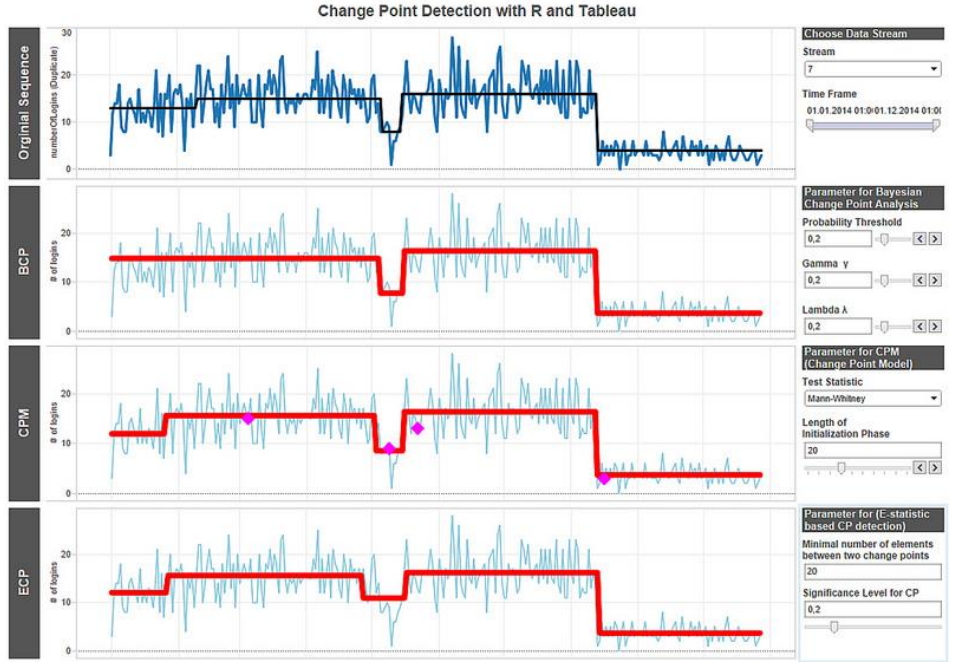
UBC MLRG (Summer 2016): Miscellaneous

Some images from this lecture are taken from Google Image Search.

Changepoint Detection

- 540 covers hidden Markov models:
  - Finds latent “modes” and latent dynamics in time-series.
- Changepoint detection:
  - Task of finding breakpoints where time series distribution changes.
- Key advantage:
  - May be easier than fitting generative HMM.
- Key applications:
  - Bioinformatics.
  - Econometrics.



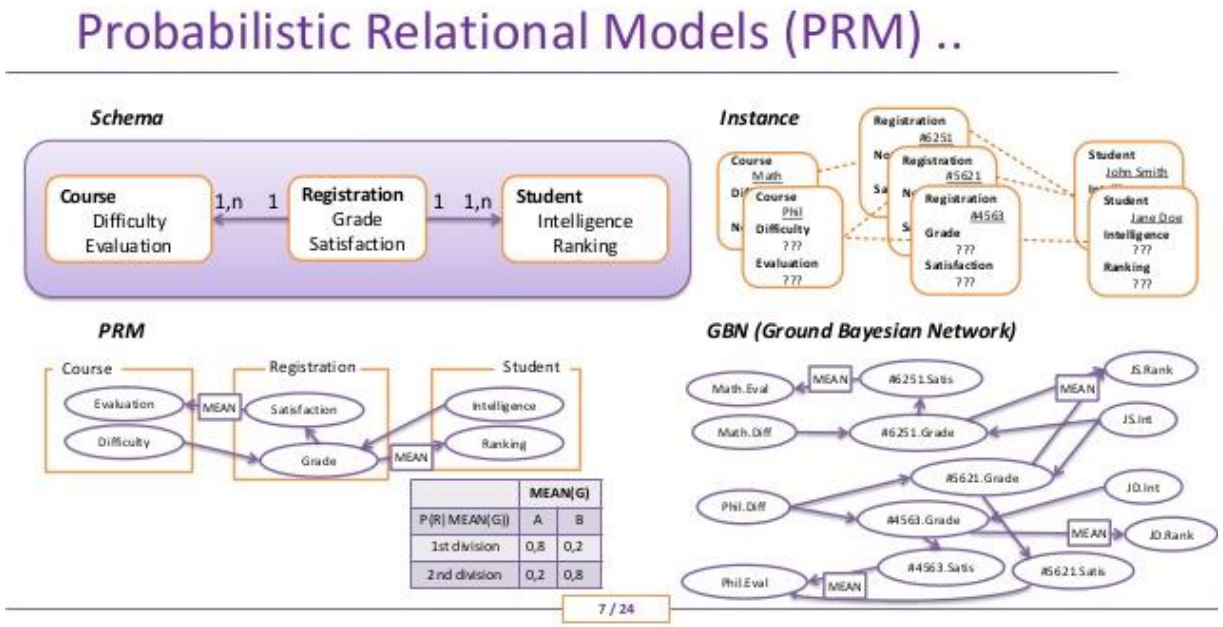
Sub-Modularity

- 540 covers convexity:
  - Class of continuous functions that is easy to minimize.
- Sub-modularity:
  - Class of discrete functions that is easy to minimize.
  - Algorithms also exist for approximate maximization.
- Key advantage:
  - Expands class of efficiently-solvable problems.
- Applications:
  - Computer vision.
  - Sensor networks.
- Related: QUBO.

Figure 1 From a set of five source images (of which four are shown on the left), we quickly create a composite family portrait in which everyone is smiling and looking at the camera (right). We simply flip through the stack and coarsely draw strokes using the *designated source* image objective over the people we wish to add to the composite. The user-applied strokes and computed regions are color-coded by the borders of the source images on the left (middle).

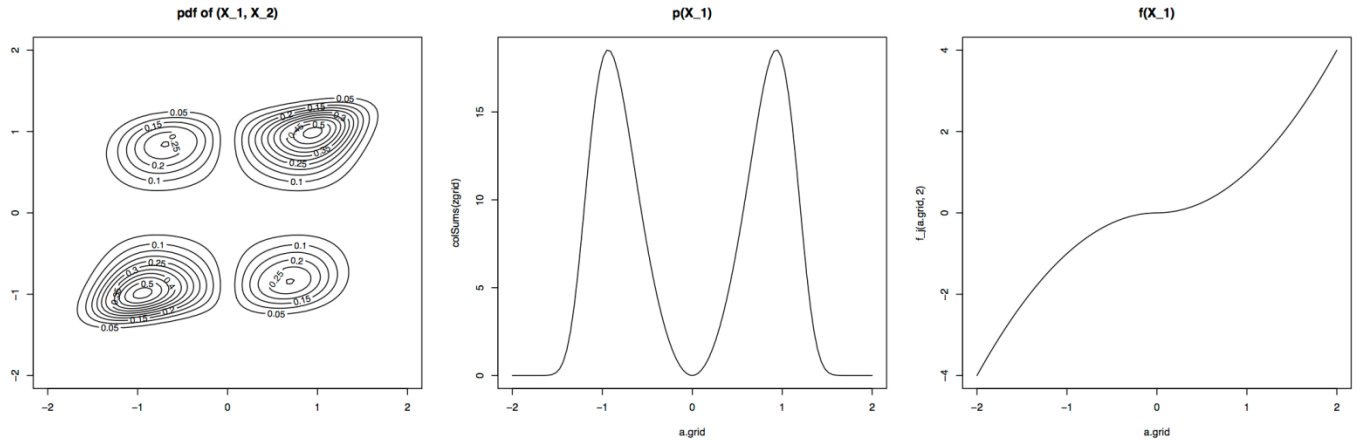
Relational Models

- 540 covers Bayesian networks:
  - Describes relationships between variables.
- Probabilistic relational models and Markov logic networks:
  - We have “types” of variables and probabilities on logical statements.
- Key advantage:
  - More expressive language.
- Applications:
  - Adding probabilities to databases.
- Related: sum-product networks.

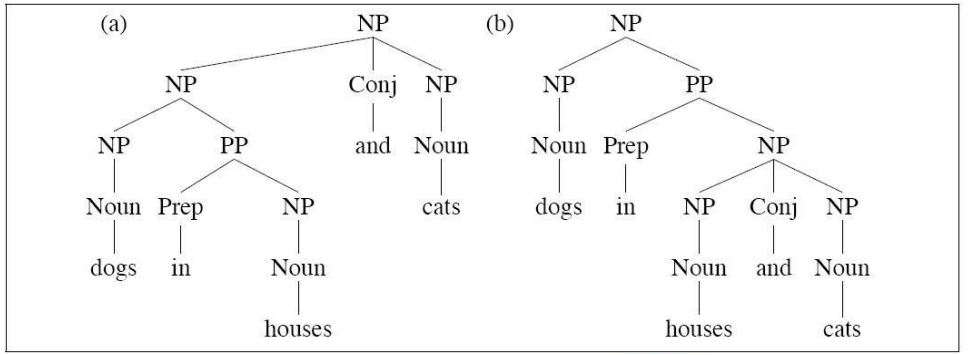


Continuous Graphical Models

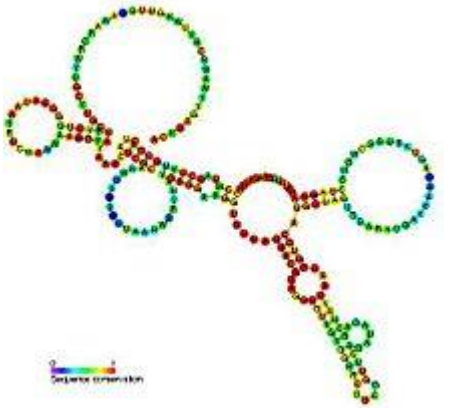
- 540 covers discrete and Gaussian graphical models:
  - Convenient due to conjugacy.
- Nonparanormal and Gaussian-copulas models:
  - More flexible continuous distributions.
- Key advantage:
  - Gaussians are very restricted class.
- Applications:
  - Stock market crash of 2008.



Grammars



- 540 covers Markov models:
  - Useful for modeling sequence data with Markov assumption.
  - Can be generalized to Bayesian networks.
- Probabilistic context-free grammars:
  - Different generalization using “recursive” Markov assumption.
- Key advantage:
  - Dependencies at different scales.
- Applications:
  - Natural language processing.
  - RNA secondary structure.
- Related: And-Or trees, image grammars.



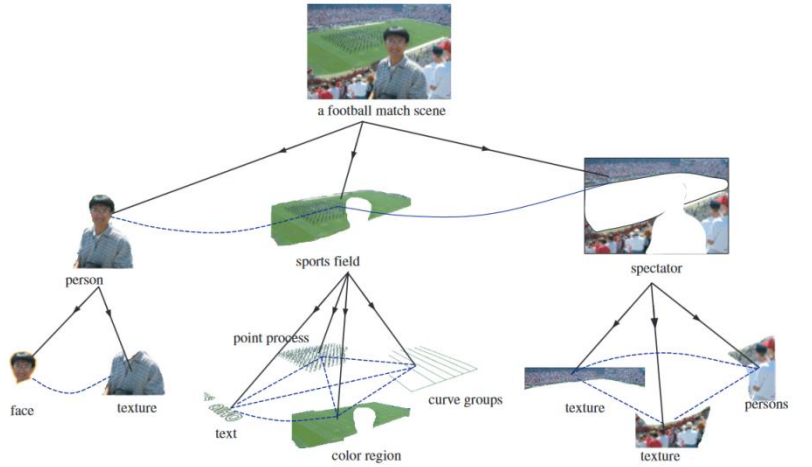


Fig. 1.1 Illustrating the task of image parsing. The parse graph includes a tree structured decomposition in vertical arrows and a number of spatial and functional relations in horizontal arrows. From [72].

Spectral Methods

- 540 covers expectation maximization:
  - Only finds local optimum.
- Spectral methods:
  - Consistent estimators.
- Key advantage:
  - No local minima if you have enough data.
- Applications:
  - All the usual HMM applications.

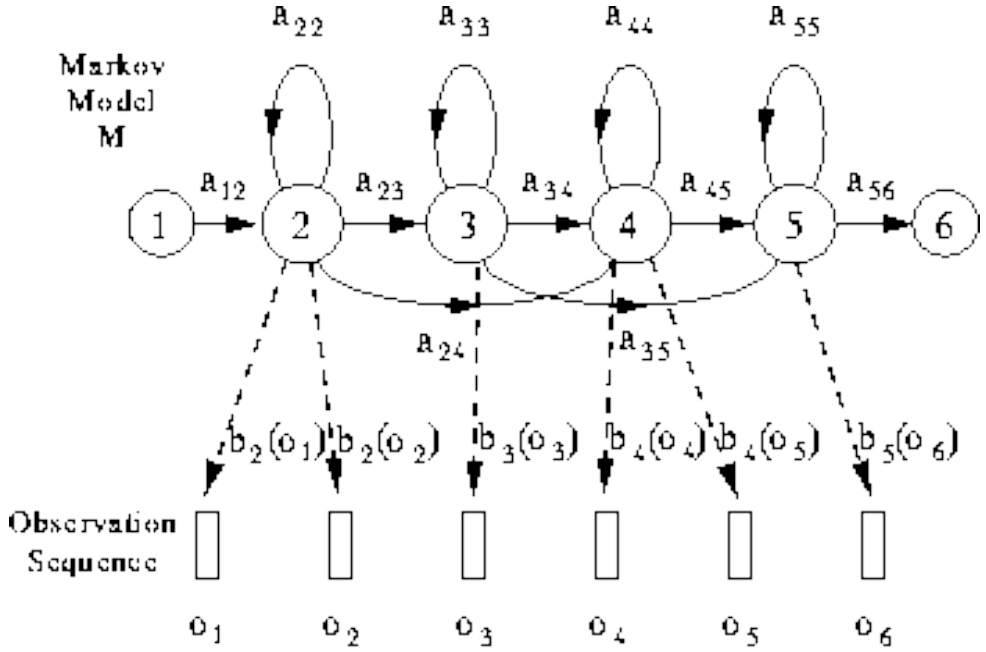


Fig. 1.3 The Markov Generation Model