

A Framework for the Analysis of Spatial Game Data

Ein Analyseframework für raumbezogene Spieldaten

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Location based Games

Put the 'fun' in education

Intersection of GIS and gaming technology¹

- Game actions tied to real-world spatial places ('Break the magic circle')
- Locomotion as essential game part
- Foster recognition of environment
- Focus through game related tasks
- Trade-offs between board and race style games²

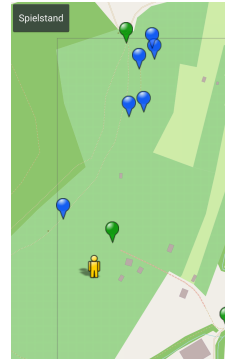


Figure 1: Geogame map view

¹Ahlqvist and Christoph Schlieder, "Introducing Geogames and Geoplay: Characterizing an Emerging Research Field".

²C. Schlieder, Kiefer, and Matyas, "Geogames: Designing Location-Based Games from Classic Board Games".

Goal definition

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- framework for analysis
- 2 zielgruppen: expert users/researcher vs. staging/designing
- integration von externen daten (fragebögen => CSV o.ä.)
- adaptable for multiple games

Prerequisites: Game log

- Creation
- Storage

New components

- Per-game importer (Web client, File loader, ...)
- Analyzer modules (number crunching)
- Output & Visualization (CSV, [Geo]JSON, KML, Graphs, ...)
- Interface (Configuration)
- Cross-game comparisons

3 State of research

- Log processing
- Pedestrian traces
- Analyzing games
- Location based games
- Summary

Modern log processing stacks

Technologies: Collection, Time-series databases, Frontend

- ELK (Elastic search, Logstash, Kibana)³⁴⁵⁶

- Collectd, Influx DB, Grafana⁷

- ...

- + widely deployed

- + powerful query languages

- mainly web/container/hardware monitoring

- spatial analysis: heavily anonymised (reduced resolution)

- fast-paced environment

TODO: bild mit importiertem GG2-logfile

³Andreassen, De Dios Fuente, and Charrondière, "Monitoring Mixed-Language Applications with Elastic Search, Logstash and Kibana (ELK)".

⁴Yang, "Aggregated Containerized Logging Solution with Fluentd, Elasticsearch and Kibana".

⁵Steinegger et al., "Analyse von Logs mit Open-Source-Werkzeugen".

⁶Sanjappa and Ahmed, "Analysis of logs by using logstash".

⁷Komarek et al., "Metric Based Cloud Infrastructure Monitoring".



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Analyzing pedestrian movement

... based on GPS logs

- GPS overestimates systematically⁸
- GPS is a suitable instrument for spatio-temporal data⁹
- Activity mining
 - Overview:¹⁰
 - Speed-based Clustering¹¹
 - Machine Learning¹²
- E.g.: Improve tourist management¹³

⁸Ranacher et al., "Why GPS makes distances bigger than they are".

⁹Spek et al., "Sensing Human Activity: GPS Tracking".

¹⁰Gong et al., "Deriving Personal Trip Data from GPS Data: A Literature Review on the Existing Methodologies".

¹¹Ren et al., "Mining Individual Behavior Pattern Based on Semantic Knowledge Discovery of Trajectory".

¹²Perner, *Machine Learning and Data Mining in Pattern Recognition*.

¹³Bernadó et al., "Analysis of tourist behavior based on tracking data collected by GPS".



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Heatmap

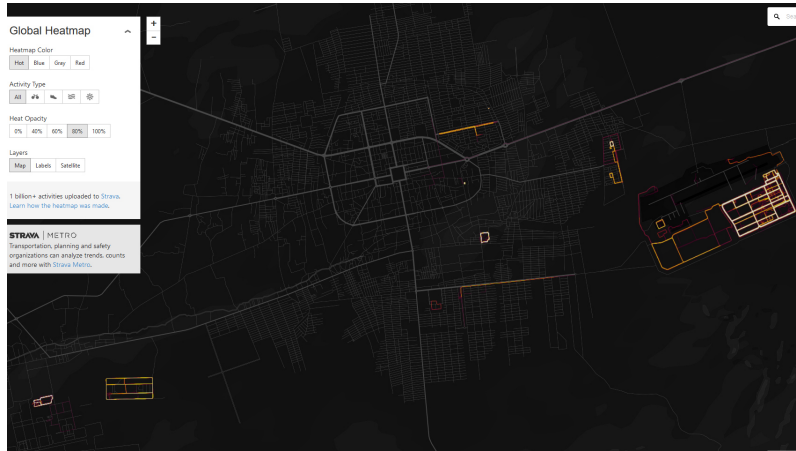


Figure 2: Heatmap: Fitnesstracker¹⁴

¹⁴*Fitnesstracker: Strava-Aktivitätenkarte legt Militärbasen und Soldaten-Infos in aller Welt offen.*

Space-time cube

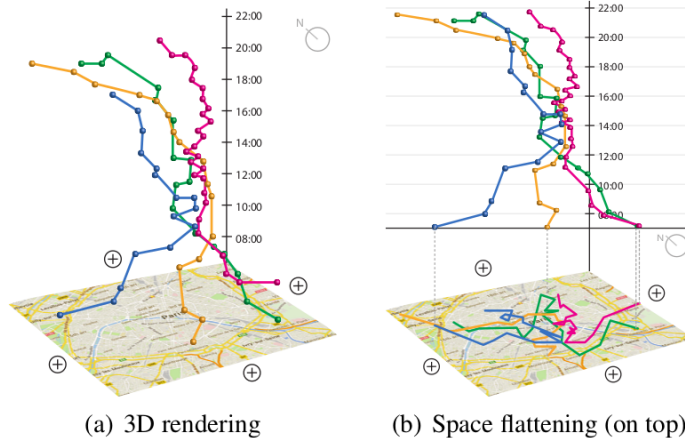


Figure 3: Space-time cube examples¹⁵

¹⁵Bach et al., "A review of temporal data visualizations based on space-time cube operations".

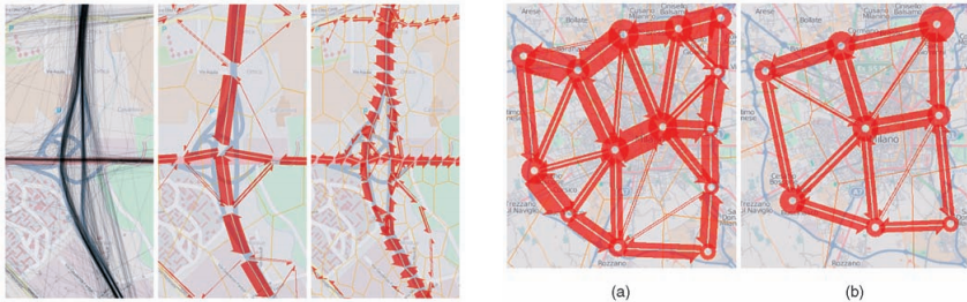


Figure 4: Trajectories and generalizations with varying radius parameter¹⁶

¹⁶N. Adrienko and G. Adrienko, “Spatial generalization and aggregation of massive movement data”.

Trajectory patterns

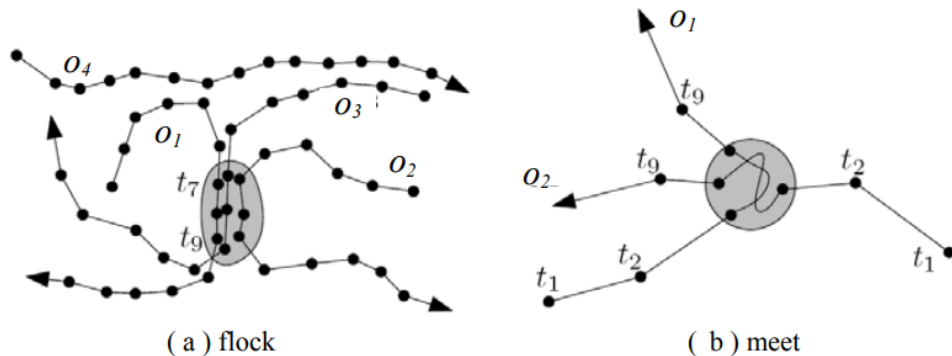
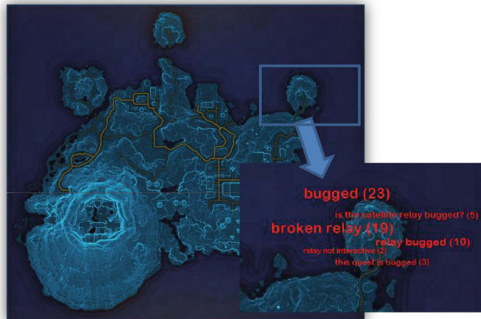


Figure 5: Flock and meet trajectory pattern¹⁷

¹⁷Jeung, Yiu, and Jensen, "Trajectory pattern mining".

Analyzing gamez

- there's more than heatmaps
- combine position with game actions
- identify patterns, balancing issues
- manual processes



(a) chat logs with players location



(b) identify critical sections

Figure 6: game analytics Drachen and Schubert, "Spatial Game Analytics"

- fragebögen (prä + post; p-hacking)

TODO: cite¹⁸

¹⁸Schaal, "Die Wertschätzung lokaler Biodiversität mit Geogames fördern – die Bedeutung von spielbezogenem Enjoyment im Spiel „FindeVielfalt Simulation“".

- log processing: doof
- fussgänger-tracks auswerten: totgeschlagen (gps messfehler, muster, verhaltenserkennung, ...)
- track rendering: linie (mit attributen), raum-zeit-würfel, heatmap, ...
- räumliche auswertung von computerspielen: läuft
- auswertung ortsbezogener spiele: macht niemand?

4 Solution approach

- Requirements
- Architecture

Requirements

...



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Solution approach

- map-reduce like
- map: analyse-läufe
 - log-eintrags basiert
 - reichern log an
 - filtern log
 - metriken über komplette log => extern gespeichert
 - => evtl. Abhängigkeiten in Reihenfolge
 - basis-funktionalität || spiel-bezogen
- reduce: Operieren mit Ergebnissen (über alle verarbeiteten logs hinweg)
 - render
 - verteilung, ...



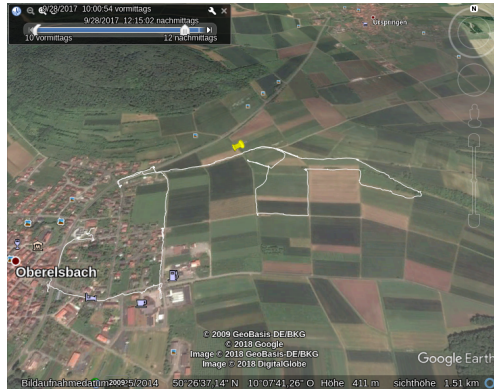
Figure 7: flowchart

- python (3.6)
- standalone library/cli tool
- web based configuration/runner/API(flask)
- ...

Configuration & results

```
{
  "logFormat": "zip",
  "entryType": "@class",
  "spatials": [
    "de.findevielfalt.games.game2.instance.log.entry.LogEntryLocation"
  ],
  "actions": [...],
  "boards": [...],
  "analyzers": {
    "analyzers": [
      "BiogamesCategorizer",
      "LocationAnalyzer"
    ]
  },
  "sequences": {
    "start": "de.findevielfalt.games.game2.instance.log.entry.LogEntryCache",
    "end": {
      "@class": "de.findevielfalt.games.game2.instance.log.entry.LogEntryInstanceAction",
      "action.@class": "de.findevielfalt.games.game2.instance.action.CacheEnableAction"
    }
  },
  "custom": {
    "simulation_rounds": [...],
    "simu_data": [...],
    "instance_start": "de.findevielfalt.games.game2.instance.log.entry.LogEntryStartInstance",
    "instance_id": "instance_id",
    "instance_config_id": "config_id",
    "sequences2": [{"id_field": "sequence_id"...}],
    "coordinates": "location.coordinates",
    "metadata": {"timestamp": "timestamp"...}
  },
  "source": {
    "type": "Biogames",
    "url": "http://localhost:5000/game2/instance/log/List/",
    "login_url": "http://localhost:5000/game2/auth/json-login",
    "username": "ba",
    "password": "<secret>",
    "host": "http://0.0.0.0:5000"
  }
}
```

(a) Analyzer configuration



(b) Result visualized

Figure 8: Example: Generate KML tracks (BioDiv2Go; Oberelsbach2016)

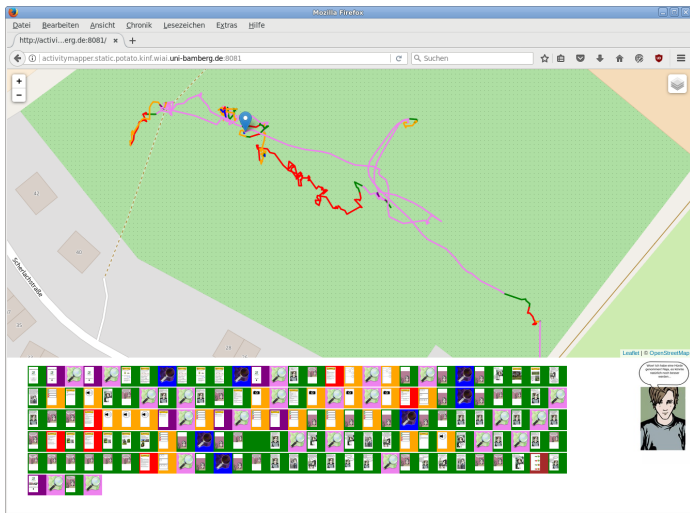


Figure 9: Combined screen activity and spatial progress

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