Understanding graph-cuts first

- Learning through example
Example – Graph-cuts for hiring

You are hiring John and Amy for two locations

Goal – minimize the cost
Example – Graph-cuts for hiring

A labeling problem

Seattle

John

Amy

New York
Example – Graph-cut for hiring

We pay 160 units

Seattle

90

John

Amy

80

100

New York
Example – Graph-cuts for hiring

We pay 160 units

Graph-cut

Seattle

John

80

Amy

New York

Graph-cut

90

80

100
Example – Graph-cuts for hiring

We pay ??? units
Example – Graph-cuts for hiring

We pay ??? units

Seattle

New York

Graph-cut

John

Amy
Example – Graph-cuts for hiring

- We pay 220 units
- Is it the best deal?

Seattle

Graph-cut

90

60

80

100

New York

John

Amy
Example – Graph-cuts for hiring

We pay 170 units
Is it the best deal?
Example – Graph-cuts terminology

Interactions are more complicated now
Example – Graph-cuts terminology

Interactions are more complicated now

Seattle

Data term

John

90

80

60

Amy

New York

80

100
Example – Graph-cuts terminology

Interactions are more complicated now

Data term

Regularization term

Seattle

John

Amy

New York
Labeling problem on graph nodes

Total penalty has two terms
- **Data term** – for assigning label to node
- **Regularization** – for assigning labels to neighbors, tries to keep them together

Minimize

(Data term) + (Regularization)
Solving Graph-cuts optimization

- For \#(labels) = 2

Exact solution by max-flow-min-cut algorithm
Solving Graph-cuts optimization

- For #(labels) > 2

Approximate solution by alpha-expansion, belief propagation etc.
Solving Graph-cuts optimization

- Good news: Standard solvers are available!
- You can get graph-cuts optimization code from Vladimir Kolmogorov’s website

http://www.cs.ucl.ac.uk/staff/V.Kolmogorov/software.html
Applications of graph-cuts to images

- **GrabCut (Interactive Foreground Extraction)**
  
  *Rother et al., SIGGRAPH 2004*
  
  
  *[Microsoft Research]*

- **Digital Photomontage**
  
  *Agarwala et al., SIGGRAPH 2004*
  
  
  *[University of Washington, Microsoft Research]*
Problem of assigning labels to nodes in graph

- Each node has some cost for a label
- Neighboring nodes have costs based on their labelings
- Under some conditions over cost values,

**Standard graph cut algorithms can be used to minimize the total cost of labeling**