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)
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

- 70 m = your distance estimate for landmark 1
- 30 m = your distance estimate for landmark 3
- 90 m = your distance estimate for landmark 2
Output: Best Fit Position

You current location

Position, which best fits your distance estimates
Physical Scoring Mechanism
Scale Matters

You current location

Distance you will have to walk

10 m

1 km
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:
- Add at least 12 Features to your map
- Download the Android game at:
Game Balancing
From Singleplayer to Multiplayer

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

Know your Gamer Slang

- Imba
- Nerf
- OP (Overpowered)
- Buff
- …
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
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 with 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 geographic 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
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

ABGGS
Agent-based Geogame Simulator
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
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/](http://geogames-team.org/files/helsinki/geottt/)
- Keep different player tactics in mind
- Send the [thomas.heinz@uni-bamberg.de](mailto:thomas.heinz@uni-bamberg.de)
Thank you for your attention.

Questions & Discussion
Locomotion Time

- the time a player needs to move from game position A to game position B
- computed from geodata and assumptions about physical abilities
- Not necessarily symmetric: \( \text{time}(P_x, A, B) \neq \text{time}(P_x, B, A) \)

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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