

Statistical Relational Learning

Lifted Inference Methods based on Belief Propagation & Graph Cuts



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Statistical Relational
Activity Mining



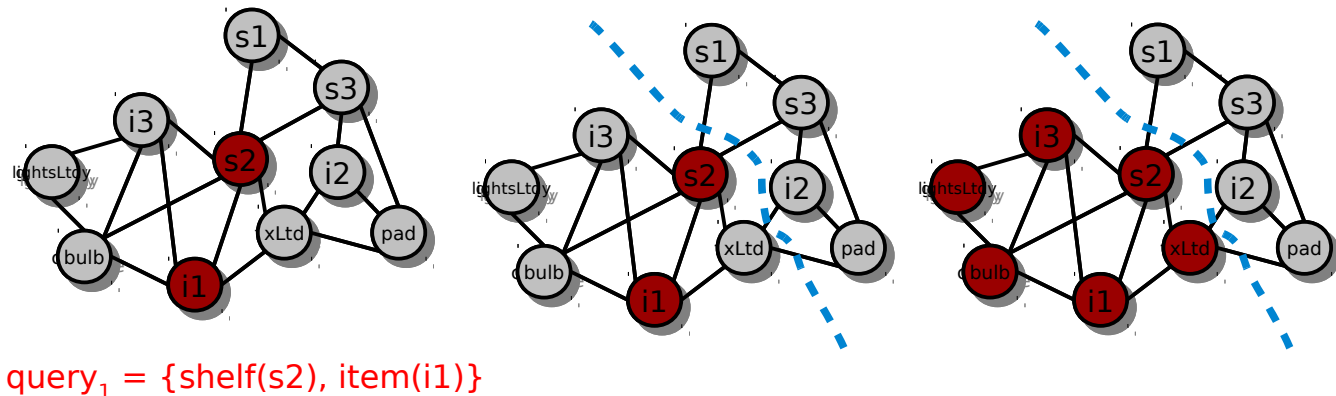
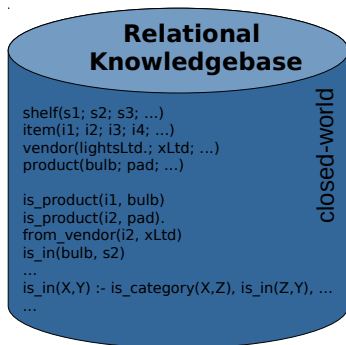
Interactive Segmentation of Relational Knowledge via Graph Cuts

■ WHAT is relational Segmentation?

Image Segmentation:



Relational Segmentation:



We **segment** relational data into foreground and background.

Interactive Segmentation of Relational Knowledge via Graph Cuts

■ WHAT EXACTLY is relational Segmentation?

- infer fg/bkg state of RVs → segmentation
- in richly structured domains → relational data
- interactively → adaptive to dynamic environments/ queries
- prior knowledge → Bayesian inference

■ WHY do we need relational Segmentation?

Huge amounts of **complex** relational knowledge

- ➔ **www**, YAGO (<http://www.mpi-inf.mpg.de/yago-naga/yago>), bioinformatics, robotics, ...
- information retrieval, planing, localization, reasoning
- analysis of complex data, knowledge representation
- scalable inference methods

■ HOW to perform relational Segmentation?

- Graphical Models (e.g. Markov Networks)
- Graph Cuts (exact; efficient; successfull in Computer Vision

Boykov et al., PAMI, '04
Szeliski et al., ECCV, '06)

Interactive Segmentation of Relational Knowledge via Graph Cuts

■ Scenario: Fetch-And-Carry

- mobile-manipulation robot
- dynamic environment
- partly known maps
- uncertainty
- efficient/fast inference



■ Scenario: Capitals of Europe (Information Retrieval)

- searching by examples
- query completion
- Bayesian Sets [Ghahramani et al., NIPS, '05](#) / GoogleSets
- uncertain information/ entity resolution

london berlin france

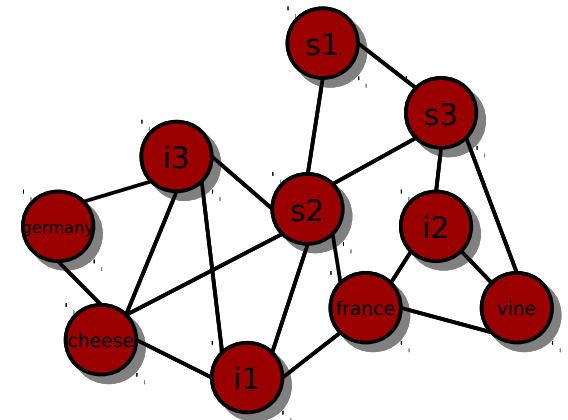
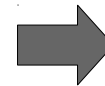
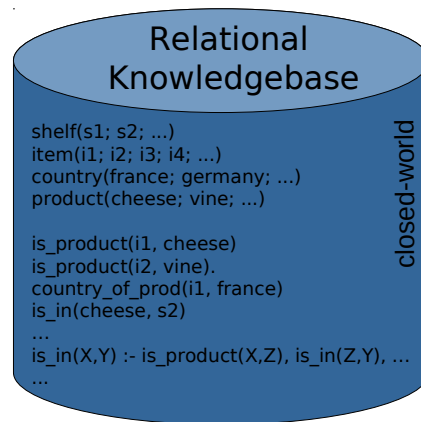
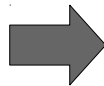
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continent(europe)
city(vienna)
country(germany)
city(amsterdam)
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Interactive Segmentation of Relational Knowledge via Graph Cuts

■ Illustrative Example



complex and dynamic¹ environment



graphical representation
→ Markov Network

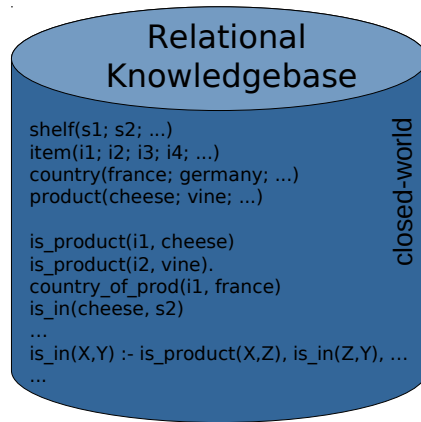
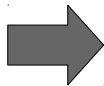
¹ We are not modeling the dynamic environment, but we can cope with changing situations/ queries in our relational world.

Interactive Segmentation of Relational Knowledgebase via Graph Cuts

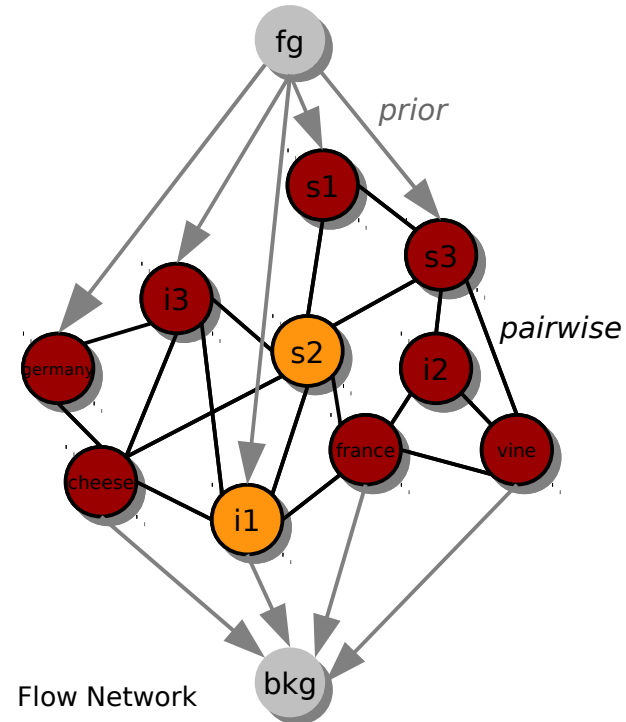
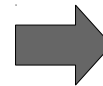
■ Illustrative Example



complex and dynamic environment



query = {shelf(s2), item(i1)}

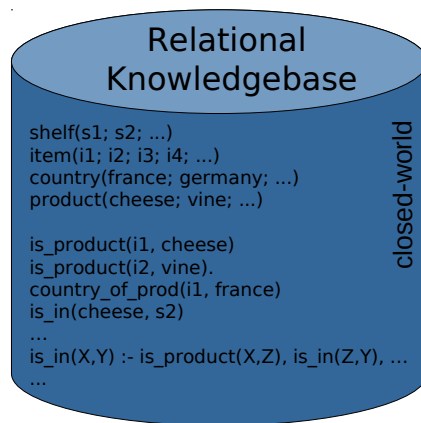


Interactive Segmentation of Relational Knowledgebase via Graph Cuts

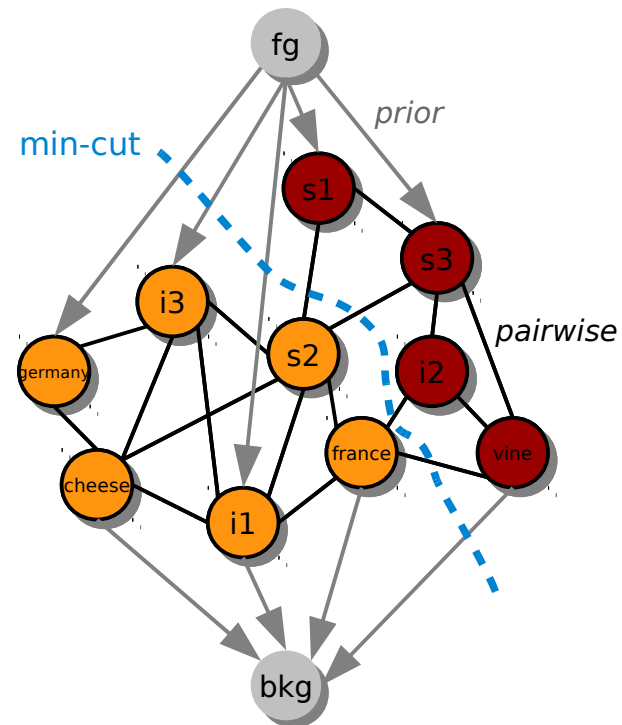
■ Illustrative Example



complex and dynamic environment



query = {shelf(s2), item(i1)}



fg = {shelf(s2), item(i1), country(france),
item(i3), product(cheese), ...}

bkg = {shelf(s3), item(i2), ...}

Interactive Segmentation of Relational Knowledge via Graph Cuts

■ So far:

- **problem formulation** for relational segmentation
- open up possibilities to do fast and scalable inference in Graphical Models
- deal with highly structured, incomplete and noisy data

■ Extending/ Generalizing:

- (interactive) image segmentation [Boykov et al., ICCV, '01](#)
- Bayesian Sets [Ghahramani et al., NIPS, '05](#), Google Sets (<http://labs.google.com/sets>)
- relational keyword search [Markowetz et al., SIGMOD, '07](#)

■ Work in Progress:

- **applications** in information retrieval and **robotics**
- **lifted** graph cuts
- ...

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- **Thanks for your attention!**
 - **Questions?**

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