קורס גרפיקה ממוחשבת

2008 סמסטר ב'

Image Processing II

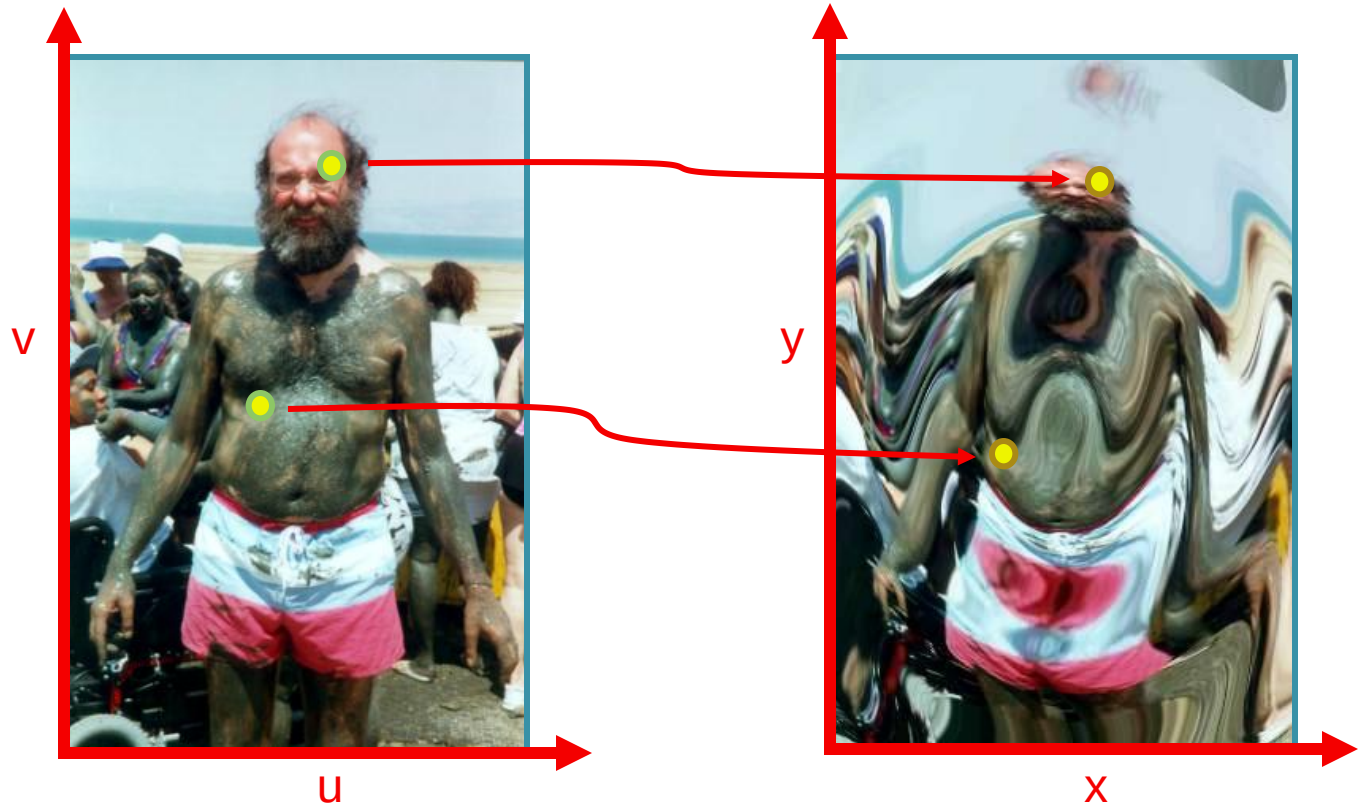
חלק מהשקפים מעובדים משקפים של פרדו דוראנד, טומס פנקהאוסר ודניאל כהן-אור

Agenda

- Warping to Mapping
- Seam Carving

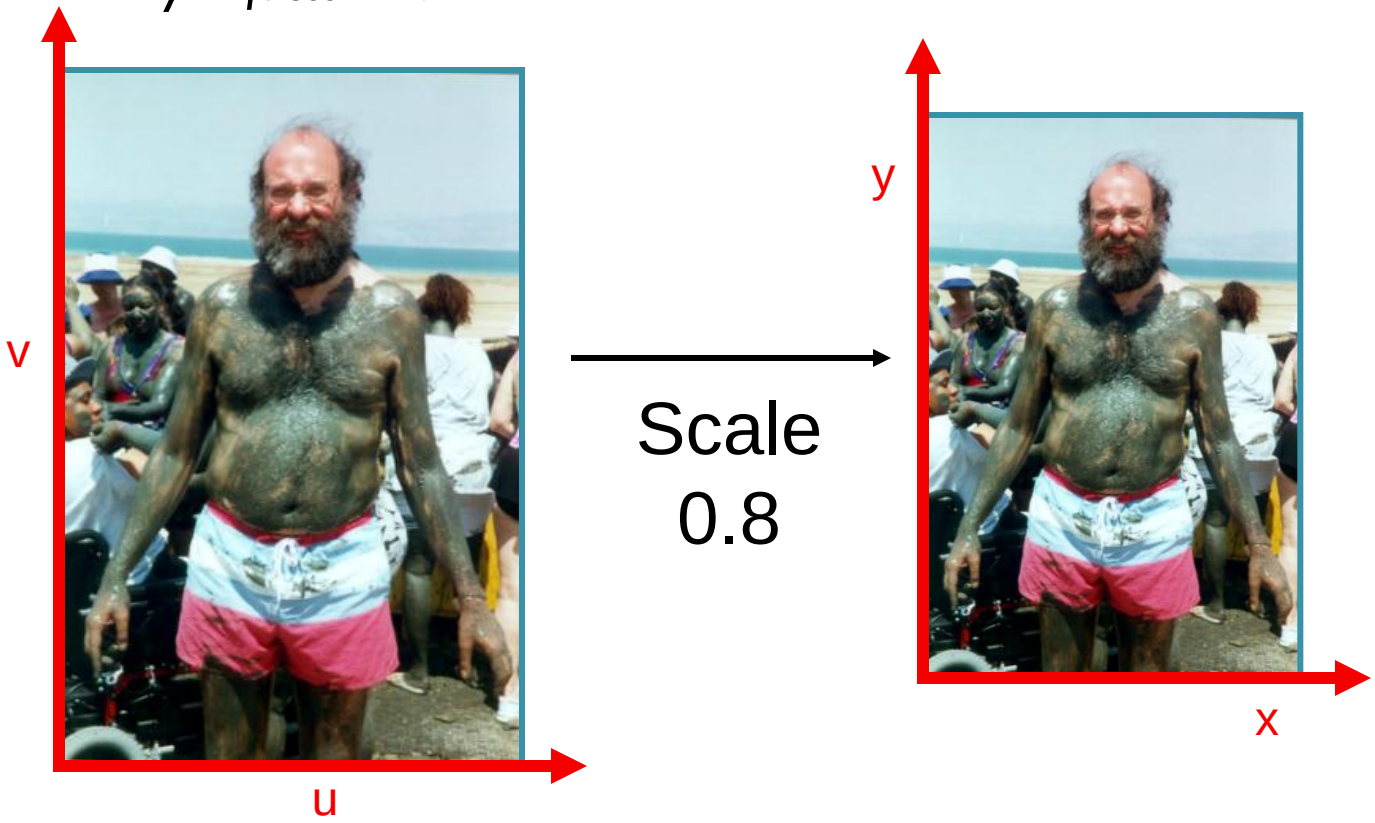
Mapping

- Last time we started to discuss warping and mapping
- In general, we define a transformation
  - Destination (x,y) for every source (u,v)



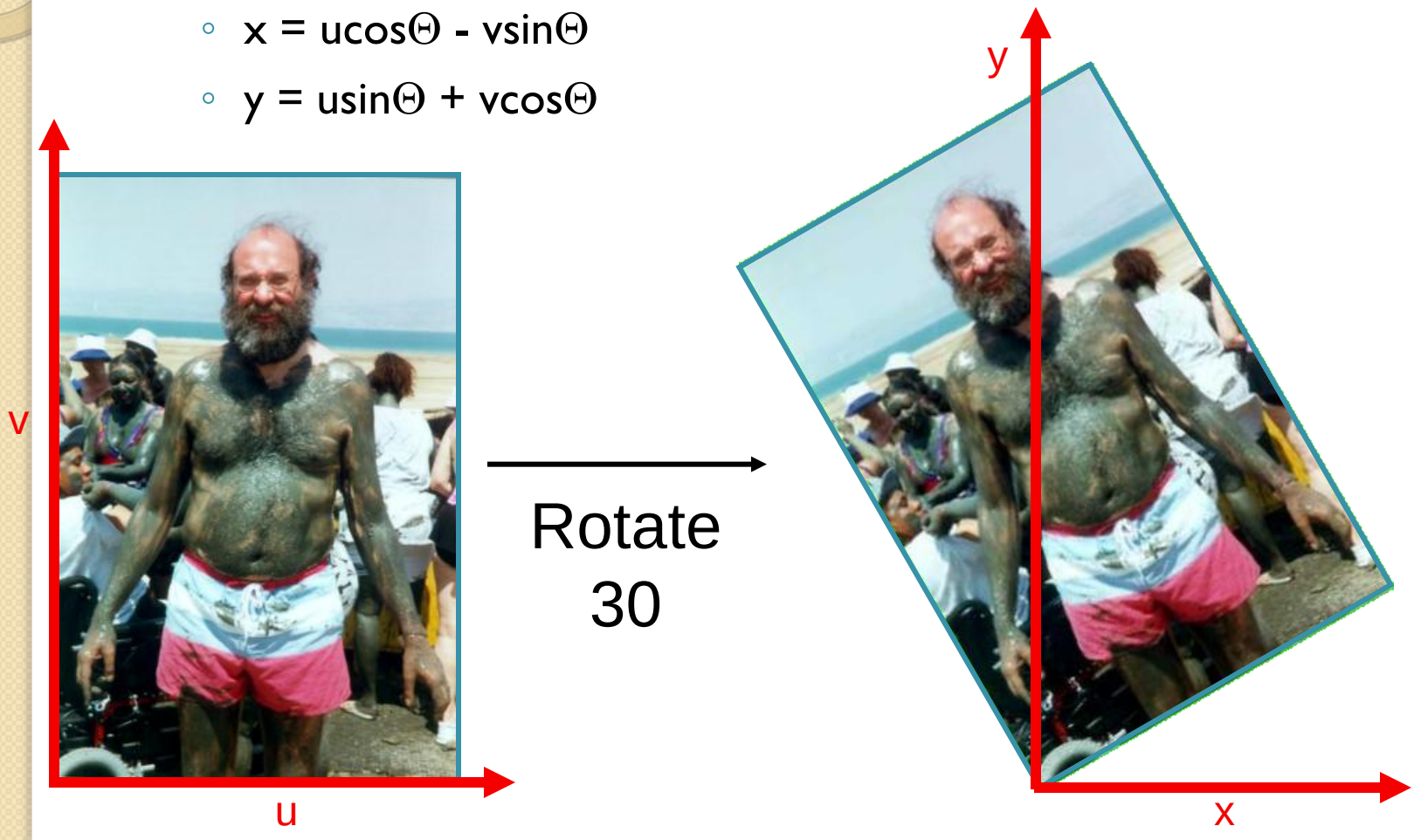
Example Mappings

- Scale by *factor*:
  - x = *factor* * u
  - y = *factor* * v



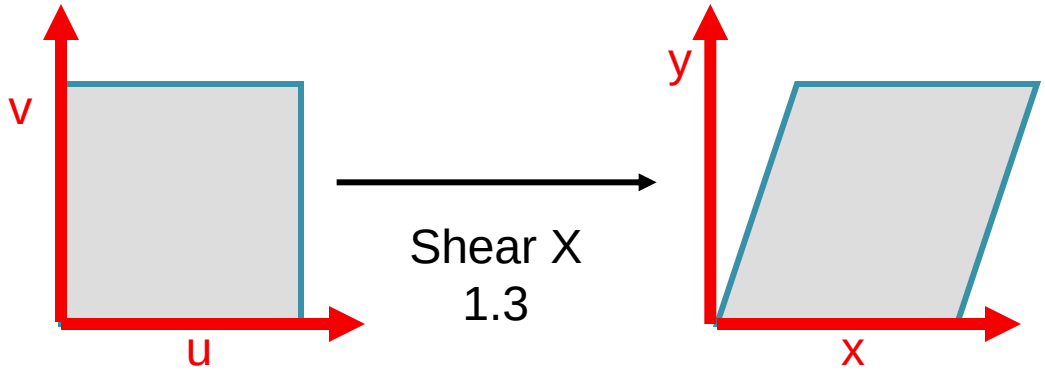
Example Mappings

- Rotate by Θ degrees:
  - x = ucosΘ - vsinΘ
  - y = usinΘ + vcosΘ

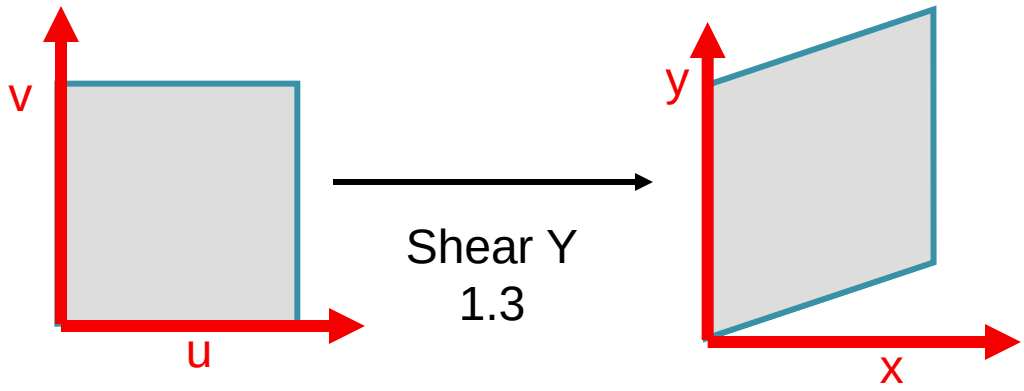


Example Mappings

- Shear in X by *factor:*
  - x = u + *factor* * v
  - y = v



- Shear in Y by *factor:*
  - x = u
  - y = v + *factor* * u

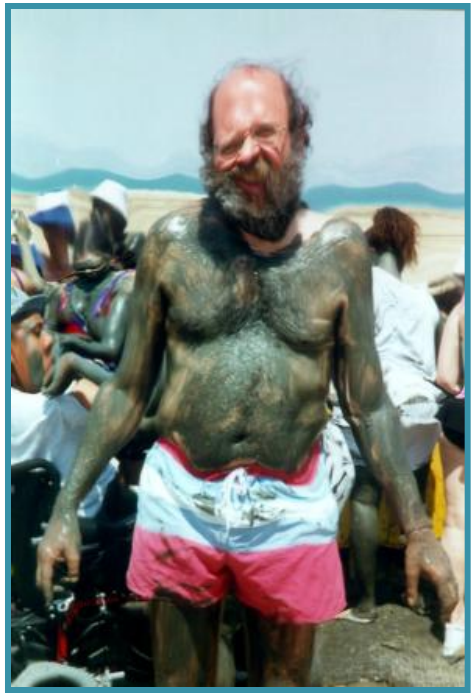


Other Mappings

- Any function of u and v:
  - $x = f_x(u,v)$
  - $y = f_y(u,v)$

Fish-eye

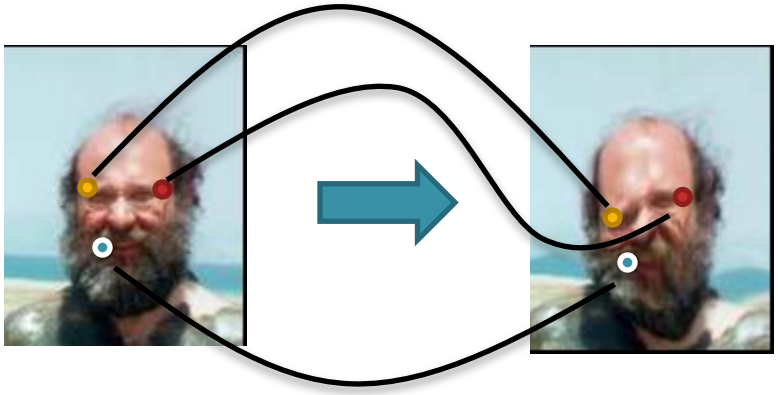
"Swirl"



"Rain"

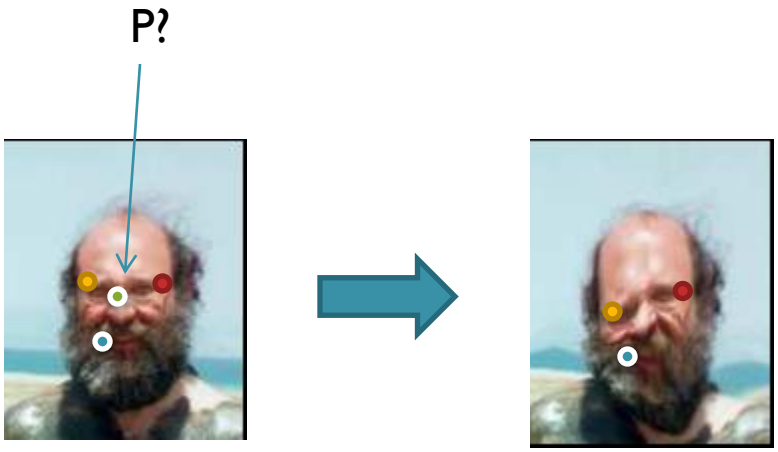
Point Correspondence

- Another way to define mapping is by correspondences
  - A ←→ A’
  - B ←→ B’
  - C ←→ C’



Point Correspondence

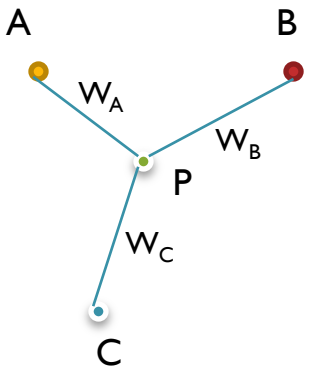
- Another way to define mapping is by correspondences
  - A ←→ A’
  - B ←→ B’
  - C ←→ C’

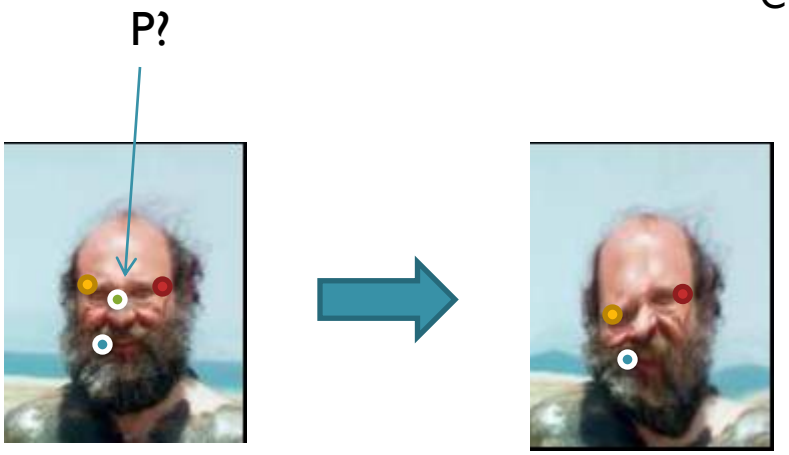


Point Correspondence

- How to compute P'

$$P' = w_A A + w_B B + w_C C$$



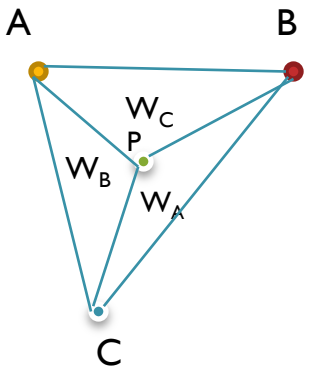


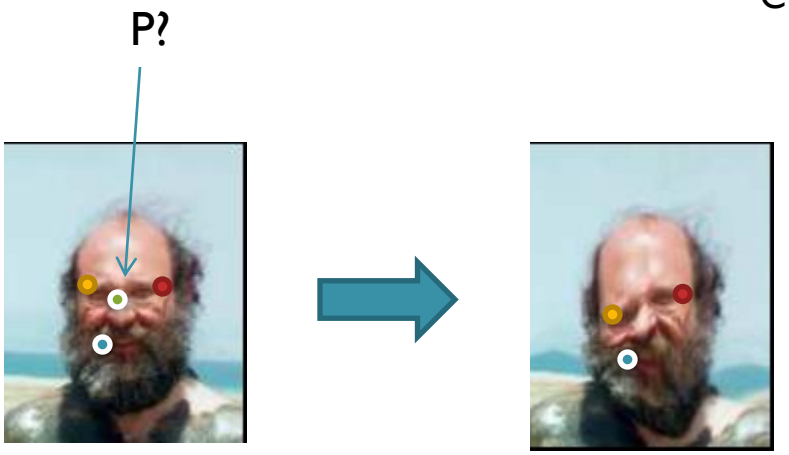
Point Correspondence

- How to compute P’

$$P' = w_A A + w_B B + w_C C$$

Barycentric Coordinates





Possible application: Morphing

- User specifies corresponding points
- Blend while warping

Seam Carving

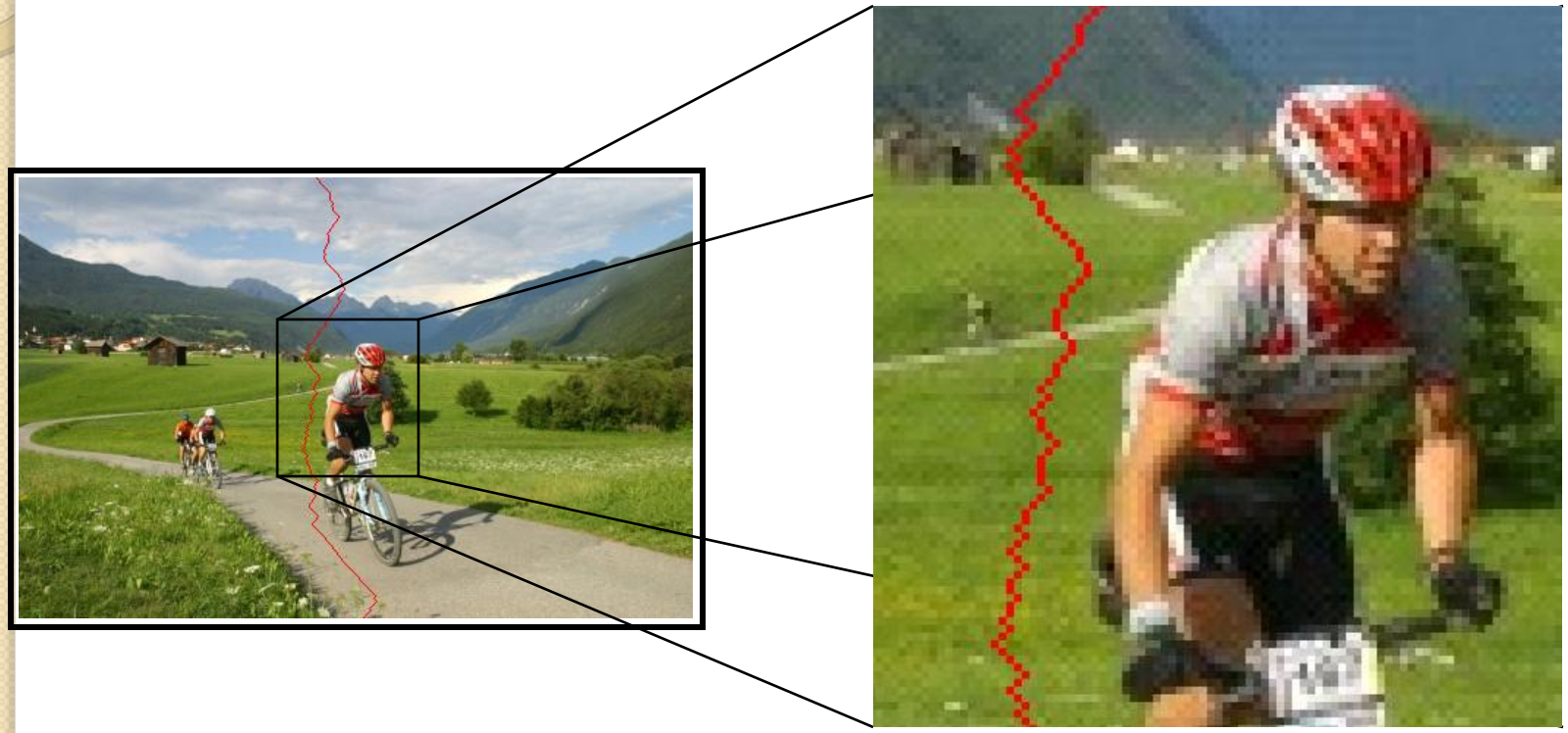
- Seam Carving for Content-Aware Image Resizing
- A 2007 SIGGRAPH paper
  - Ariel Shamir (IDC)
  - Shay Avidan (MERL)

Seam Carving

Cropping

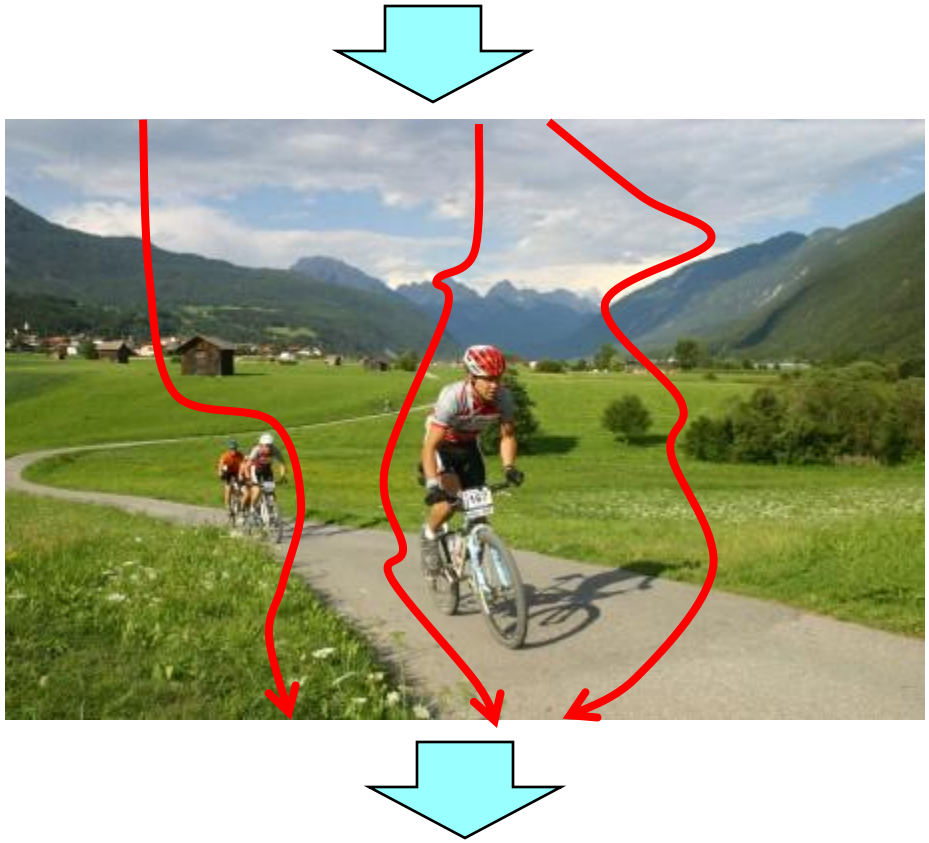
Scaling

A Seam

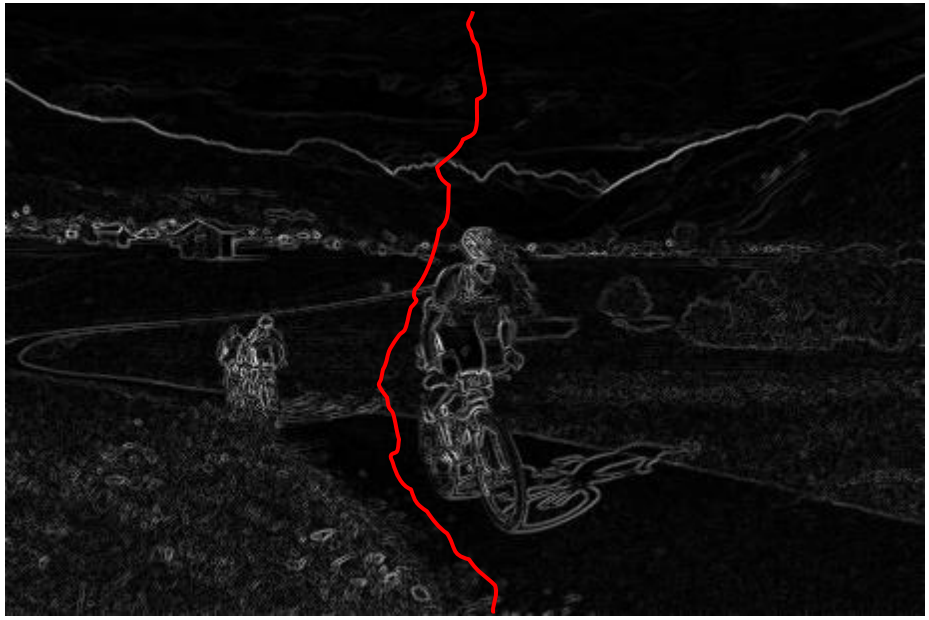


Seam Carving

Finding the Seam?

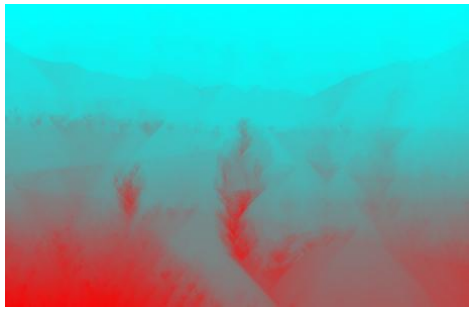


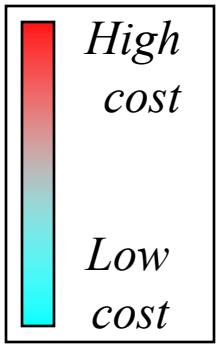
Finding the Optimal Seam

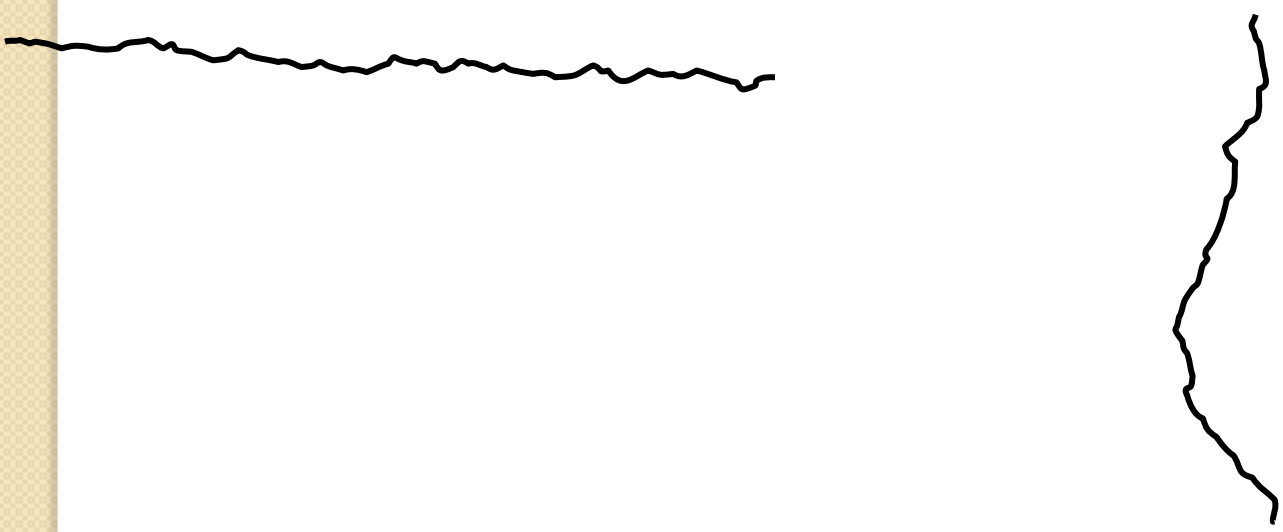


$$\Rightarrow s^* = \arg\min_{s} E(s)$$

Dynamic Programming





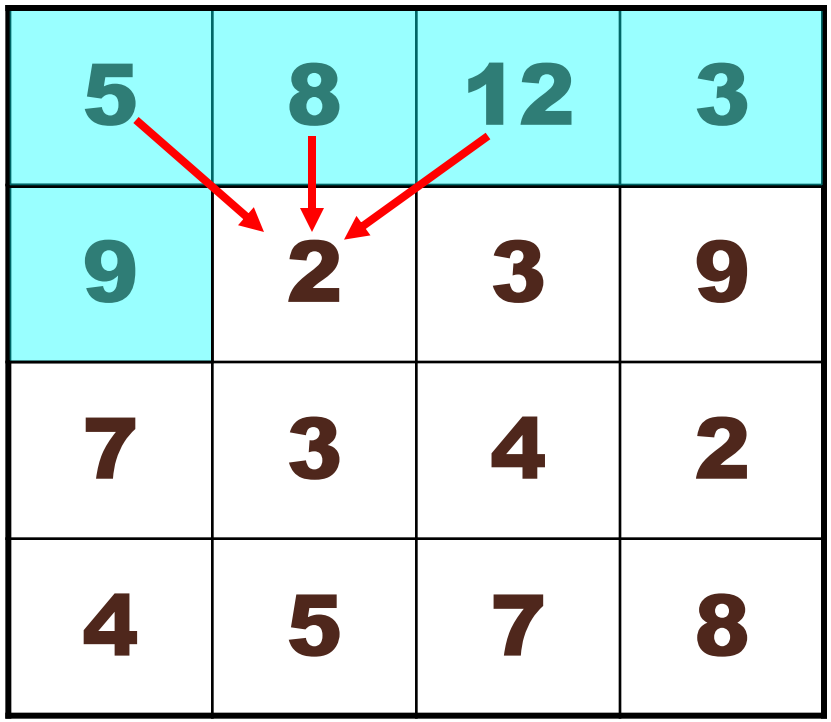


Horizontal Cost

Vertical Cost

Dynamic Programming

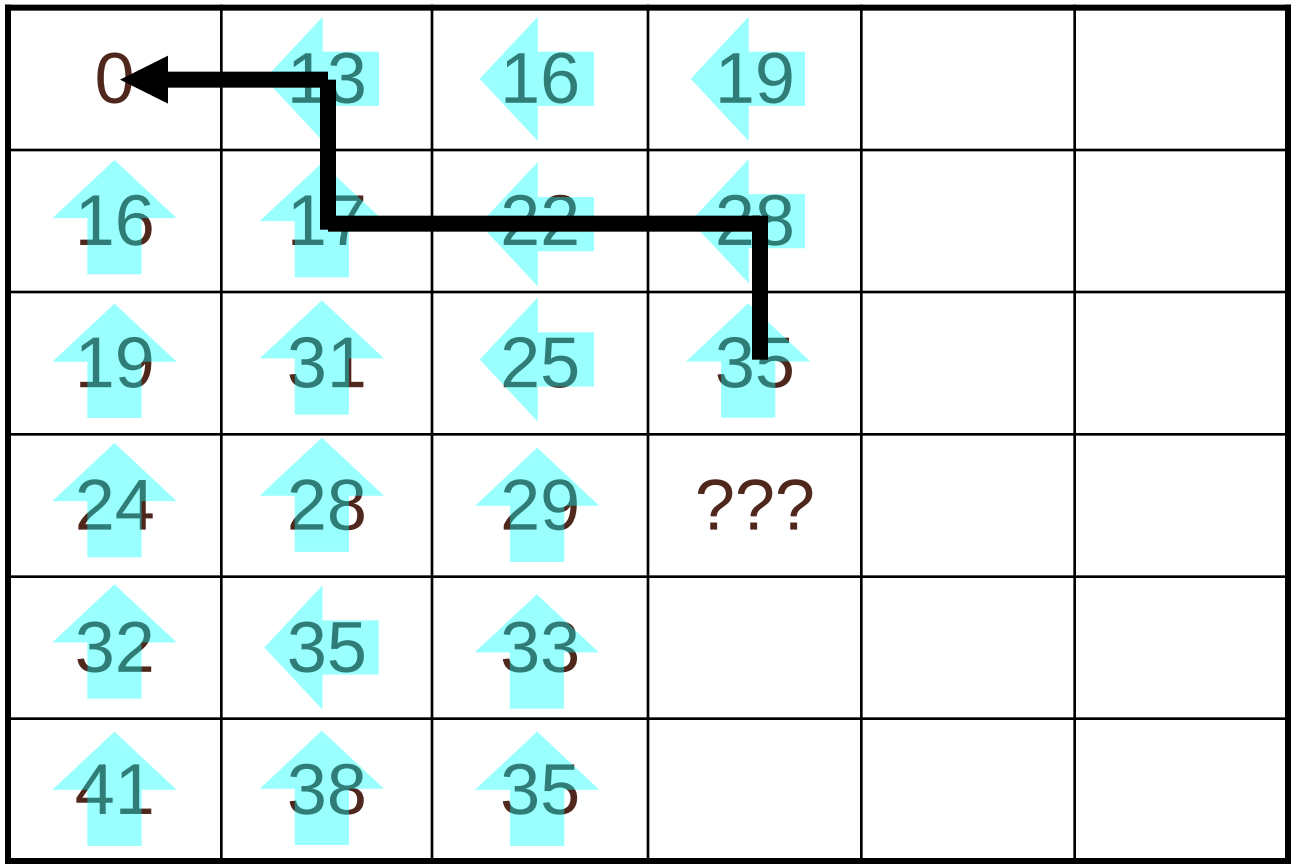
M(*i*,



Optimal Order Map

*Removal of **vertical** seams*

*Removal of **horizontal** seams*



A Local Operator!

Aspect Ratio Change

Aspect Ratio Change

Original

Seam Carving

Scaling

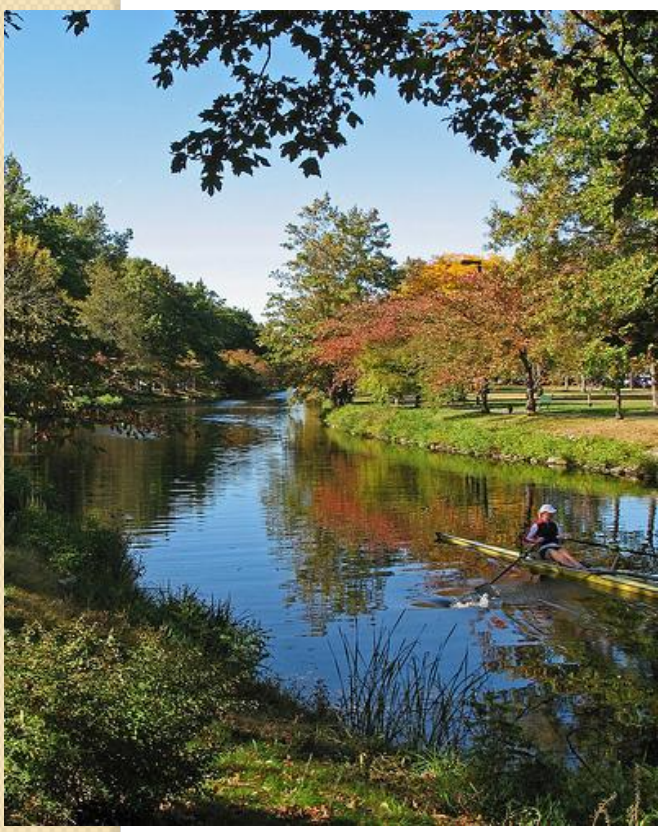
Aspect Ratio Change

Cropping

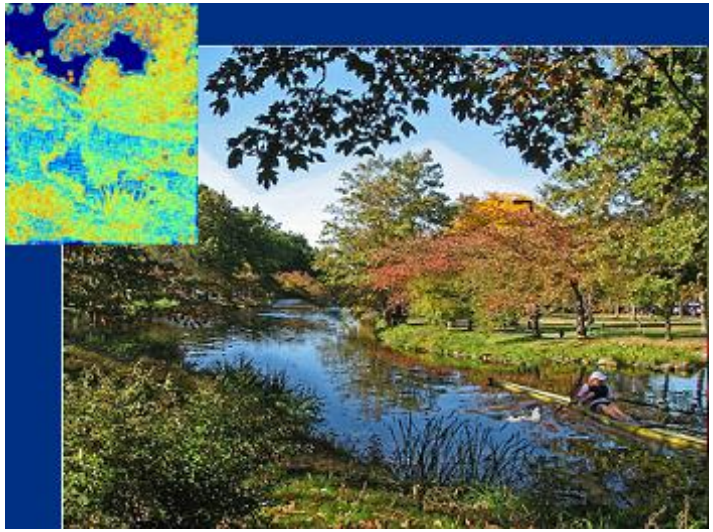
Seams

Scaling

Different Energy Functions



- *Histogram of Gradient*
- *Entropy*
- E_1
- *Mean shift &* E_1



Energy Preservation

Energy

10%

30%

40%

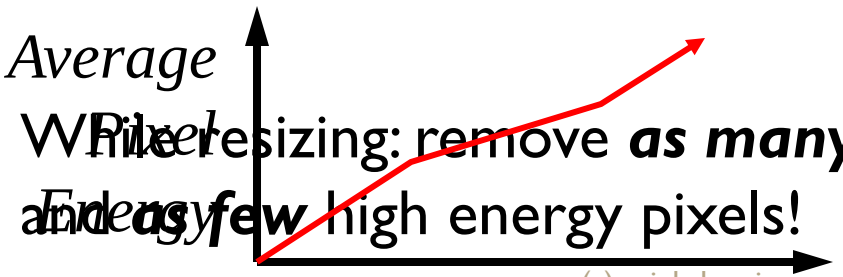
75%

While resizing: remove ***as many*** low energy pixels and ***as few*** high energy pixels!

Energy Preservation

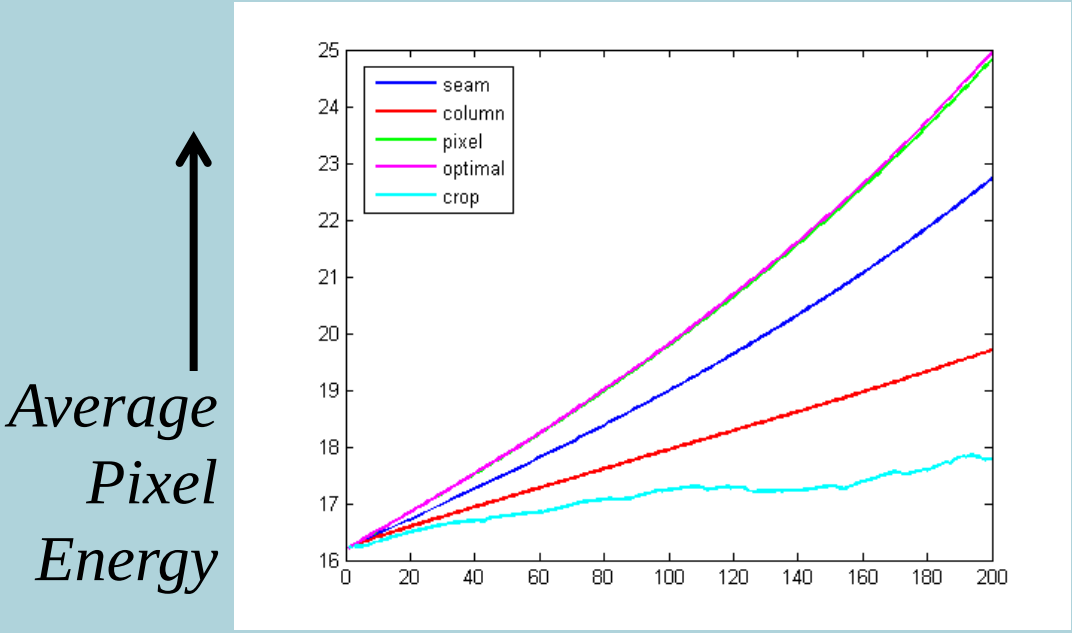
If we measure the average energy of pixels in the image after applying a resizing operator…

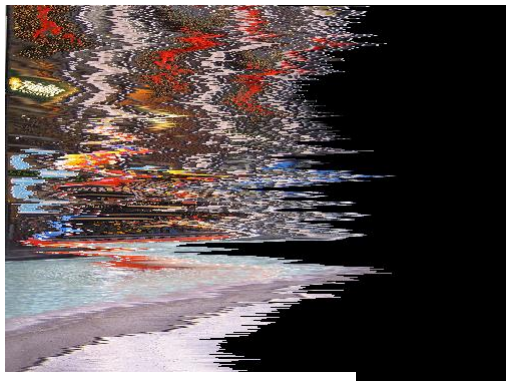
…the average should increase!



While resizing: remove ***as many*** low energy pixels and ***as few*** high energy pixels!

Reduce Width





crop column pixel optimal

Exercise #1 – Image retargeting

- See definition on course website
- Submission: on 18/6/2008
- Headsup:
  - Exercise #2 will be published 11/6/2008 (week overlap)
  - Exercise #3 will be published (I hope) beginning of July