The Spatial Knowledge Representation of Players in Mobile Outdoor Gaming

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Motivation

- Current technology allows people to be connected at any place and any time.
- Location-based services are used for a broad range of applications.
Getting knowledge from location data

- Know how to get to the nearest pharmacy
- Find the best route for reach the gas station
- Get advice and discover near interesting places
Knowing “where are you” is interesting…
...but knowing “how do you move” is even more!
Getting knowledge from movement data

What kind of commuter are you?
How do you spend your leisure time?
Do you prefer crowded places?
Mobile outdoor gaming

- Most of the approaches in MOG have currently taken advantage of location data without any sense of mobility.

- There is a need for analyzing and understanding movement as unexploited resource to enrich the gaming experience.
Objective

To develop a **Spatial Knowledge Representation (SKR)** about the movement of players to discover, understand and explain the **spatial patterns** that characterize the **interactions** in the game.
Main issues on SKR

- Spatial representation have been tied up by a static cartographic paradigm. (Peuquet, 2002)
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- Spatial representation have been tied up by a static cartographic paradigm. (Peuquet, 2002)

- New representations are needed to conceptualize movement as a dynamic, complex, and non-linear phenomenon.

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www.vrvis.at/scivis

http://pedestrianlevitation.net
What should be a SKR?

- A surrogate of real world
  - “The map is not the world”

- A set of Ontological commitments
  - About what exists and what are the relations between the concepts?

- A fragmentary theory of intelligent reasoning
  - Which inferences can be sanctioned?

- A medium for efficient computation
  - For organizing, storing, manipulating and recovering information.

- A medium of human expression
  - Telling the others (and machines) about the world.

Adapted from Davis, Shrobe and Szolovits, 1993
Our approach

- Make an explicit conceptualization of space and movement.
- Make commitments about what movement is.
- State which inferences can be done.
- Compute the spatial patterns and discover new knowledge.
- Produce visualizations to explore and explain the results.
The Frequentie 1550 pilot game

Frequency 1550 is a mobile city game that uses GPS and UMTS technology to let pupils of the secondary schools actively learn about history instead of passively absorb knowledge.
Making a explicit conceptualization of space...

Multi-Tier Framework

Cognitive space*

“What is understood can be represented…”

*S Formerly social

Sensing space

“What is perceived can be represented…”

Symbolic Space

“What is interpreted can be represented…”
Making commitments about what movement is...

Movement is a complex system of interactions.

Cognitive space

- Actor
  - Player
  - Team
- Behavioural Interaction
  - Meeting
  - Association
  - Cooperation
  - Competition
  - Collaboration
  - Confrontation

Sensing space

- Vector
  - Move
  - Stop
- Topology
- Density
- Flow
- Observational Interaction
  - Approximation
  - Separation

Symbolic space

- Attractor
- Physical
- Non-physical
- Symbolic Interaction
  - Confluence
  - Encounter
- Participant
  - Individual
  - Collective

is grain of
has movement
has attractor
has observatio nal interaction
has_node
has_vector
has_density
has_topology
performs
has actor
belongs-to
has Symbolic Interaction
Stating which **inferences** can be done...

What is an “Encounter”?  

**Encounter**

- Symbolic_interaction
- has_participant some (Individual and (min 2))
- has_observational_interaction some (Approximation and (has_vector some move))

OWL DL notation
Confrontation

Behavioural_interaction has_actor some (Player min 2 and (Player belongs_to some Team (a,x)) and (Player belongs_to some Team (b,y)) and (different_from (a,b)) and (different_from (x,y))) has_symbolic_interaction some Encounter

What is an “Confrontation”?

Stating which **inferences** can be done…
Computing the **spatial patterns** and discovering new knowledge…

Spatial patterns for “Encounters”
Computing the **spatial patterns** and discovering new knowledge…

Visual Patterns for “Stops”
Computing the **spatial patterns** and discovering new knowledge…

**Multidimensional Patterns of “Attractors”**
Producing new visualizations…

Attractors

Flows

Confrontations
Conclusions

- Mobile devices link real and virtual worlds by providing location information, and could change the perception of the environment, creating new cultural, social, and virtual landscapes.
- New spatial knowledge representations are needed to provide models for different notions of space and movement.
- Our approach demonstrated to support multiple representations and therefore could be extrapolated to other application domains.
Future research work

- Continue the development of the concept of interactions as a metaphor of movement.
- Implement the symbolic and cognitive space tiers.
- Apply our approach in different application domains.
  → Movement of visitors in the Dwingelderveld National Park (Netherlands)
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