SPIDER MAPS

for Passenger Information and Trip Planning Enhancement in Public TransportationNetworks

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SPIDER MAPS

- Background
- Roots
- What?
- Improving

1 Background

- Man tried to capture time and space
  - Invented Maps to capture space

- Industrial Revolution
  - Changes in economy, society
  - Large Urban Areas
  - Complex Transportation systems

- People are concentrating in big cities
  - 80% of the world population lives in urban areas

1 Background

- Current maps are not efficient
  - Paper Maps are produced manually | High Cost
  - They do not reflect user context | Inflexibility

- Objective
  - Improve passenger Information and Trip Planning| achieve higher ridership in Public Transportation through the use of automated Spider Maps

2 Roots – Evolution of Maps

- Maps: abstractions of space
  - Loss of information | an advantage!
  - Distortion of space | practicality

- Peutinger Map
  - Famous map from 13th century A.D.| some principles used in current metro maps!

2 Roots – Evolution of Maps

Schematic Maps

Famous Schematic Map
- London Underground Diagram (Beck, 1933)

- Innovative | Line Orientation and Distortion
- Controversial.. But successful!

2 Roots – Context Awareness

Maps are part of a Communication Process:

- Syntax | symbols
- Semantics | meaning
- Pragmatics | context

• Current map production and research has been traditionally focused on the first two!

What is context in transportation maps?

2 Roots – Context Awareness

- Context is *"Any information that can be used to characterize a situation of an entity (…) which is relevant to the interaction between a user and an application, including the user"* (Dey, 2001)

Context Types:

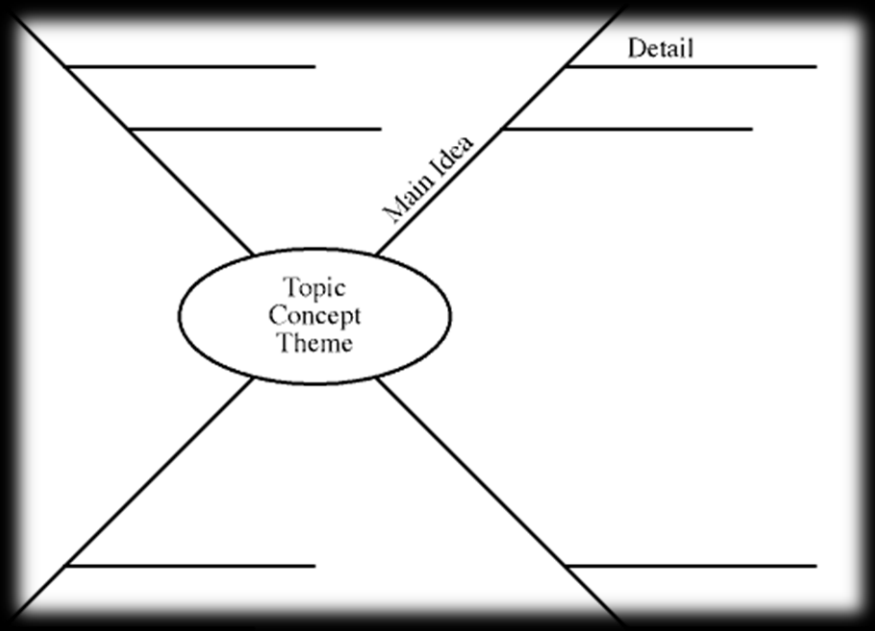
- User
- Space
- Time

What if we use context to improve maps?

2 Roots – The Spider Map Concept

Spider Map Graphic Organizer

- Used in K-12 schools in USA to improve leaning
- Describes a central idea
- From the central idea, main ideas are attached



What if we explore this concept in schematic maps?

2 Roots – Automated Schematic Maps

Schematization Process

- Reduces unimportant details through abstraction
- May use distortion and other visual techniques
- Nowadays executed by a handful of skilled designers and cartographers

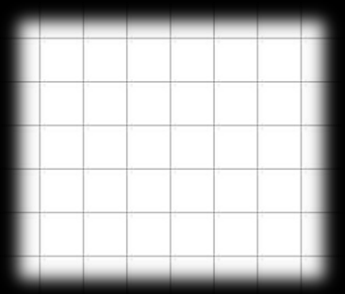
Automated generation of Schematic Maps

- Schematization process needs to be automated!
- Some efforts, but consider only parts of the problem
- Complex combinatorial multi-objective problem

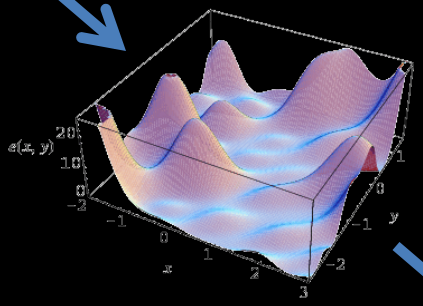
What if we generate Schematic maps automatically?

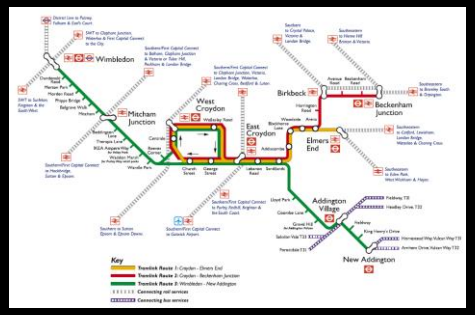
2 Roots – Automated Schematic Maps

Automation of the Schematization Process:



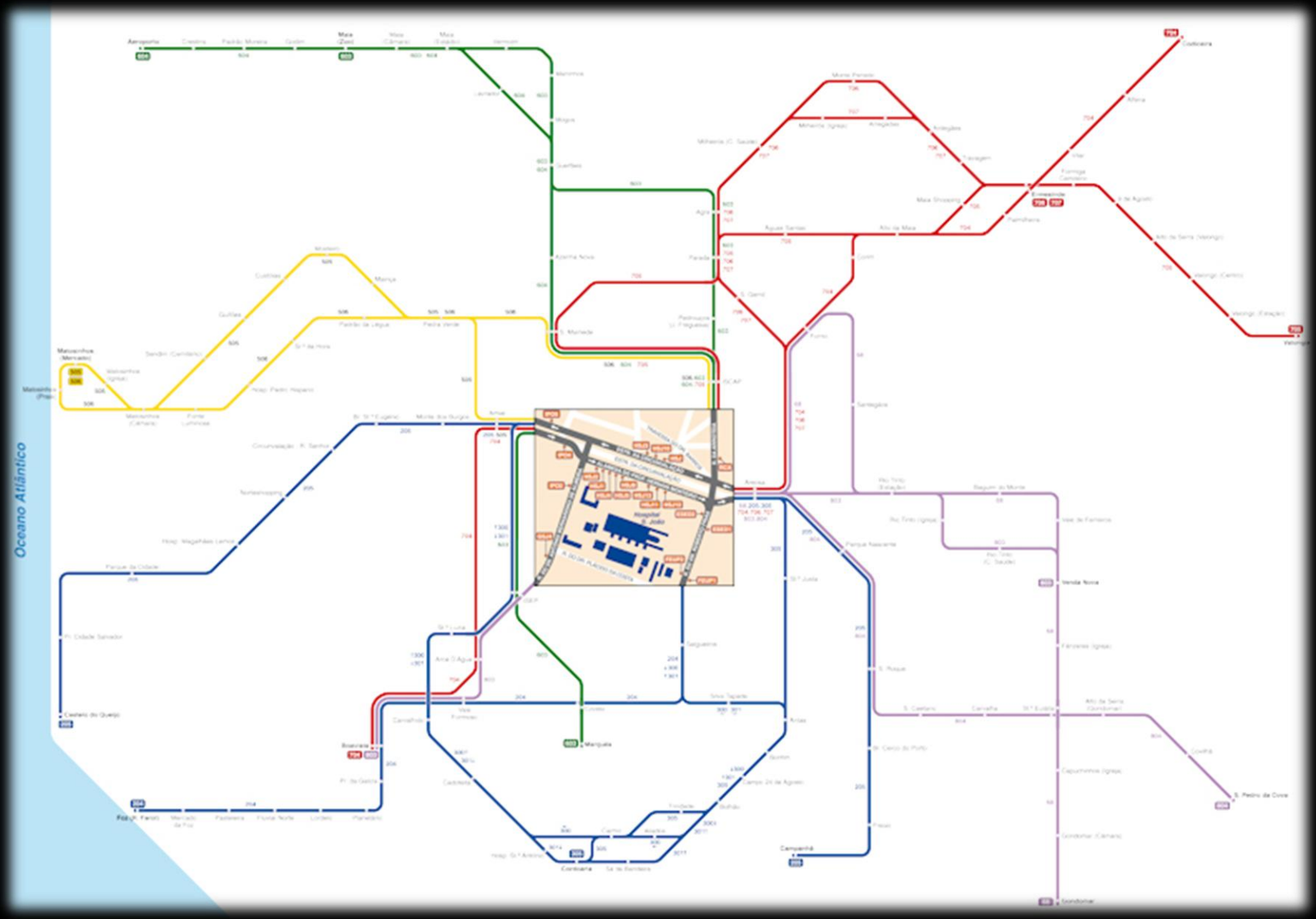
Output Schematic Map





What

.. is a Spider Map?


Oceano Atlântico
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Matosinhos (Mercado)
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Castelo do Queijo
Foz do Douro
Boavista
Marquês
Carmo
Contumil
Campanhã
Vila Nova de Gaia
Hospital S. João
Estação de Metro
Estação de Comboios
Estação de Autocarros
Parque de Estacionamento
Vila Nova de Gaia
Vila Nova de Gaia
Vila Nova de Gaia

3 What is a Spider Map

Mathematical Definition

- SpiderMap = (V,H,E_d,A) | A Spider Map is an ordered 4-tuple of a set of vertices, a hub, a set of directed edges and a set of angles
- $|A| = 2^n$, $n \in N$ | The number of angles of the edge representation is a power of 2, being n the angle resolution

Visual Properties

- Spider Architecture | Spider architecture is good for knowledge representation and to enhance information learning
- Context as a mean to enhance learning and direct information

Improving

.. Passenger Information and Trip Planning

4 Improving

- Spider map, due to its innovative design and features, is well suited to include context information | *Where am I and where can I go to?* | Improving Trip Planning

- The hub intuitively depicts the space context where the user is at the present time with higher detail | Replaces the *"you are here"* tag used in traditional maps

- The lines flowing from the hub only represent the lines available from the user's current location, not the entire network | Reduces information overload and learning time

4 Improving

Automated Production of Spider Maps materialize their advantages:

- We can change its presentation in seconds to accommodate different time contexts (ex: special events, unpredicted disruption of service at one line)

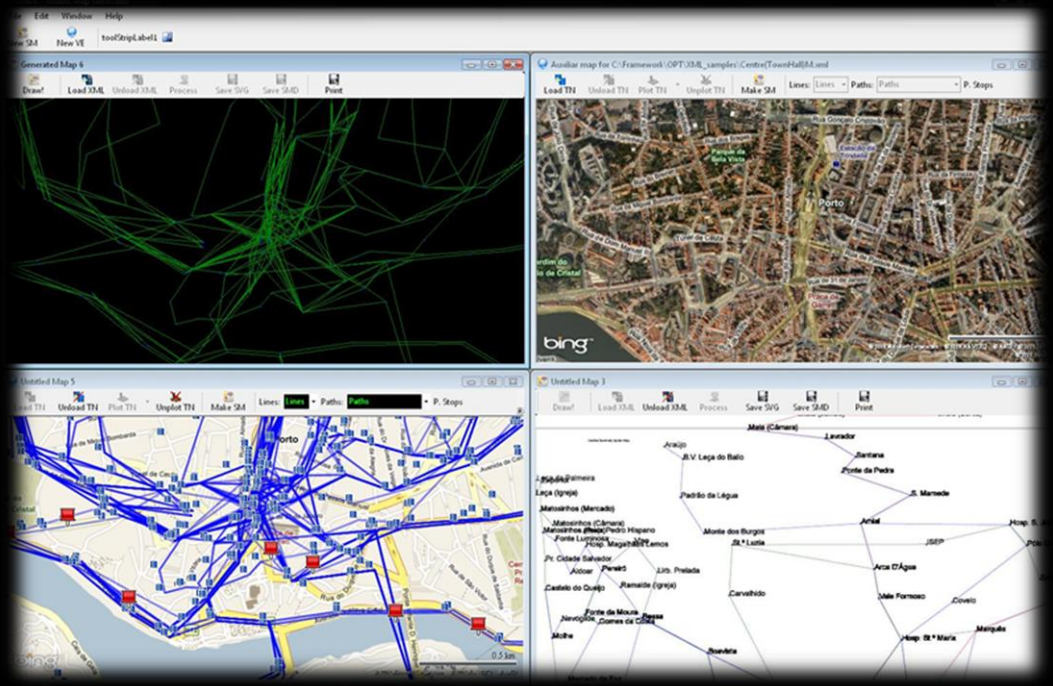
- Can be tailored to specific users in real time (ex: colorblind people, children, hotel users, etc)

- Their automated production in soft real time makes them capable of responding in real time to changes in context supporting *adaptative services* and Load Balancing

4 Improving

We developed a Software Framework

- Automated Production and testing of Spider Maps
- Schematization algorithms | GRASP, TABU SEARCH, …



4 Improving

Porto Bus System Spider Map, Portugal

Conclusions

Spider Maps, due to their definition and properties, give special attention to context and information quality | crucial to enhance passenger information and trip planning

Full potential of spider maps can only be materialized if we automate their generation

Automated Generation is possible through our Software framework | Maps already used in real world (Portugal, UK, Spain.. China)

There is further room for improvement (design quality, algorithms and further context improvement)

Thank you! | Questions ?