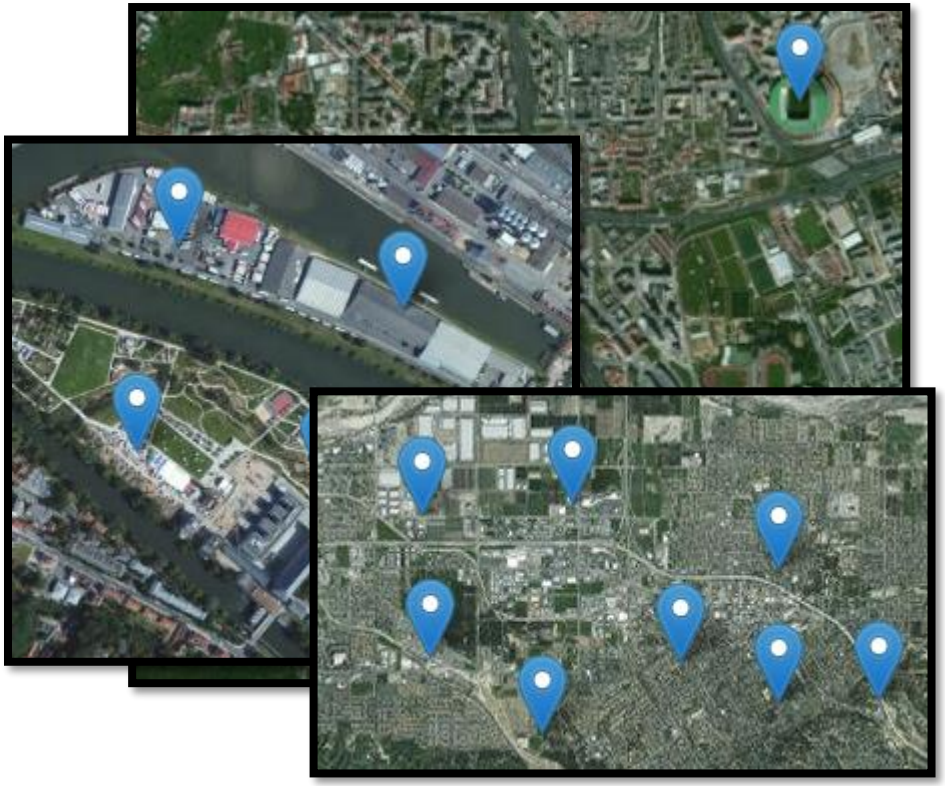
Geogames as strategic game

- Strategy
  - Strategic reasoning counts in any challenging Geogame
- Extreme version (2)
  - „Outdoor chess“
  - The Geogame is played as a pure strategic game with synchronization time >> 0

Simulation

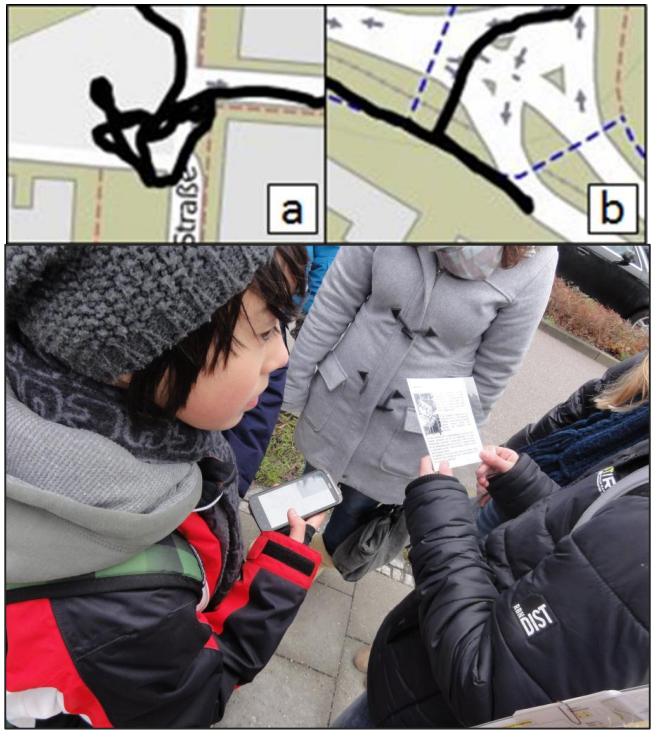
Problems with Spatial Analysis

- Conventional spatial analysis requires a lot of test run data
- Game mechanics are dependent on local conditions
- Not very good for balancing player tactics against each other



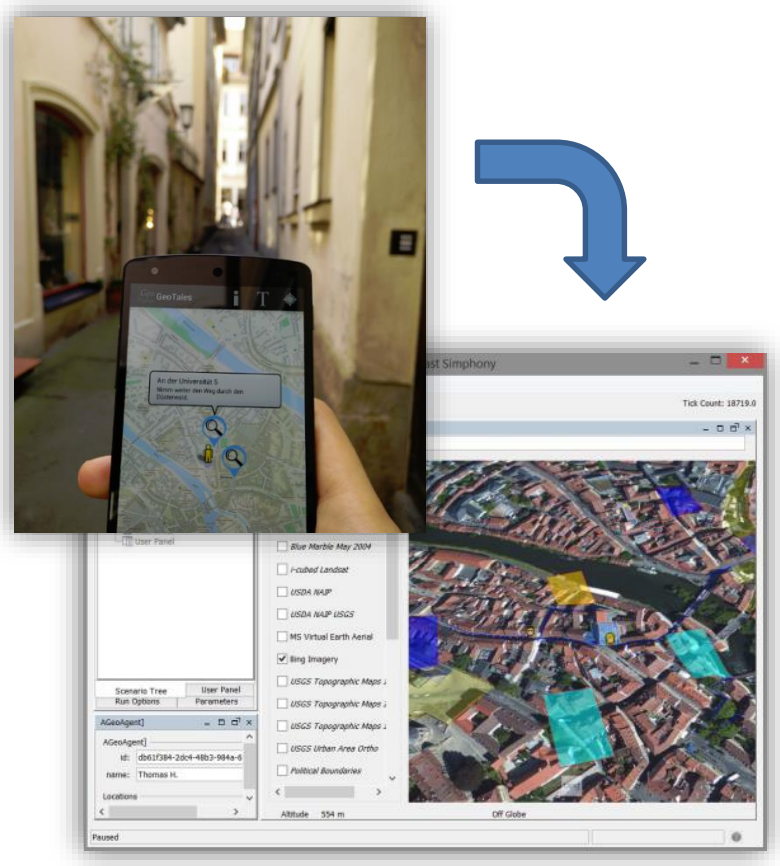
Testing Location-based Game Designs

- Testing in the field
  - Time consuming
  - Different environments
- Game analytics
  - Feedback from player data
  - e.g. trajectory analysis
    El-Nasr et al. (2013)



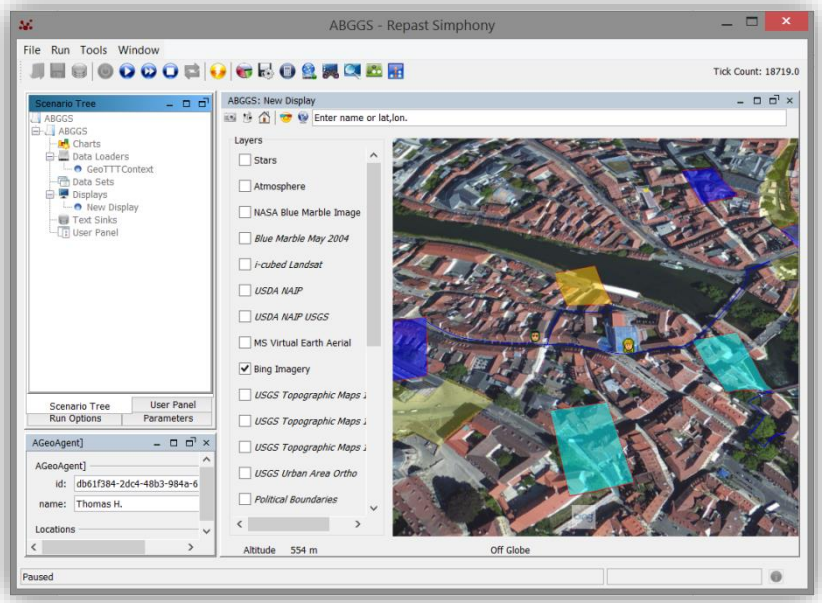
Game Analysis and Simulation to Minimizing Testing in the Field

- Game tree analysis
  - Searching the game‘s problem space
    e.g. Bouzy et al. (2012)
- Strategies in games
  - Players do try to exploit weaknesses of their opponents
- Agent-based simulation
  - Embody different strategies
  - Study game balancing for different strategy combinations



Agent-based Simulation for Development of Location-Based Game Mechanics

- Numerous agent-based Simulation Toolkits available
- Few that support processing of geographical data



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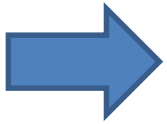
Existing Agent-Based Simulation Toolkits

Requirements
- Agent-based
- Game elements
- Pedestrian locomotion
- Real-world data



Contributions
- Framework
- Player model
- Pedestrian routing
- OSM import

Agent-based game simulation framework

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ABGGS
Agent-based Geogame Simulator

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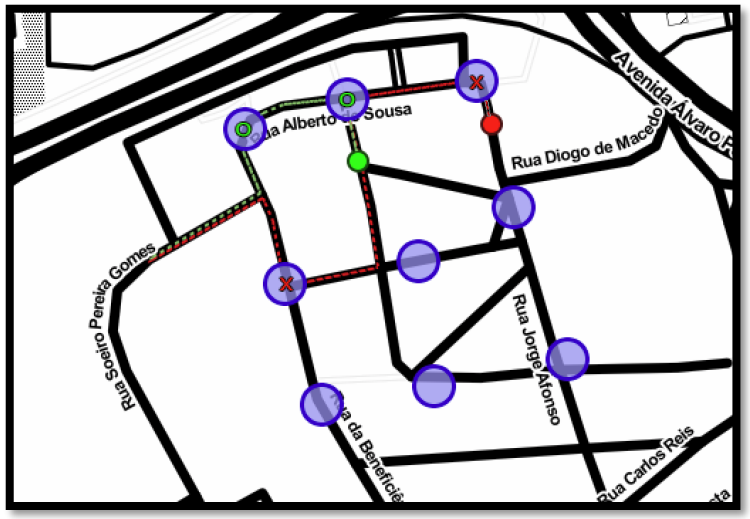
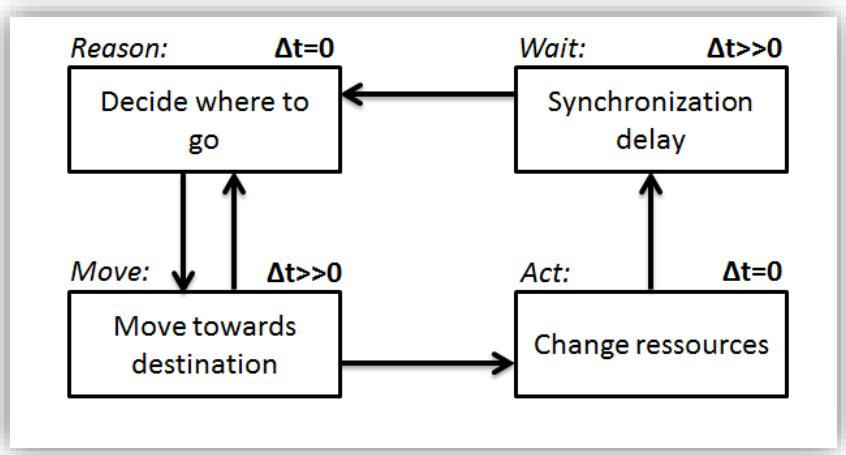
Player Model

- Game Elements:

  Places, Players, Resources, State space

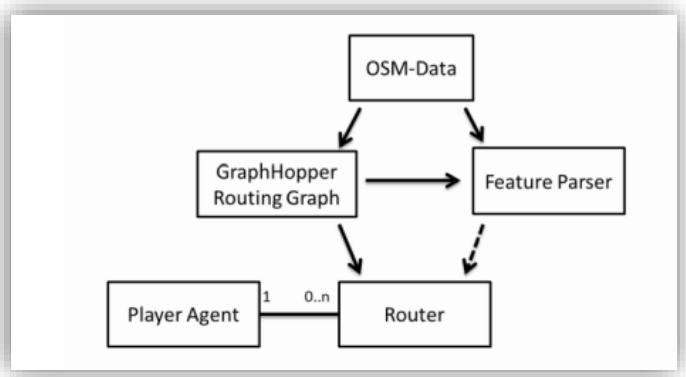
- Player model that is field-tested in a variety of different Geogames





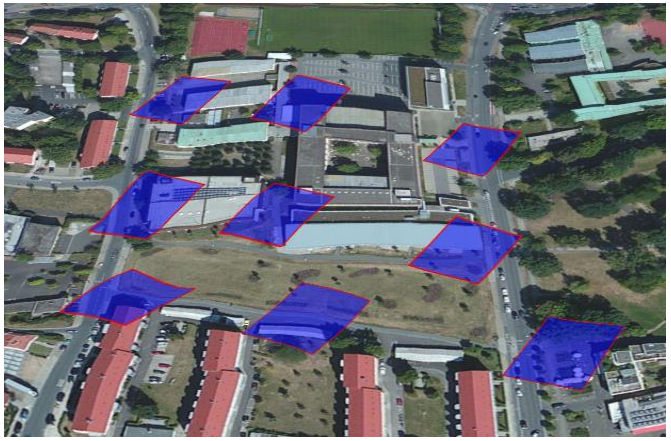
Pedestrian Routing

- Real-world data
  - Import from OpenStreetMap
- Free-space navigation
  - Visibility graph algorithm
  - Implementation extends the Graphhopper library



Player Strategies

- Random (= dumb)
  - Randomly chose the place to move to
- Paper
  - Optimal strategy for paper and pencil version: center is best move, …
- Nearest
  - Optimize locomotion behavior, ignore problem space



Comparison of Player Tactics

- Provides interesting insights to designers
- Superiority of a tactic may depend on the spatial layout
- Results can not been produced by state space analysis

		Player A		
		RANDOM	PAPER	NEAREST
Player B	RAND.	A wins: 115 B wins: 120 Ties: 15	A wins: 137 B wins: 97 Ties: 16	A wins: 231 B wins: 18 Ties: 1
	PAPER	A wins: 0 B wins: 250 Ties: 0	A wins: 111 B wins: 104 Ties: 35	A wins: 250 B wins: 0 Ties: 0
	NEAR:	A wins: 33 B wins: 212 Ties: 5	A wins: 0 B wins: 250 Ties: 0	A wins: 128 B wins: 122 Ties:

		Player A		
		RANDOM	PAPER	NEAREST
Player B	RAND.	A wins: 110 B wins: 112 Ties: 28	A wins: 156 B wins: 82 Ties: 13	A wins: 206 B wins: 36 Ties: 8
	PAPER.	A wins: 65 B wins: 173 Ties: 12	A wins: 115 B wins: 85 Ties: 50	A wins: 161 B wins: 89 Ties: 0
	NEAR.	A wins: 22 B wins: 222 Ties: 6	A wins: 71 B wins: 179 Ties: 0	A wins: 129 B wins: 121 Ties: 0

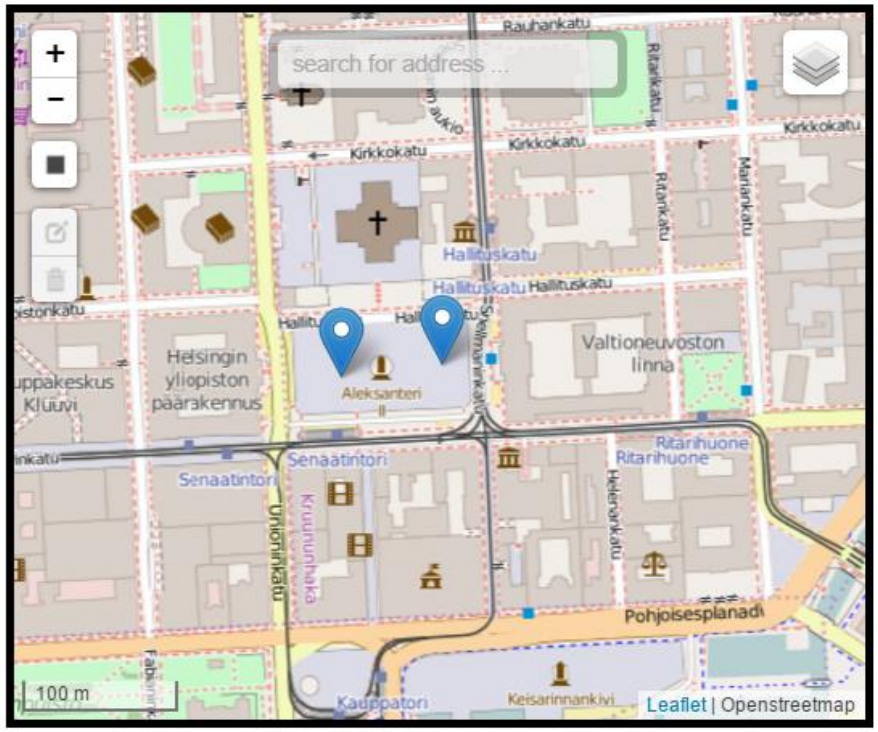
Supporting the Game Designer

- Specific lessons
  - On the small game field NEAREST always outperforms PAPER
- Game balancing
  - Naive players frequently adopt the PAPER strategy
  - Do not disadvantage naive strategies too much
- Consequences
  - Do not use the small game field for the tourist game

Task:
Create a Balanced GeoTicTacToe Game Board

- Use this online editor: http://geogames-team.org/files/helsinki/geottt/
- Keep different player tactics in mind
- Send the

  thomas.heinz@uni-bamberg.de



Thank you for your attention.

Questions & Discussion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Locomotion Time

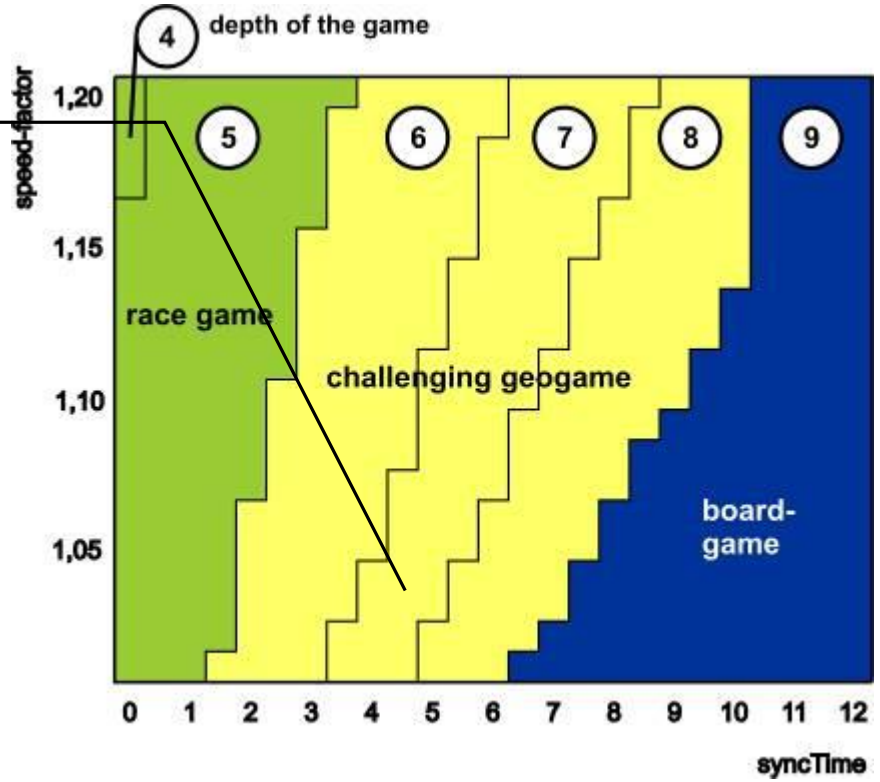
- the time a player needs to move from game position A to game position B
- computed from geodata and assumptions about physical abilties
- Not necessarily symmetric
  time(P_x,A,B) ≠ time(P_x,B,A)

	L11	L12	…
L11		300	…
L12	300		…
L13	540		…
…	…	…	

Explicit specification of locomotion times

Exhaustive analysis

speed-factor = 1.02
syncTime = 5
→
length of game 8



- The player P_X has a strategy to win in 8 moves.

Design parameters

speed-factor = 1.02
syncTime = 5
game area 500 m x 500 m
velocity 3 m/s
→
pause for 83 s