



# The Kernel:

## An Expert System for Image Processing

RMA - Dept CISS



# Goal

- Vectorization of scanned maps
  - Service Géo: provider of geo-data to Defense
  - 1000+ scanned maps, limited time frame and resources
  - Computer-based solution as a support

# Challenges

- Scene analysis
  - Experts still better than computers
  - Why: real-world knowledge  
reasoning on uncertain/incomplete data, etc
- Strategies
  - Propose suitable image processing strategies
  - Need to accurately describe context

# Proposed solution

- The Kernel:
  - An **expert system** dedicated to image processing
  - Use of high-level knowledge to mimic human expert reasoning

# Expert systems (1/3)

## Expert systems...

- Store expert knowledge as *rules*
- Apply rules onto observable *facts*, i.e. data
- Derive new facts and conclusions from the fired rules
- Model uncertain/incomplete data (fuzzy logics)

} Knowledge storage

} Reasoning

# Expert systems (2/3)

Applied to Image processing:

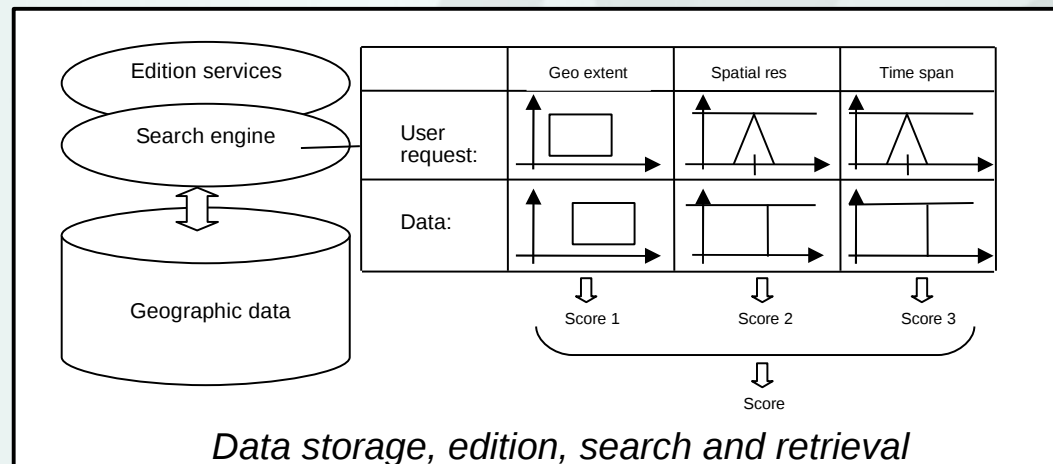
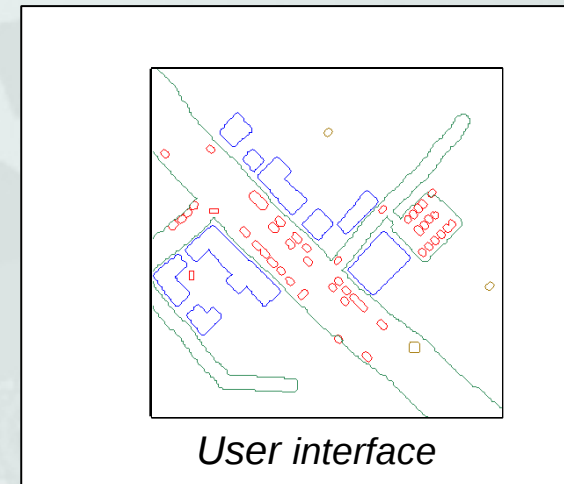
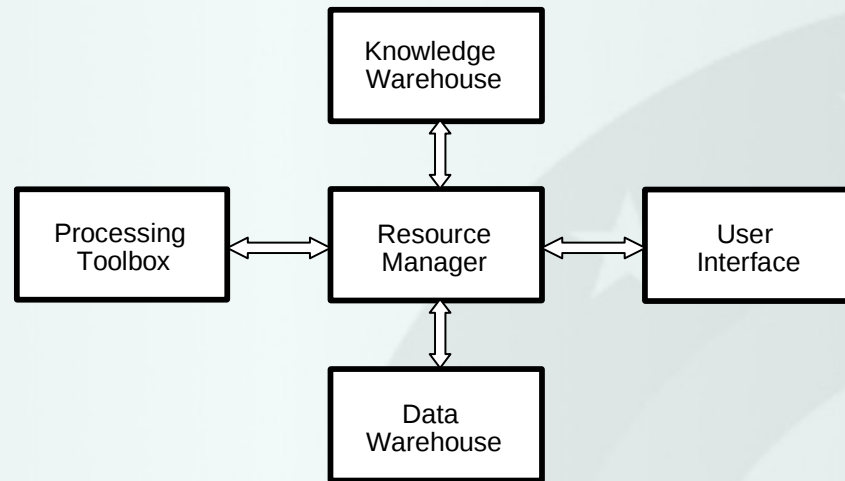
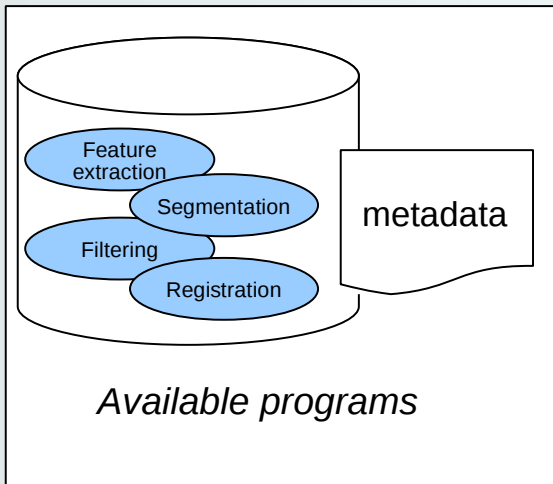
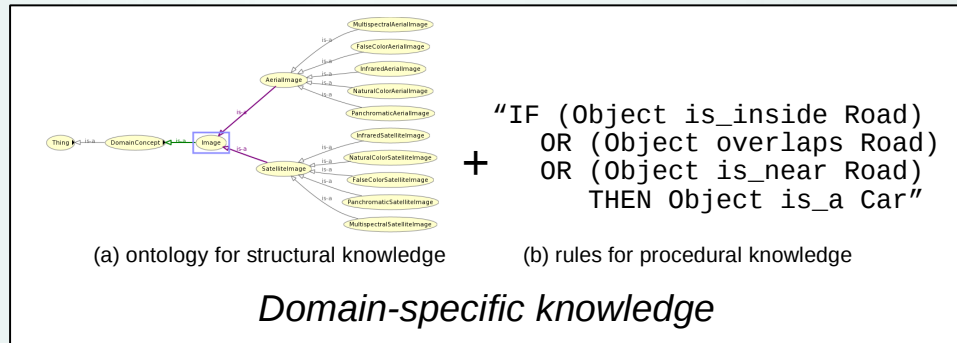
ex: pools detection:

- pool: rectangular shape, water, near a house
- facts: regions in an image (ex: segmentation)
- rule:  
“IF a region has a rectangular shape, the reflectance of water and is located near a house THEN it is likely to be a pool”

# Expert systems (3/3)

## Advantages:

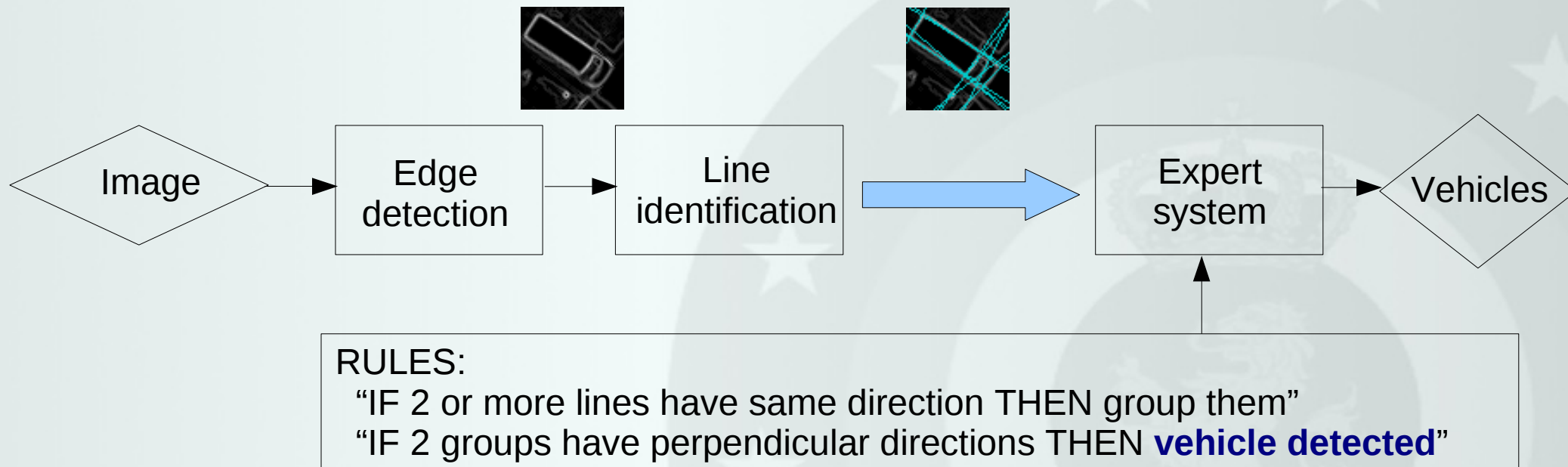
- Decoupling knowledge from reasoning
  - Generic system  
Ex: vehicle detection => other rules, same system
  - Knowledge can be re-used through projects
- System controls the order in which rules are firing  
=> discovers situations not envisaged by user



# Scene analysis (1/2)

## Detection of vehicles on VHR optical images

- 1<sup>st</sup> approach: detecting line patterns



# Scene analysis (2/2)

## Detection of vehicles on VHR optical images

- 2<sup>nd</sup> approach: detecting color patterns

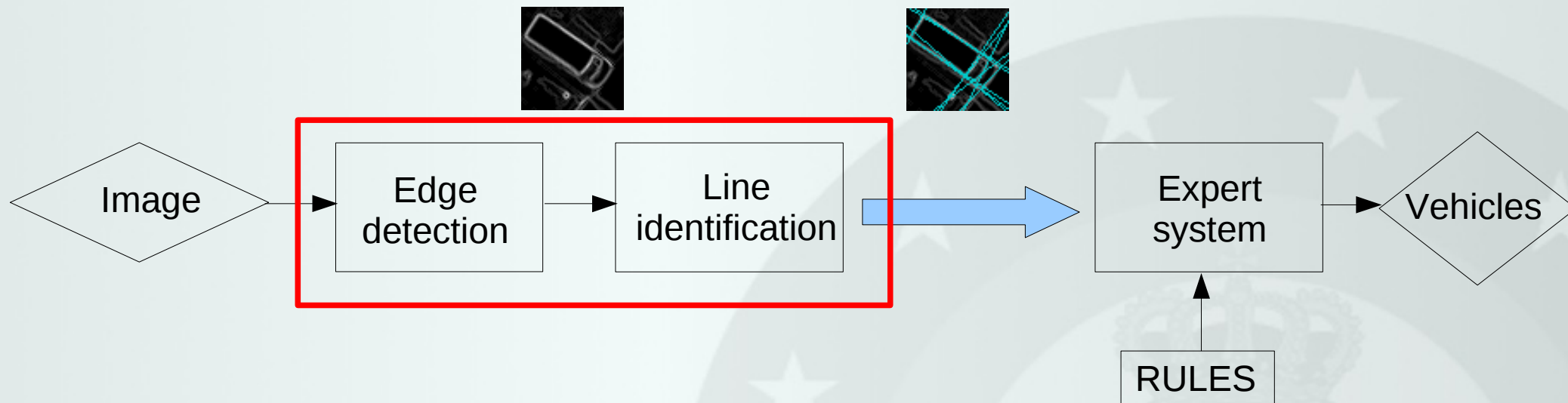


### RULES:

- “IF 2 or more touching polygons have same hue THEN group them”
- “IF 2 groups with same hue separated by a 3<sup>rd</sup> group  
AND group(1,2,3) has rectangular shape THEN **vehicle detected**”

# Strategy elaboration (1/3)

Creating a low-level processing chain



How to assemble processing units?

# Strategy elaboration (2/3)

## Creating a low-level processing chain

- Backwards reasoning:

I need to detect vehicles

=> "A vehicle has a rectangular shape"

=> I can detect lines

=> I can use Hough transform program

=> I need an edge-detected image

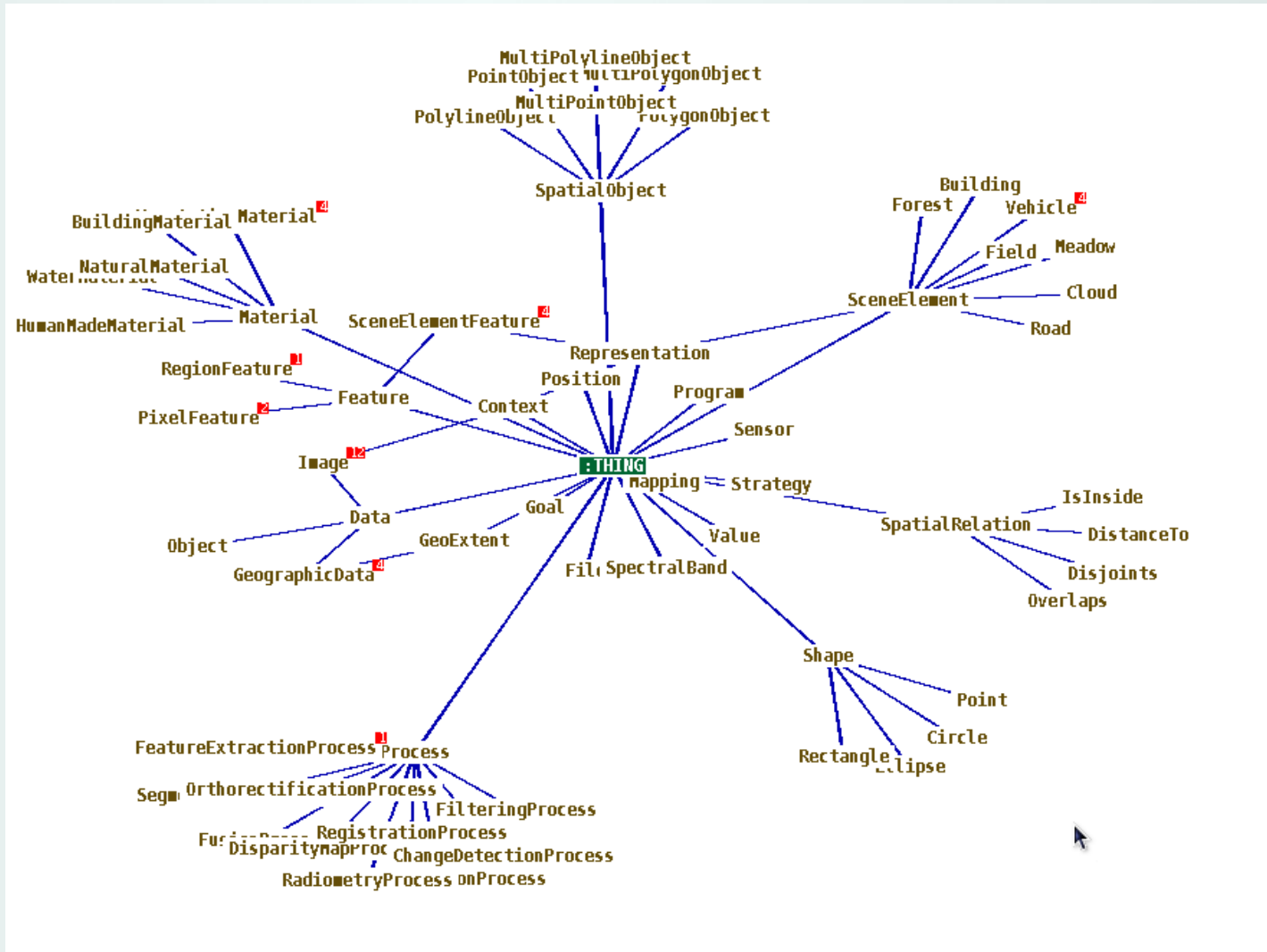
=> I can use gradient magnitude filter

=> I need an input image (will ask the Data Warehouse)

- Reasoning on "application concepts" => ontology

# Strategy elaboration (3/3)

Ontology:





# Intended use

- @ Dept CISS:
  - In-house: system for documentation, discovery, test and re-use of developed programs
  - New projects: Re-use of architecture and/or knowledge
- @ Service Geo:
  - Support to map vectorization