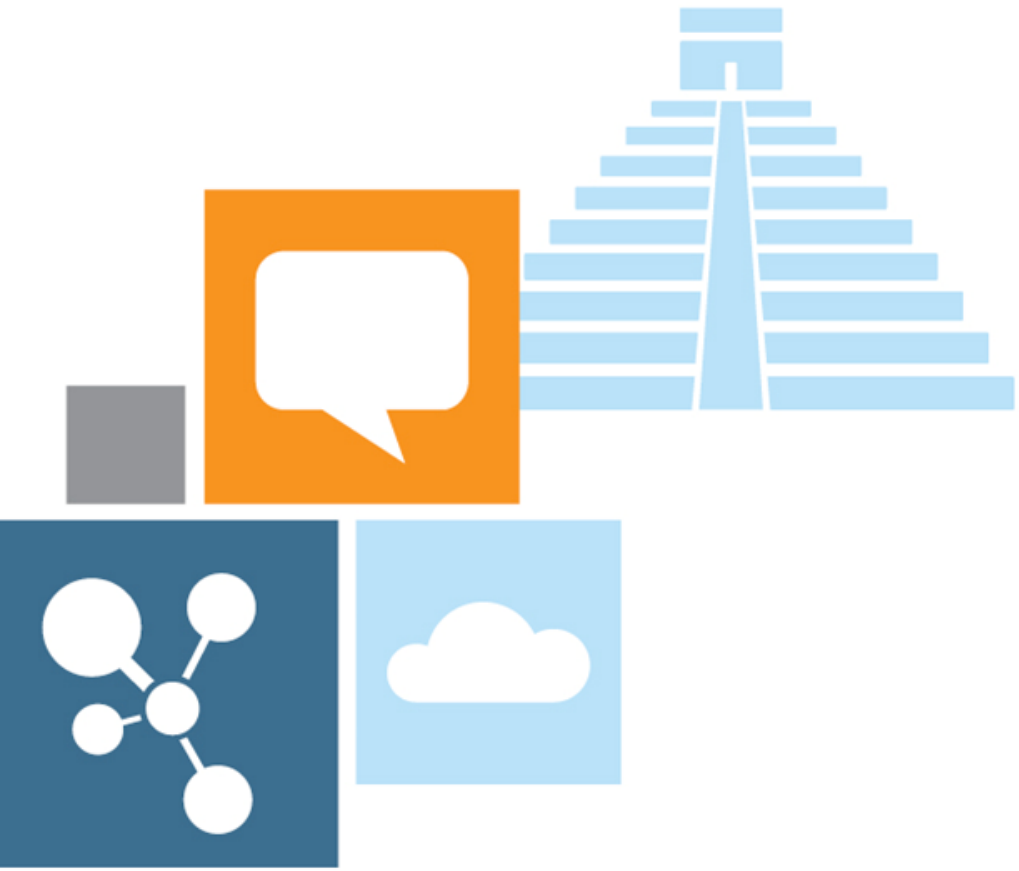
Microsoft



Microsoft® Research

Faculty Summit 2012

Riviera Maya, Mexico | May 23-25 | In partnership with CONACYT

Using Computer Vision for Graphics

Sing Bing Kang
Microsoft Research Redmond

May 24, 2012

Graphics has come a long way…

Solid modeling

Illumination modeling

Surface property modeling

Non-photorealistic rendering

Hardware

"A practical model for subsurface light transport"

"Real-time hatching"

ATI "Toyshop" demo

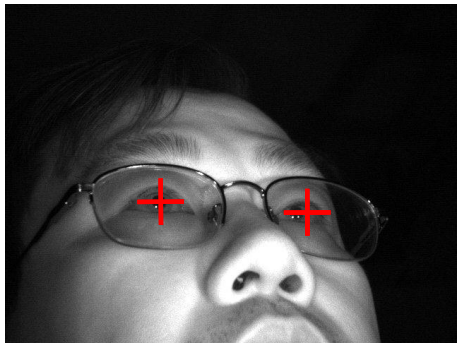
Graphics is fun, but…

- Generating compelling-looking content is laborious
- Photorealism is still hard to achieve

Computer vision to the rescue

- Computer vision: Analysis using images
- Examples
  - Segmentation
  - Recovery of surface properties
  - Stereo/geometry reconstruction
  - Tracking
  - Recognition

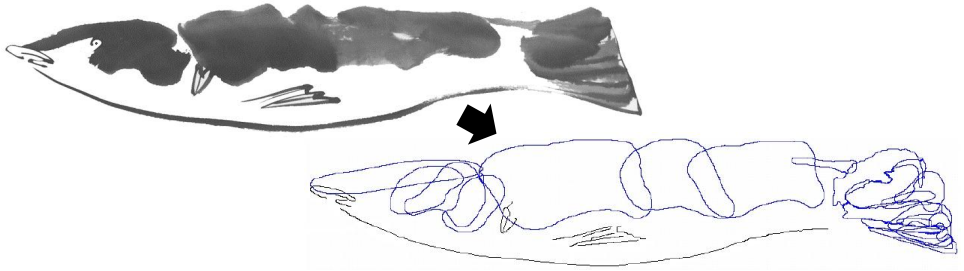
"Global matching criterion and color segmentation-based stereo"



"Eye tracking"

"Automatic naming of characters in TV video"

Illustrations



Animating Chinese paintings

3D models of trees from images or sketches

Virtual viewpoint videos

Personalization of image enhancement

Animating Chinese Paintings

TOG 2006

Start with an image

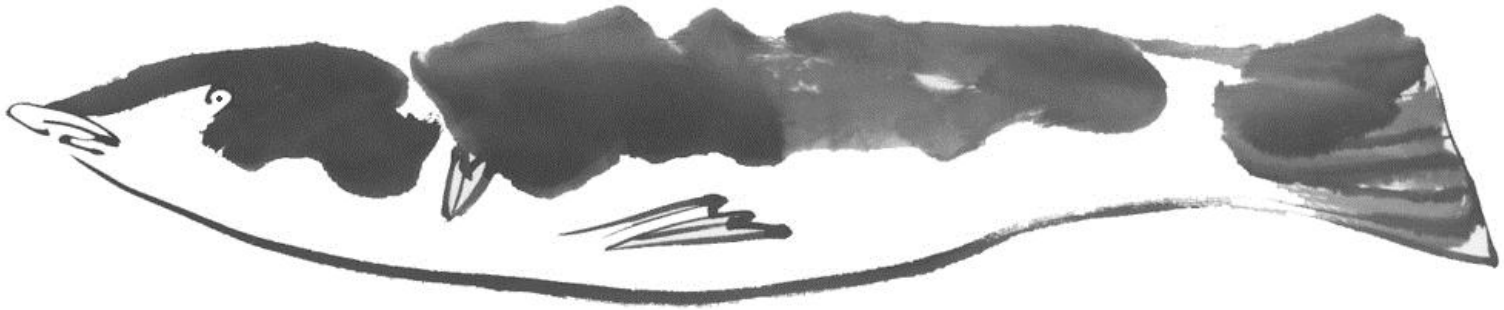
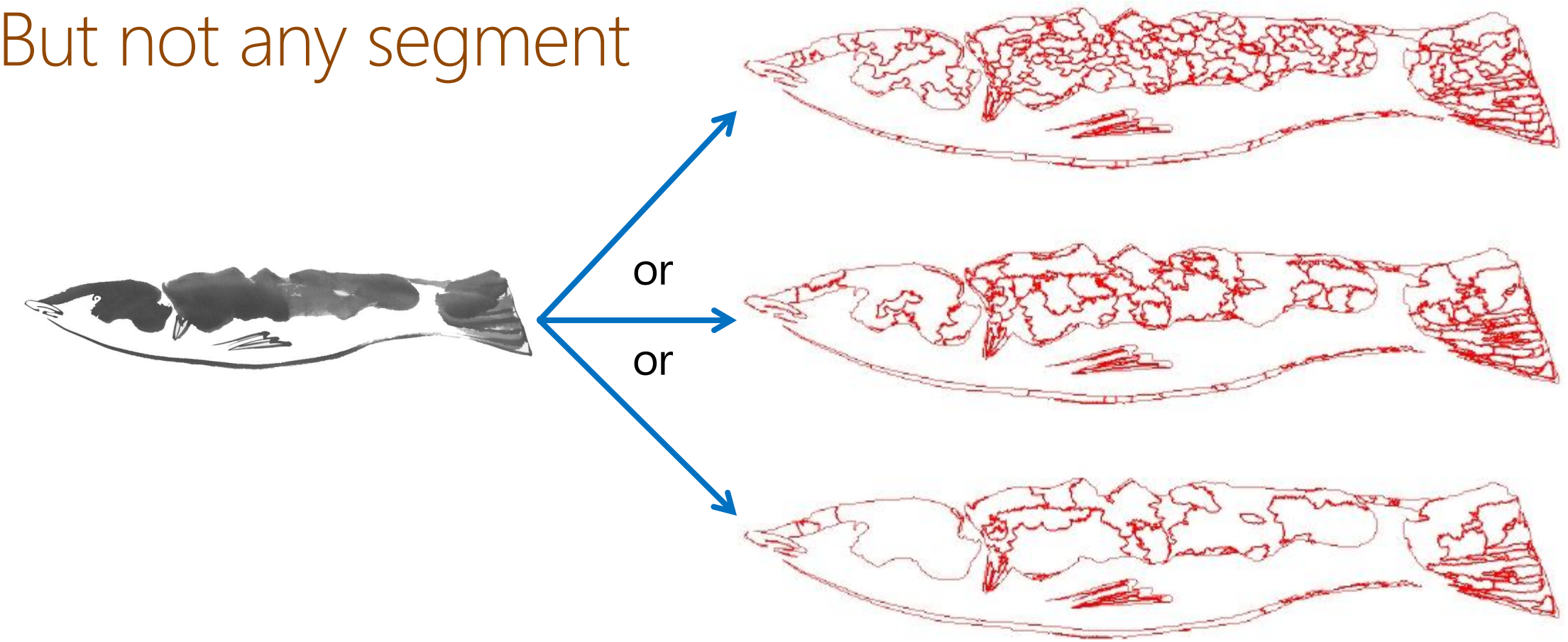


Image to this…

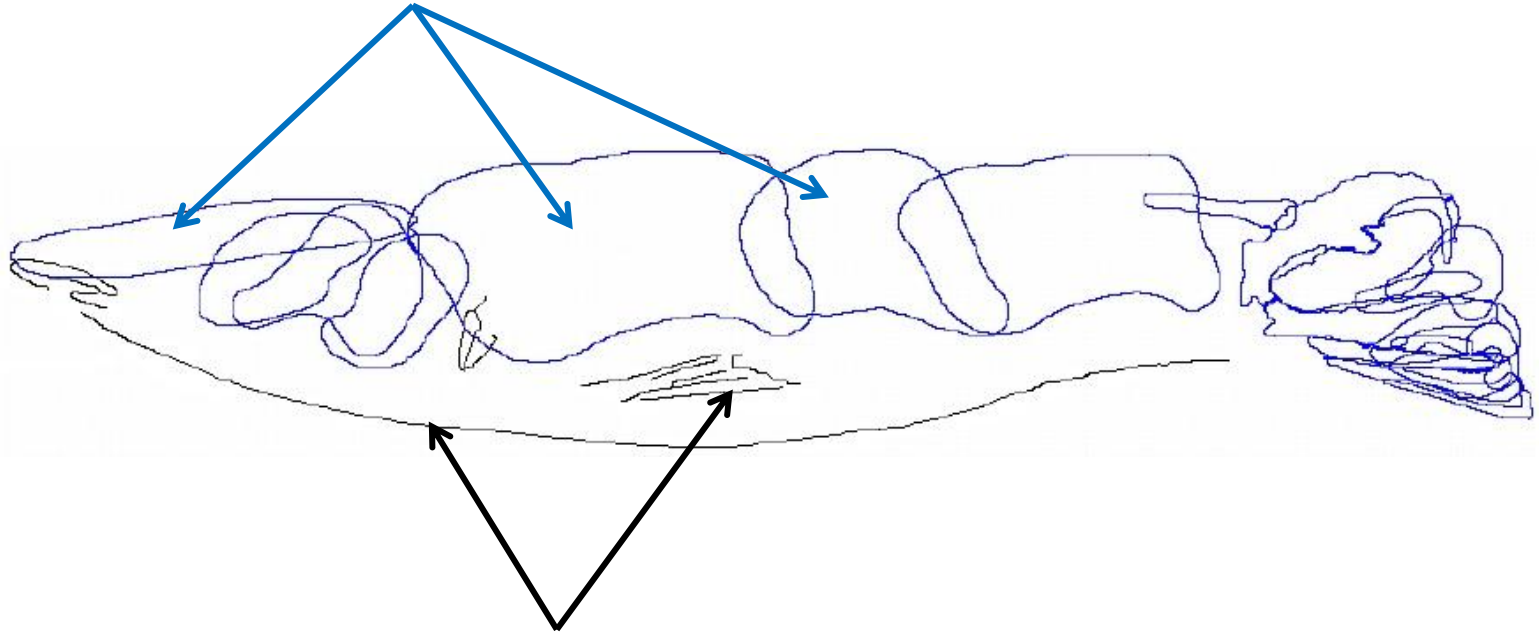
Key: Segment image into smaller parts

But not any segment



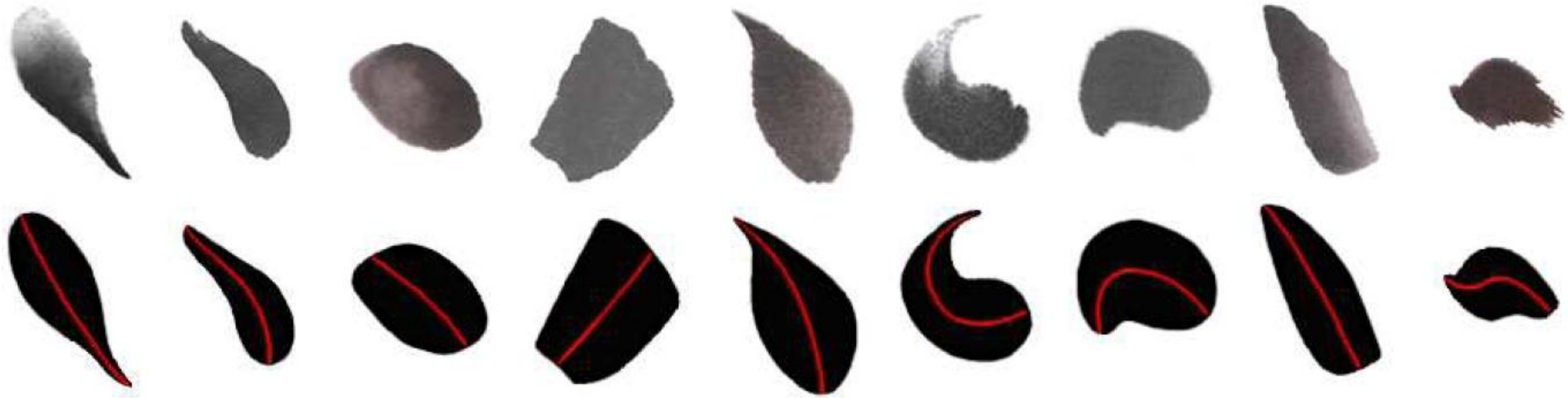
More meaningful segmentation

Broad strokes (shape and appearance)



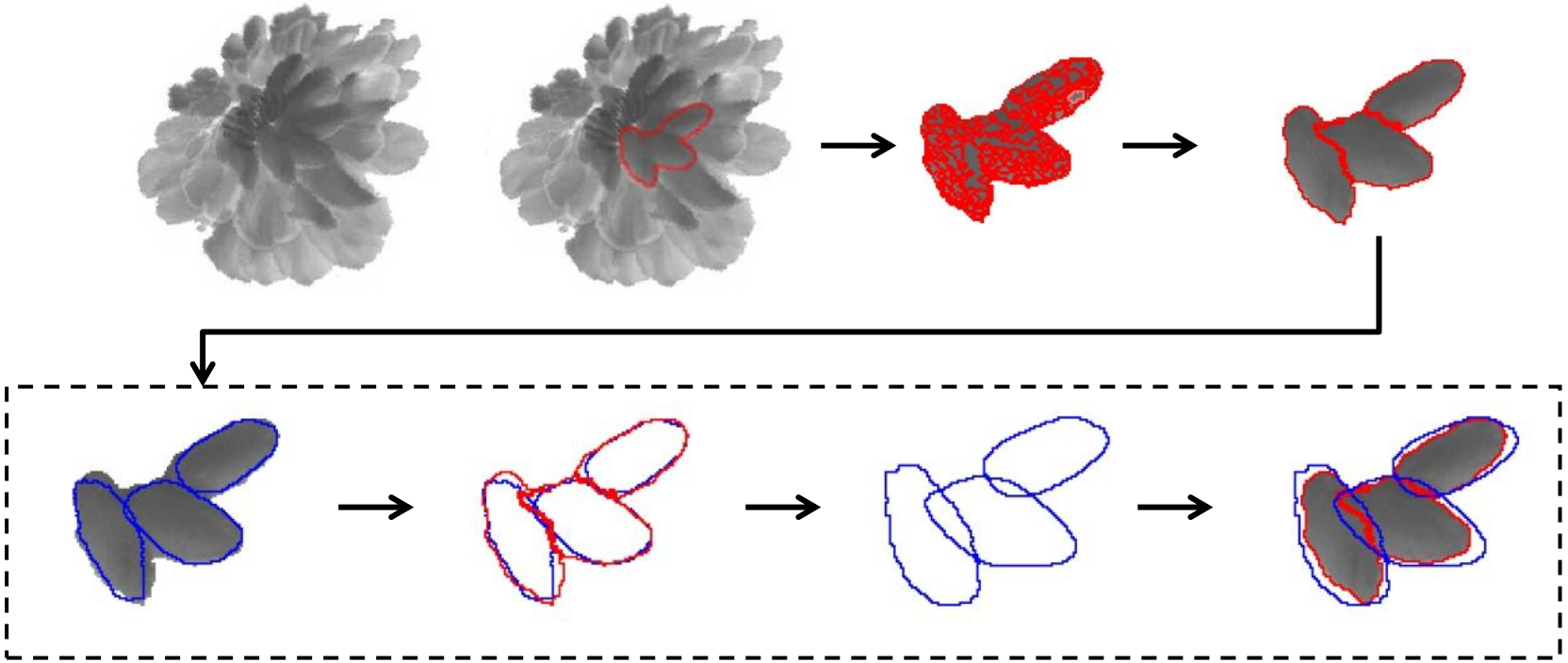
Thin strokes (interval spline)

Key to decomposition: Shape priors



62 brush strokes in library

Brush stroke fit



Fitting best library strokes

Best library strokes with actual strokes

Find similarity transforms to minimally cover actual strokes

Transformed best library strokes with actual strokes

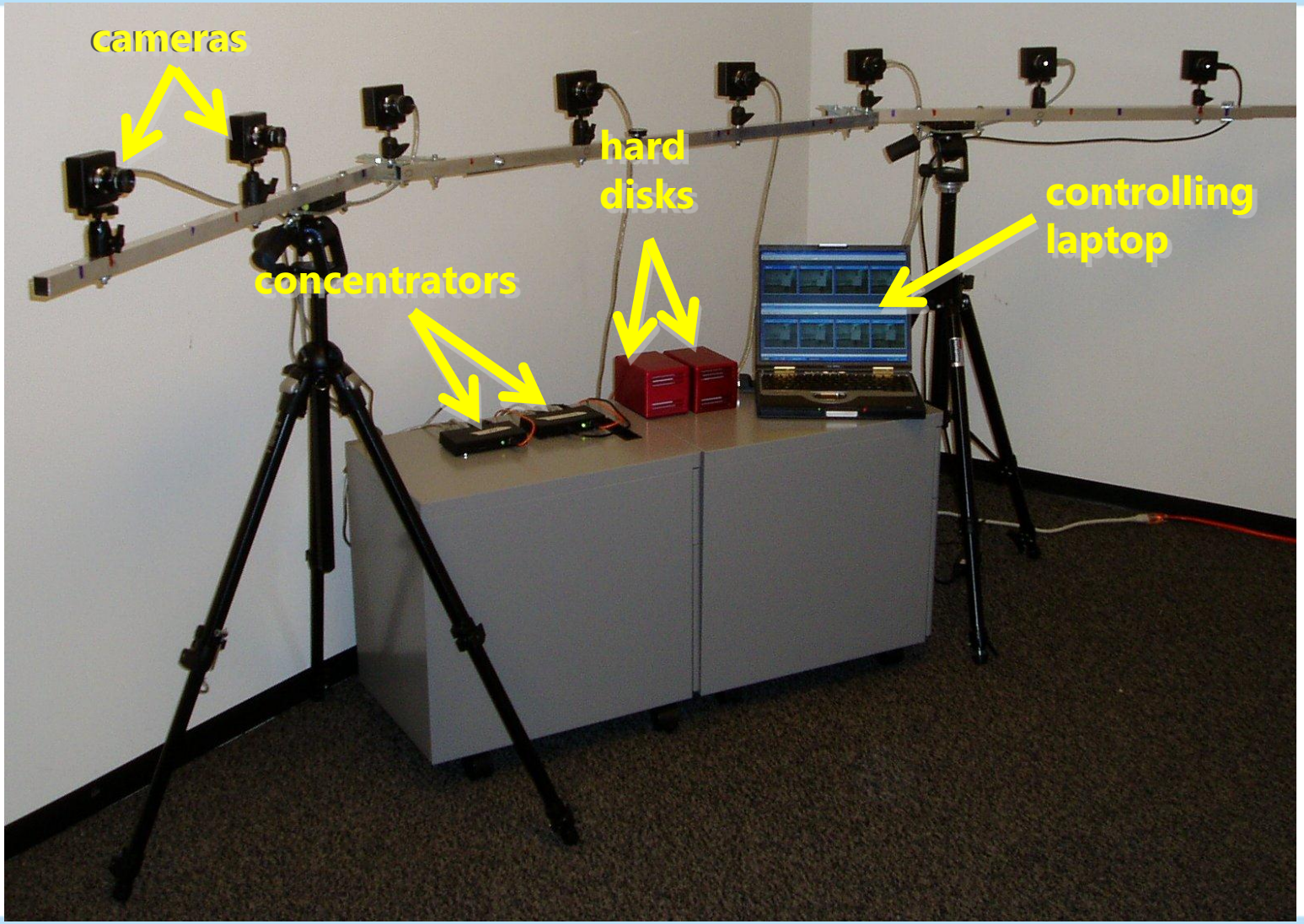
Lotus pond animation

Virtual Viewpoint Video

SIGGRAPH 2004

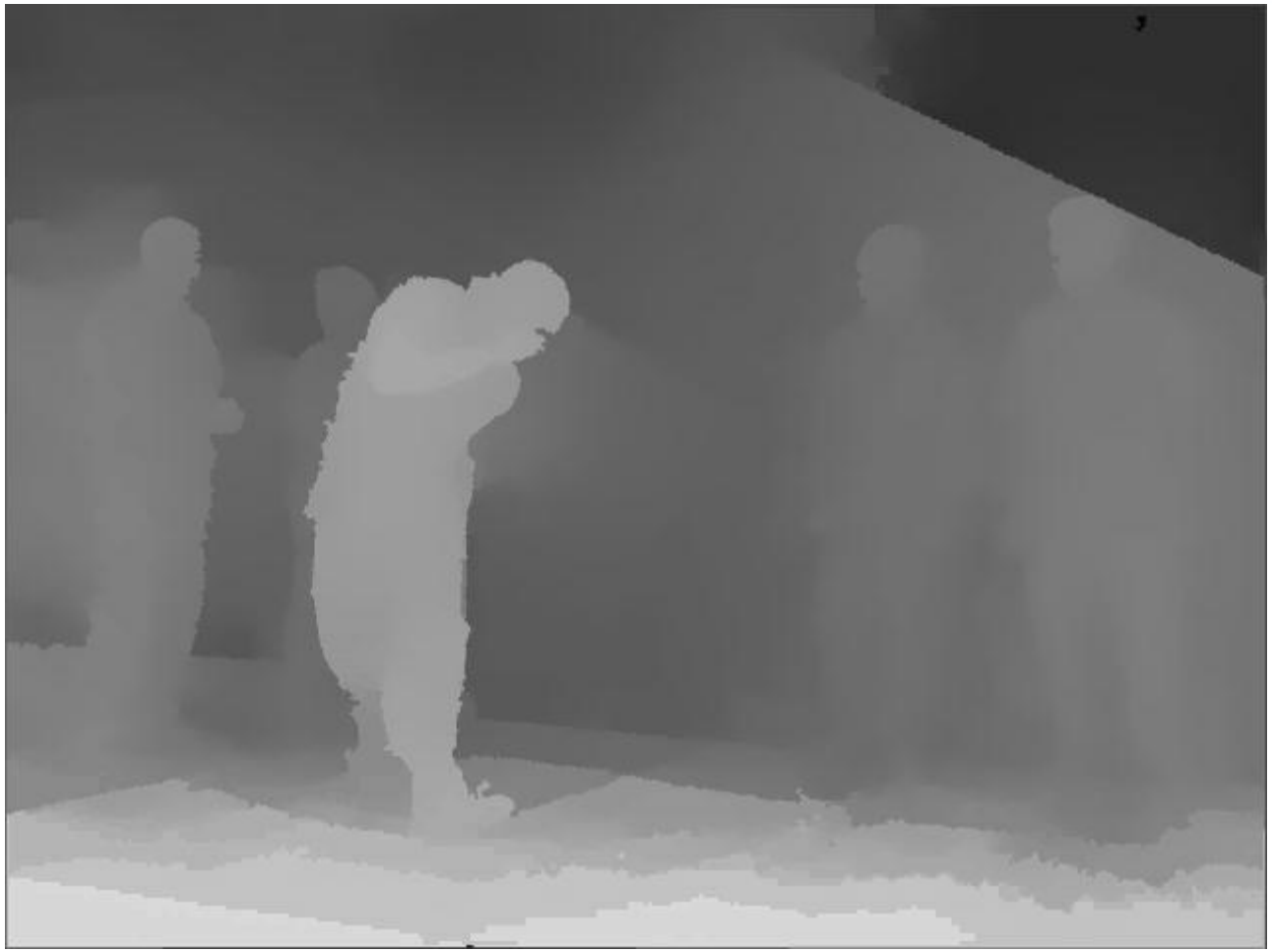
V^3 = "Steerable" video/free-viewpoint video

Capture system



Input videos

Depth computed using stereo



Final product

Modeling Plants and Trees

SIGGRAPH 2006, 2007, SIGGRAPH Asia 2008

Spectrum of plants/trees

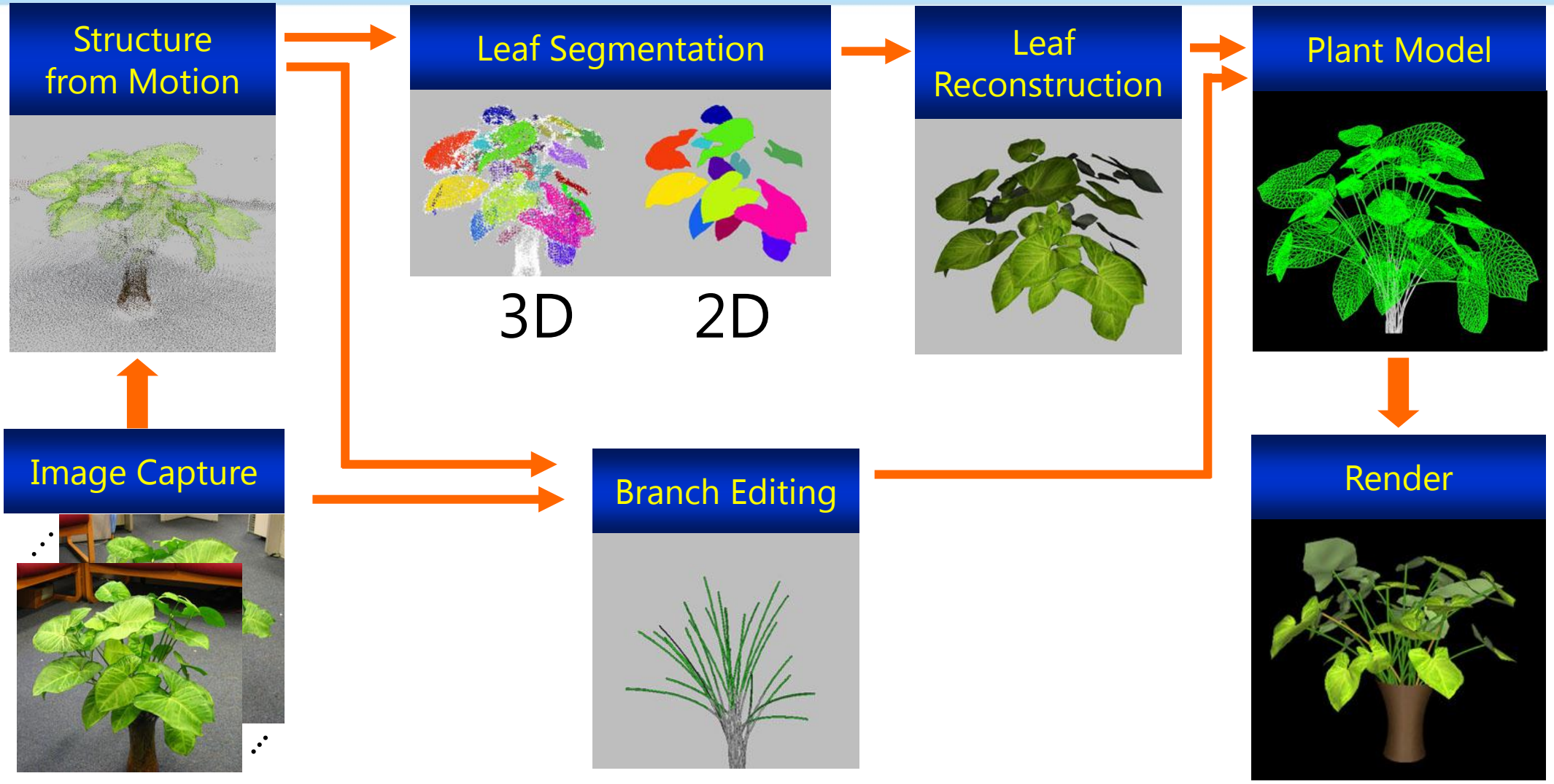
Decreasing leaf size to plant/tree size ratio

Spectrum of plants/trees

"plants"

"trees"

Plant modeling from images

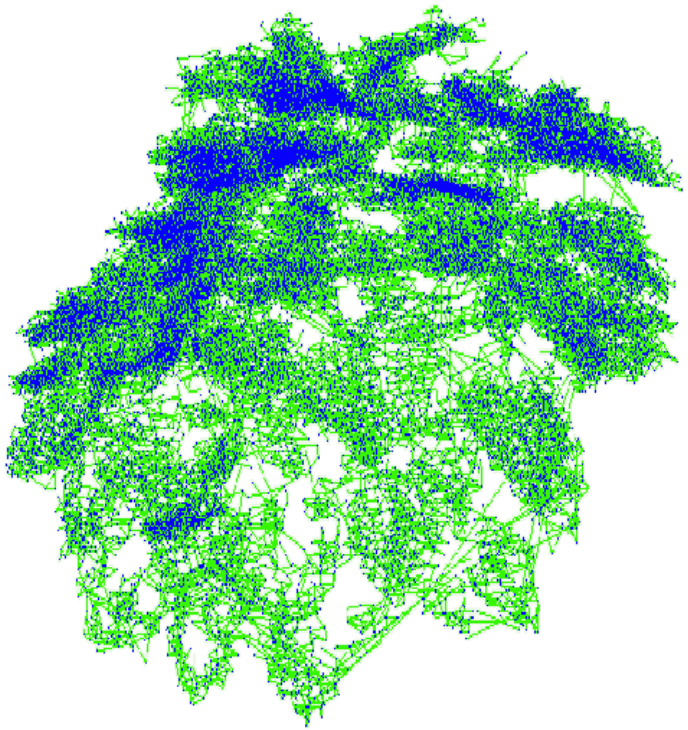


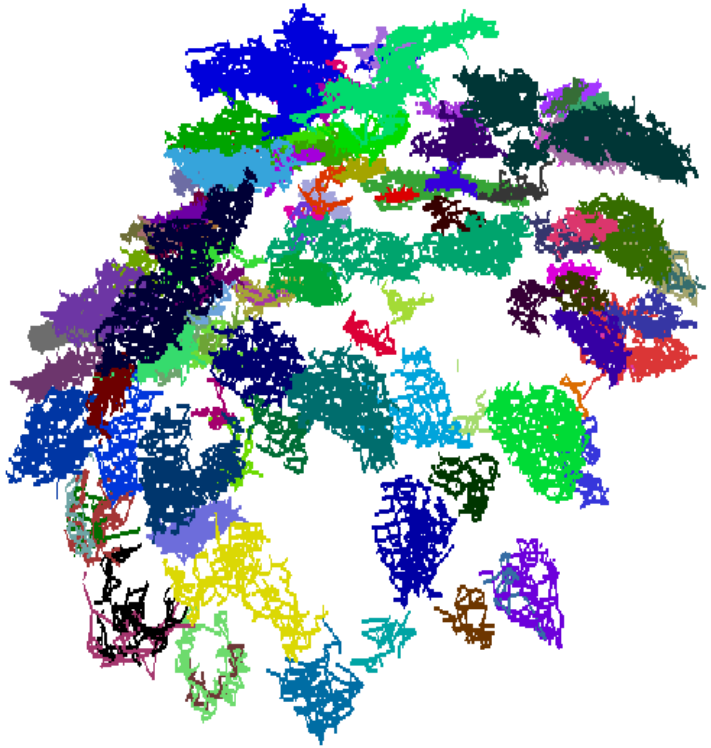
Structure from motion

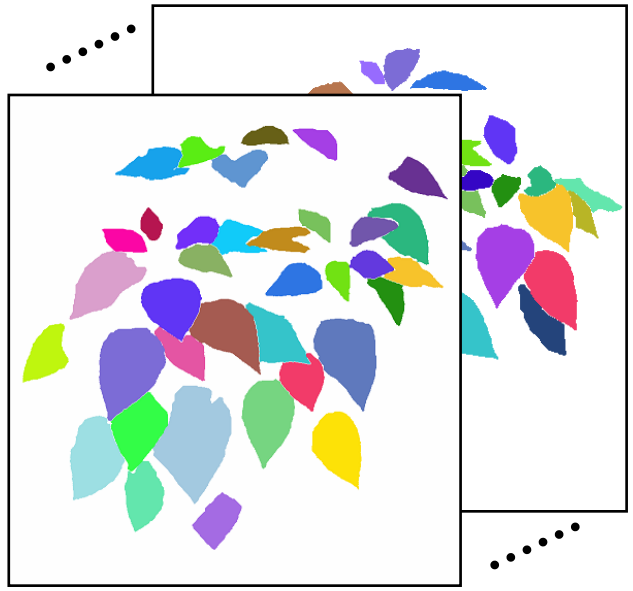
captured images
(35-45 images)

cloud of reliable 3D points

Leaf segmentation





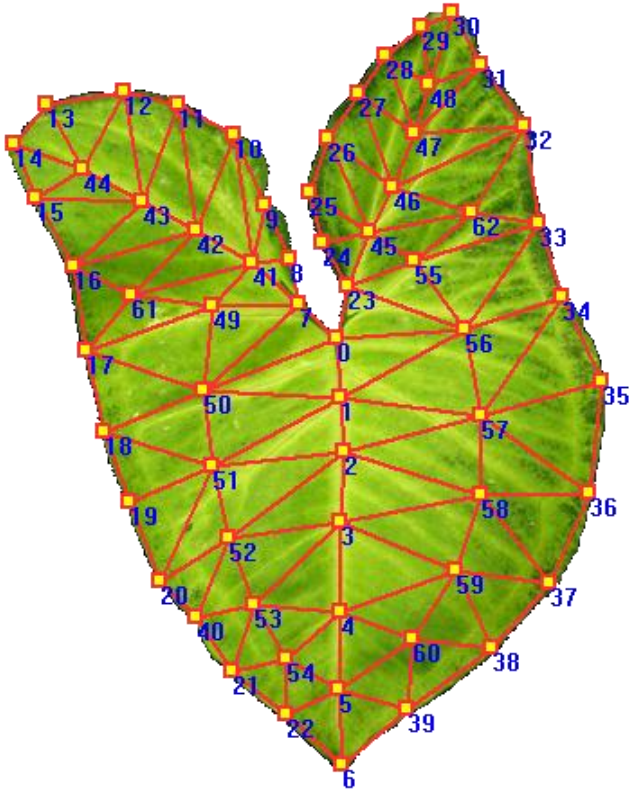


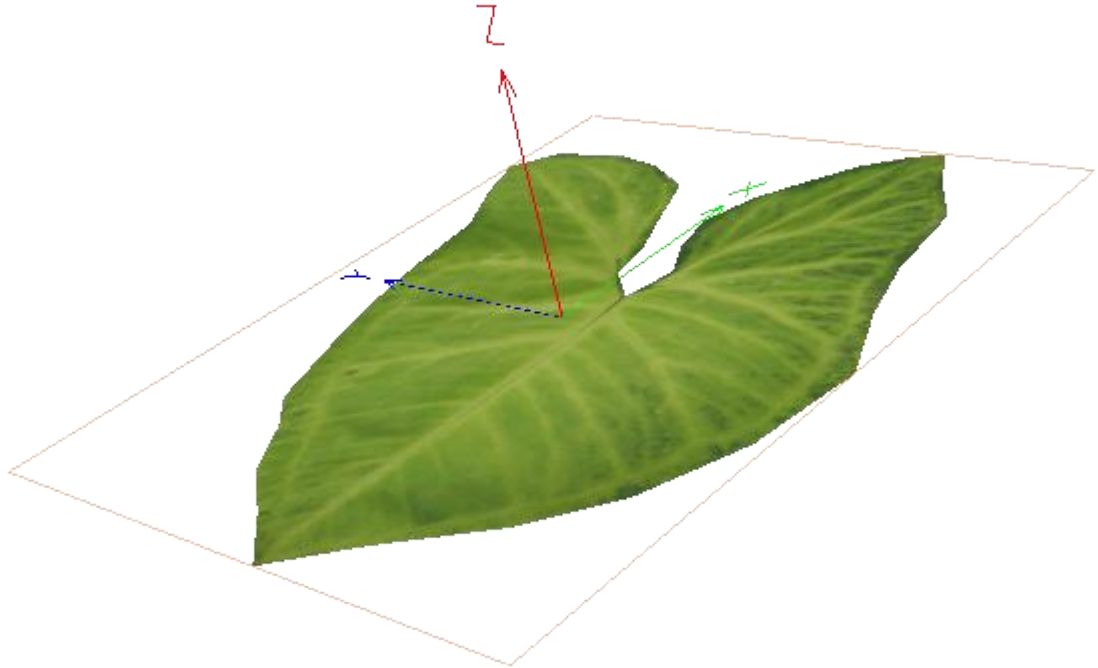
Initial 3D Graph

After 3D graph partition

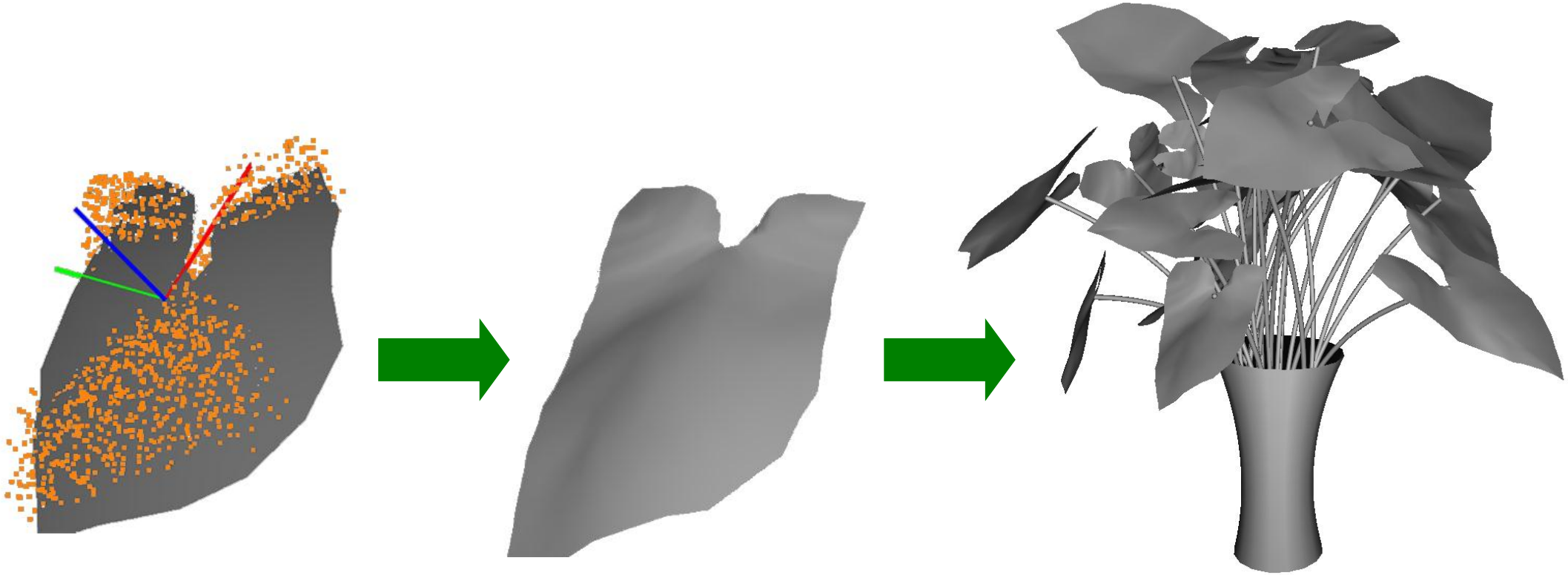
Segmented 2D leaves

Leaf model: flat mesh from image





Fit leaf model



Flat leaf model and 3D point data

After fitting model to 3D data

After fitting model to all 3D data

Interactive branch editing

More results

Tree modeling from images

Structure from Motion

Reconstruction of visible branches

Synthesis of occluded branches

Tree Model

Image Capture

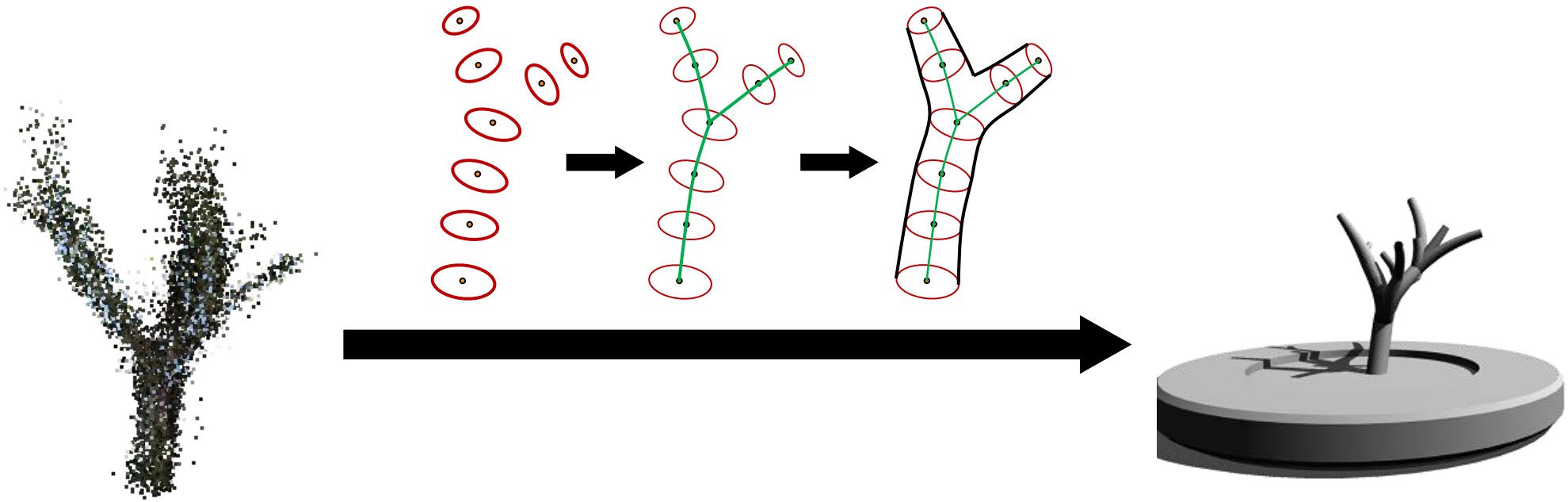
Leaf analysis

Structure from motion (again)

captured images
(10-30 images)

cloud of reliable 3D points

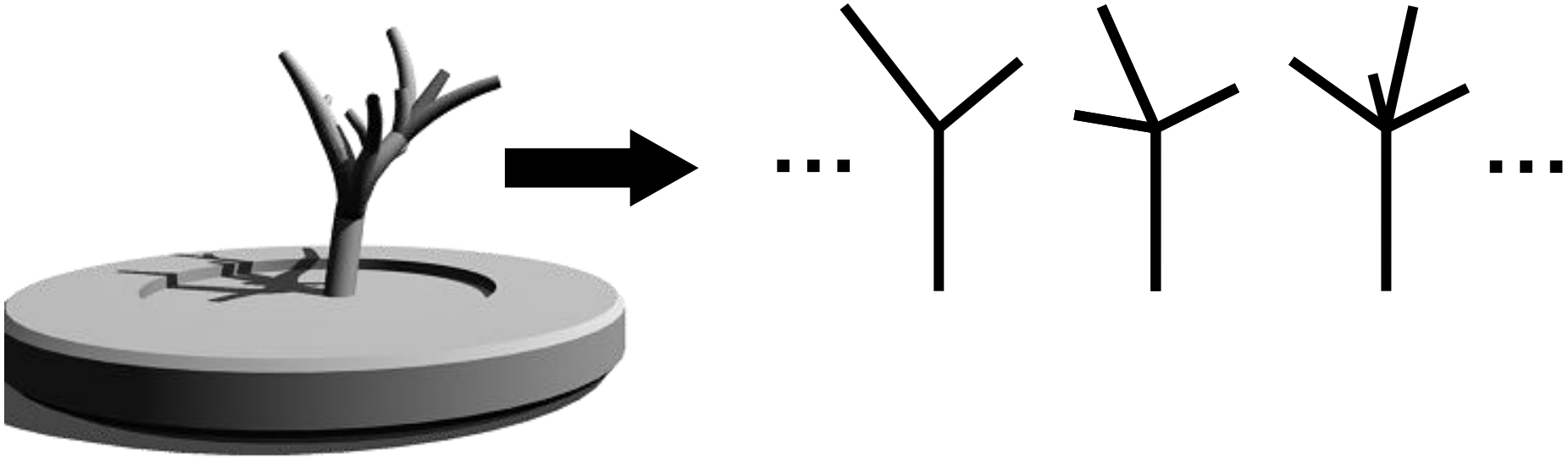
Visible branch reconstruction



Segmented branch points

3D branch model

“Building blocks”



Generate building blocks from visible branches

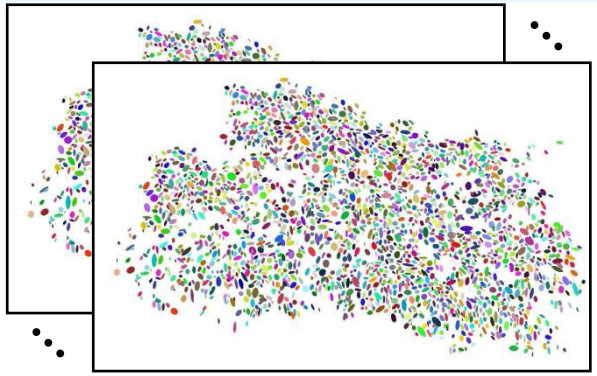
Occluded branch “hallunication”

Segmented tree points

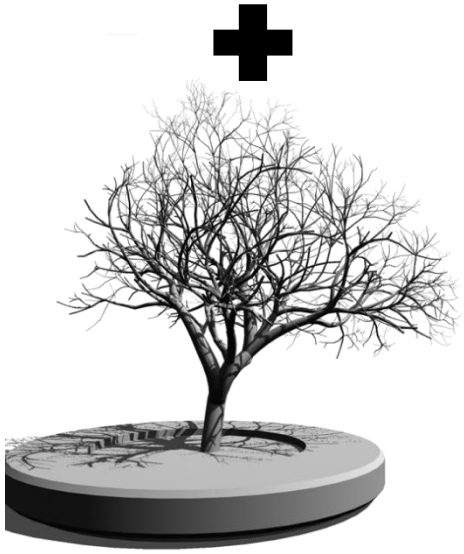
Visible branch model

Complete branch model

Leaf reconstruction



Segmented leaf images (textured)

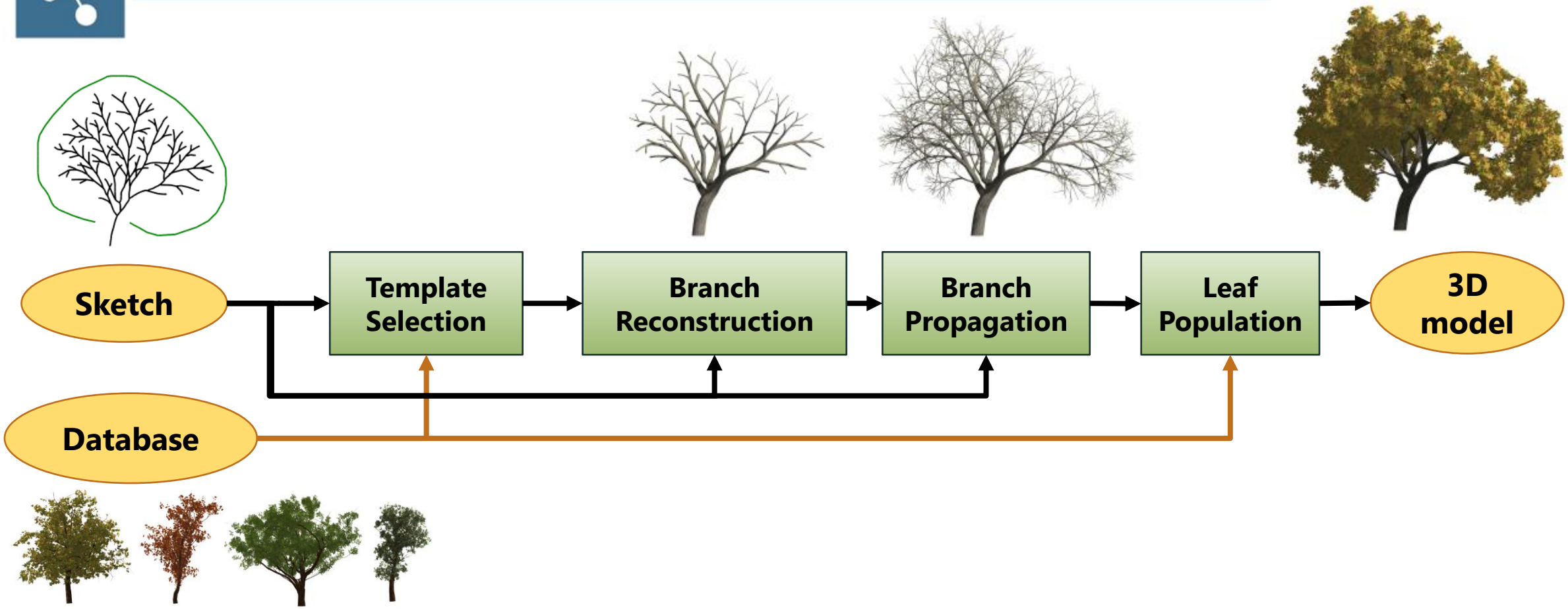


Branch model

Complete tree model
(relit with cast shadows)

Results

3D tree model from 2D sketch



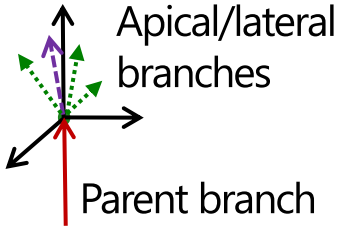
Database: Collection of tree exemplars

Exemplar

3D geometry

Tree parameters

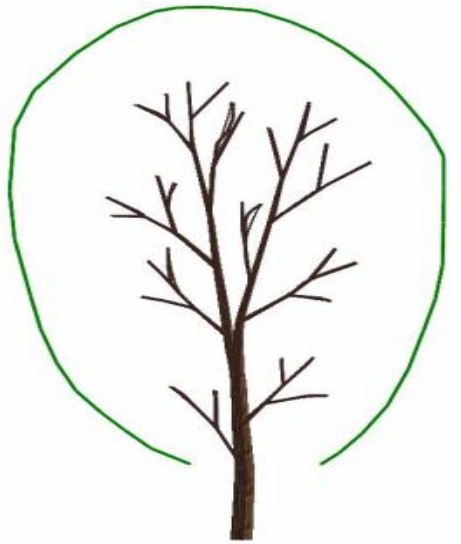
Θ



2D silhouettes

Leaf template

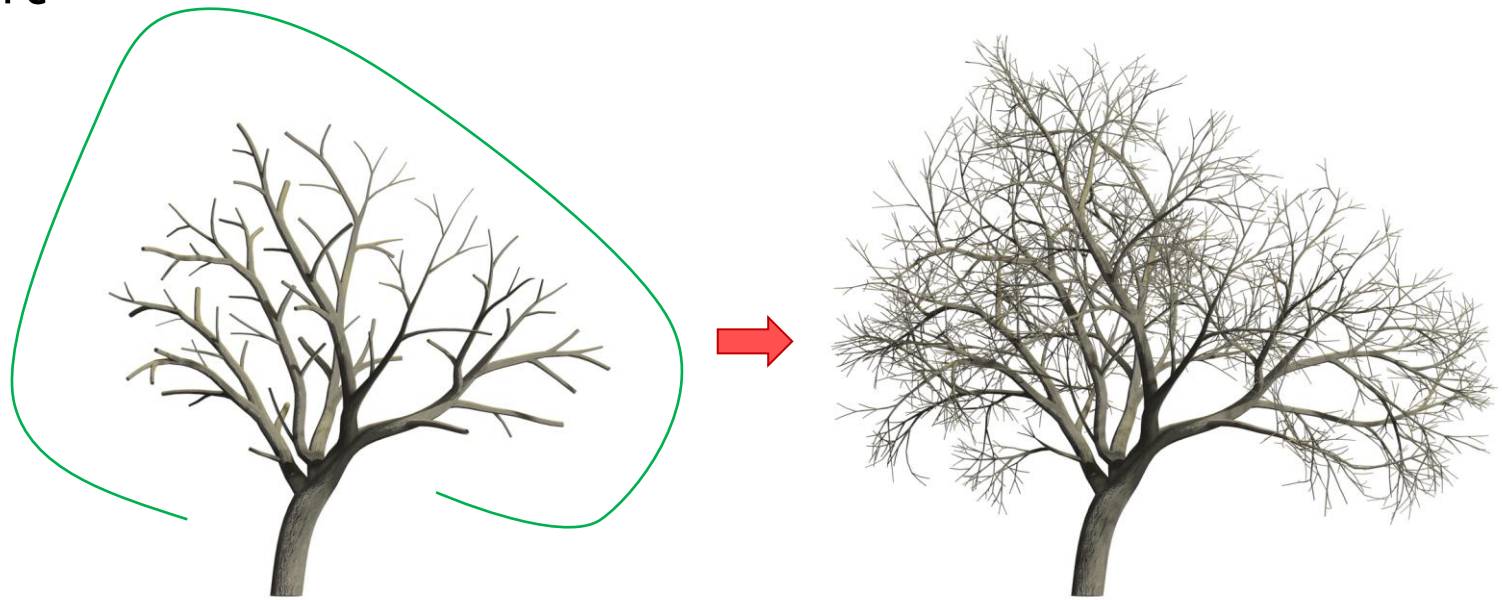
Template selection



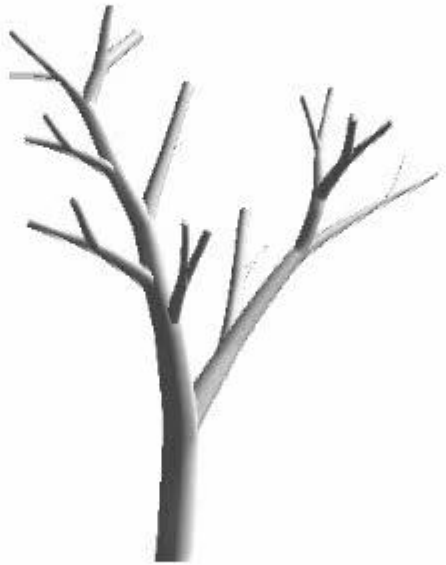
Branch propagation

Self-similarity

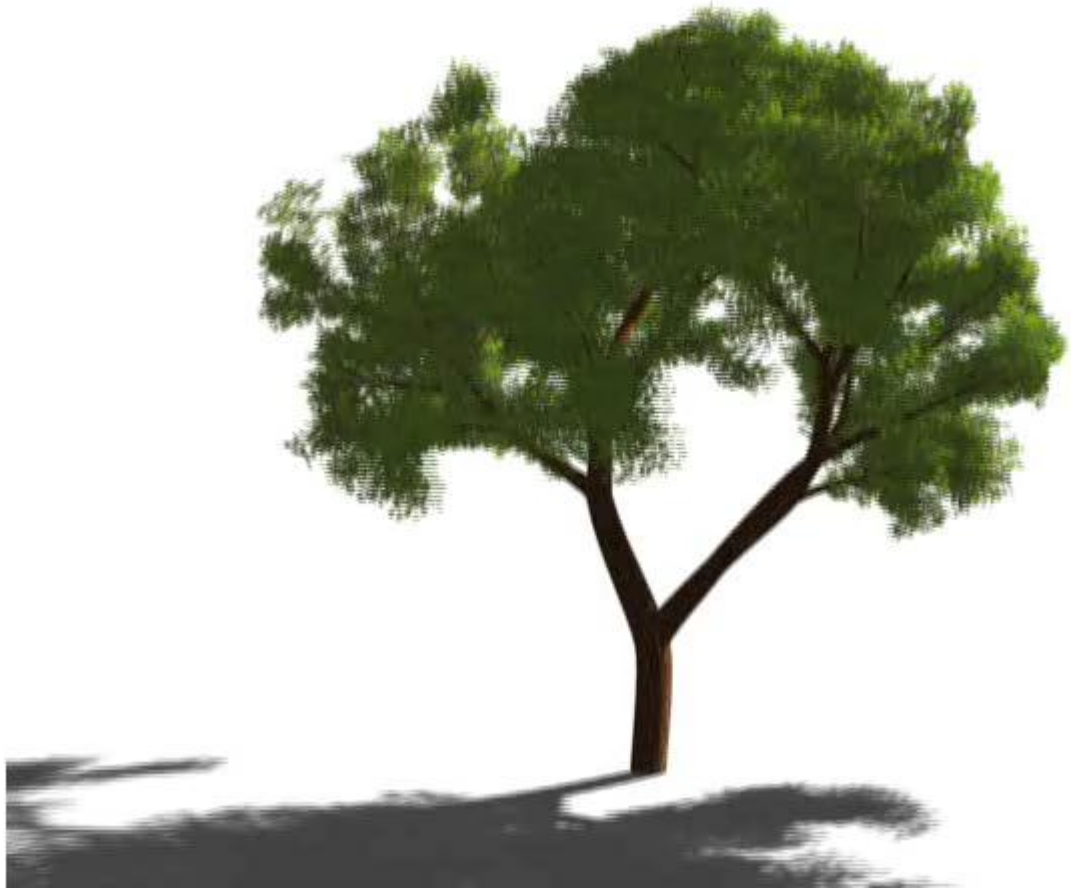
Crown constraint



Branch propagation

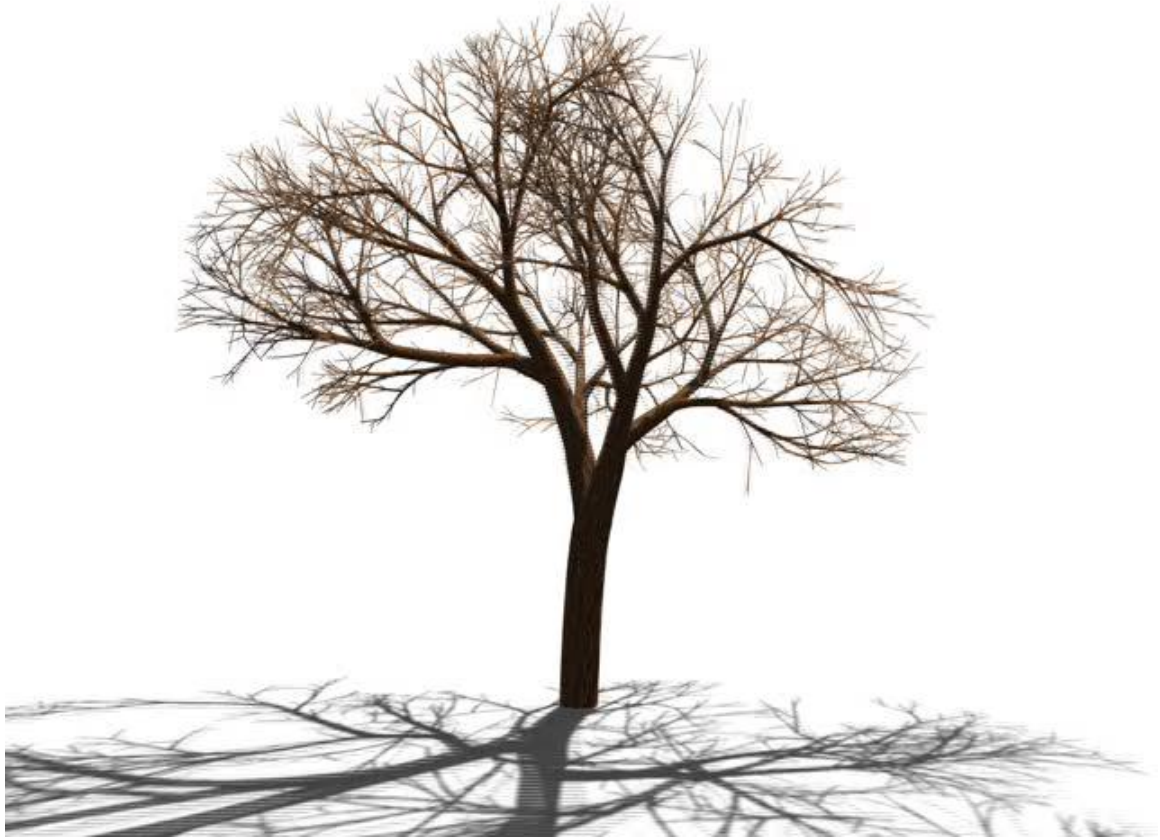


Leaf population

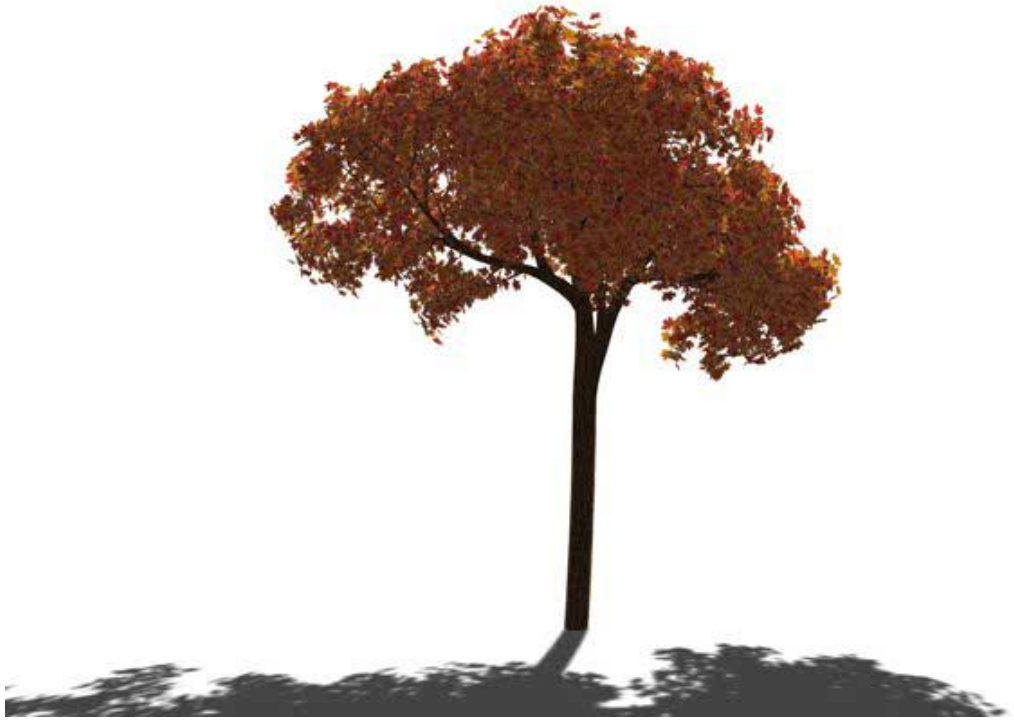


Effect of crown

Effect of crown



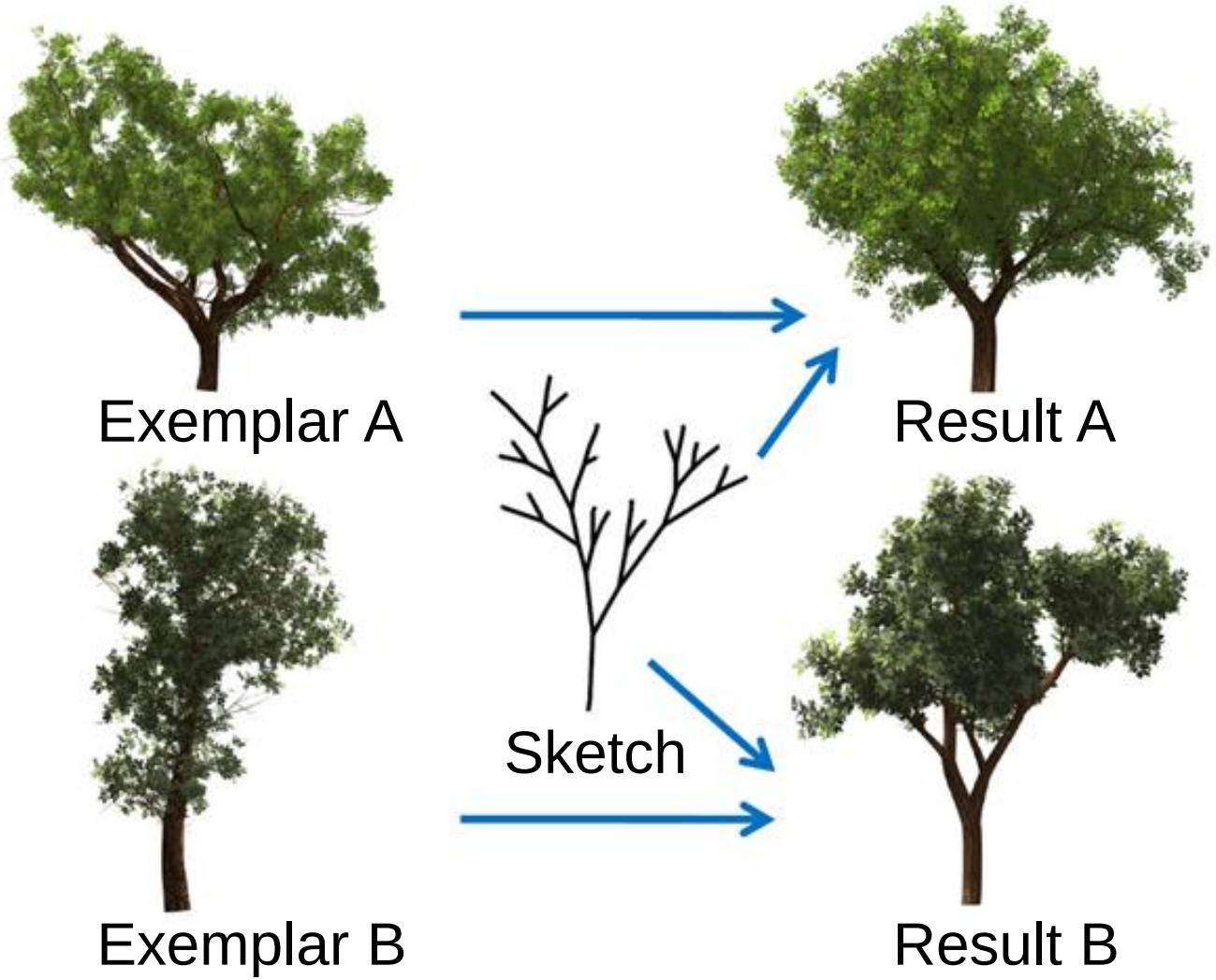
More results



More results

More results

Effect of exemplar



Personalized Image Enhancement

CVPR 2010, 2011

Automatic image enhancement

Auto-contrast and color adjustment

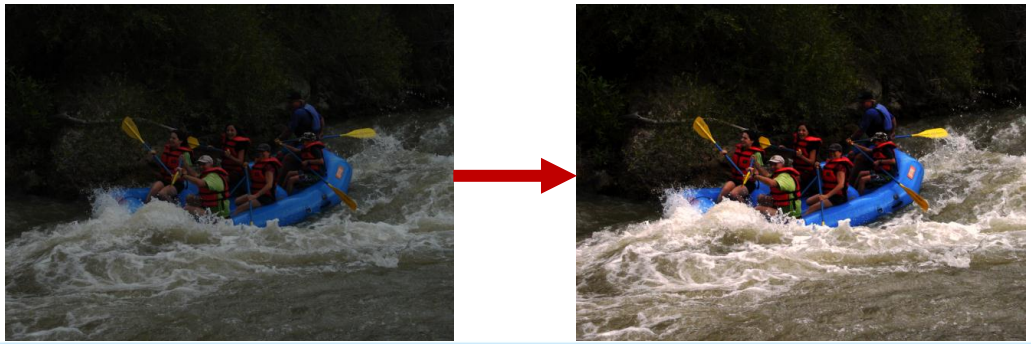
- Picasa

- Windows Live Photo Gallery

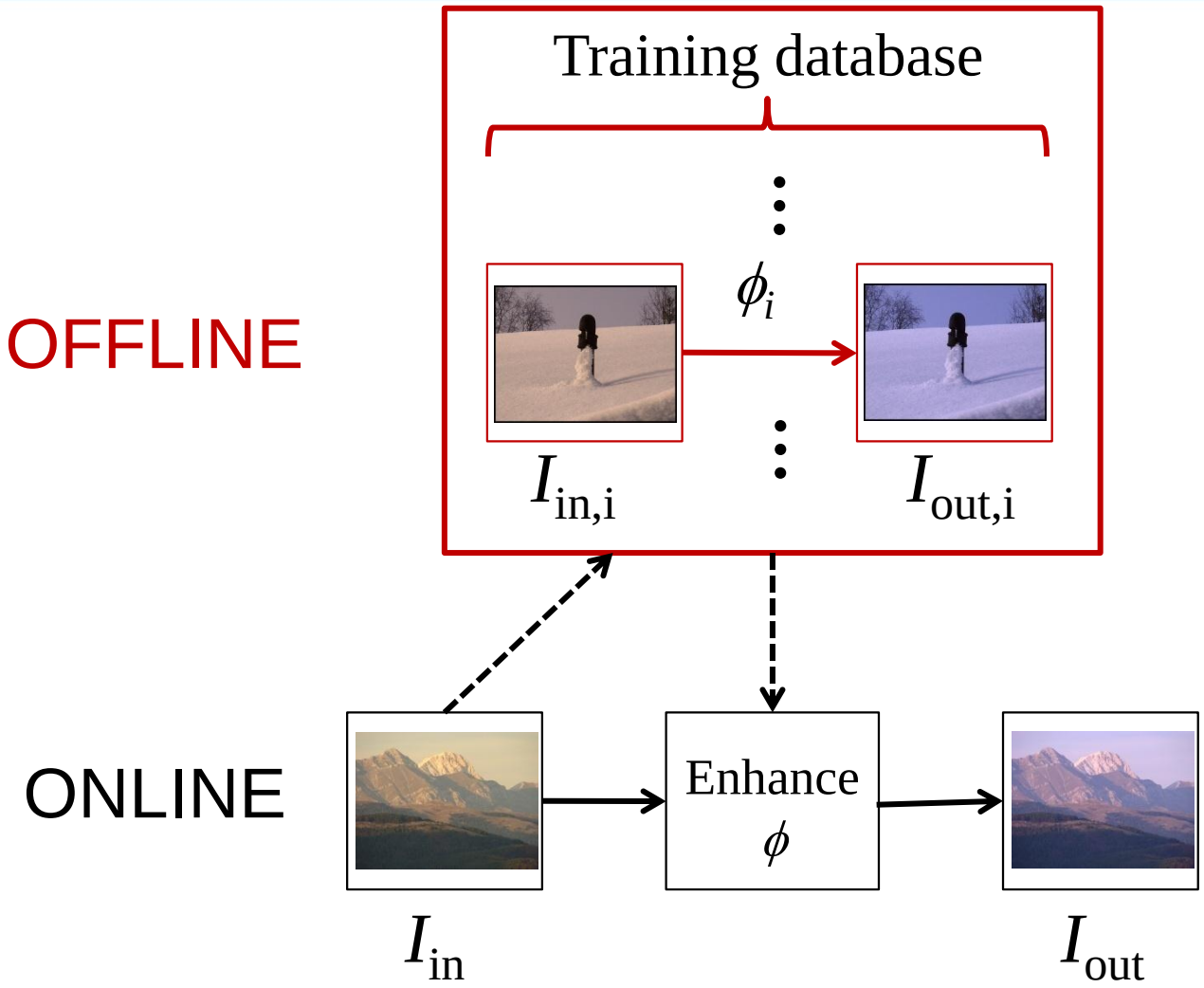
Color correction

But: different people have different preferences

Contrast/exposure correction



Personalization

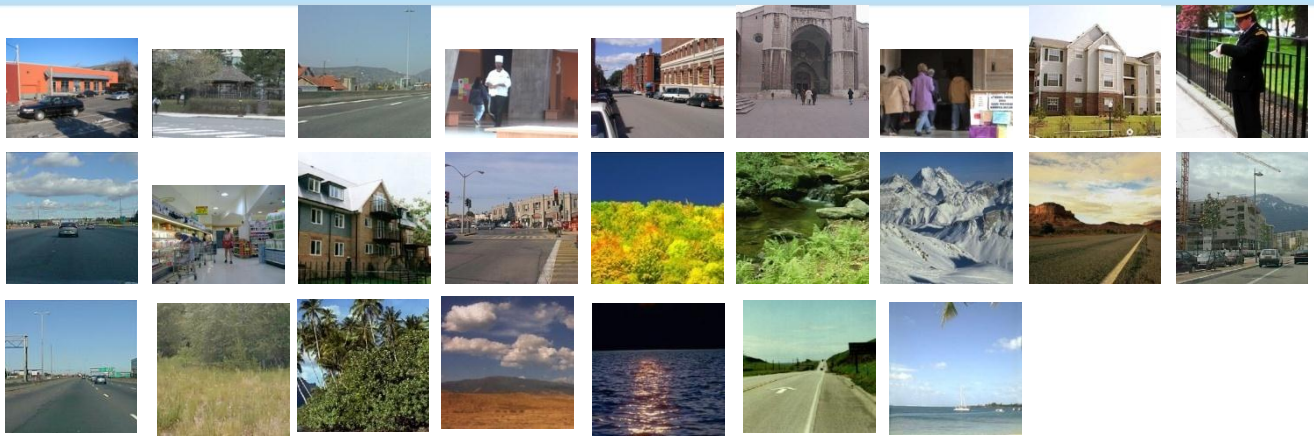


Enhance ϕ :

- Contrast (3 params)
- Color (2 params)

Training

25 training images



Training interface

Example

Input

Picasa

Photo Gallery

Subject #1

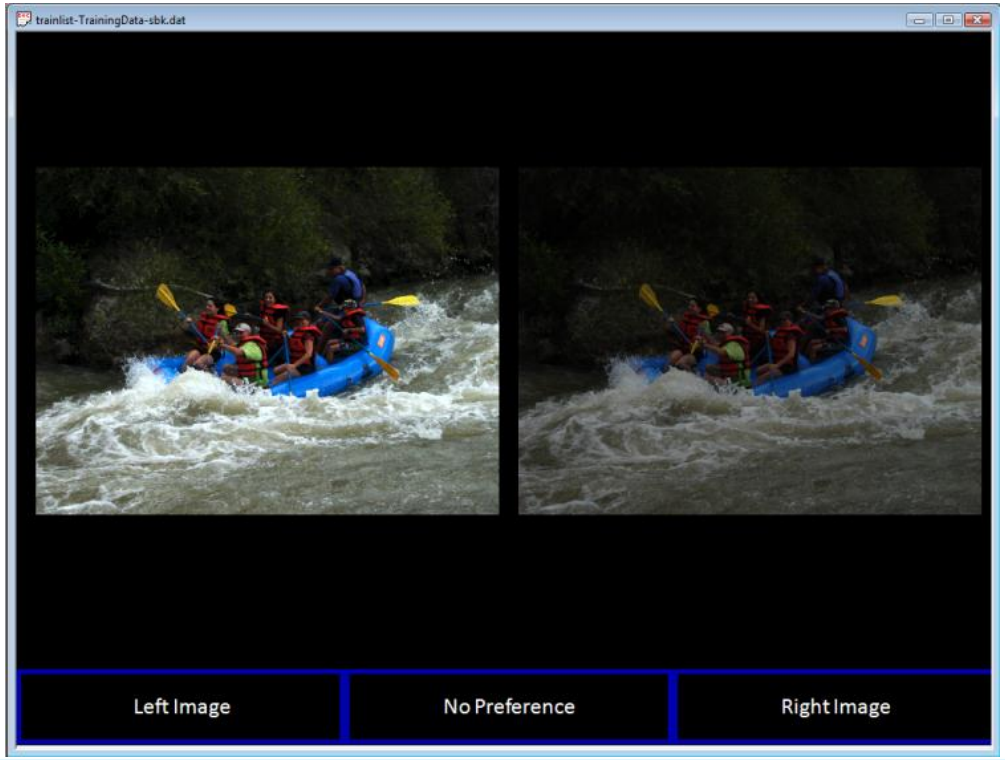
Subject #7

Subject #9

User study

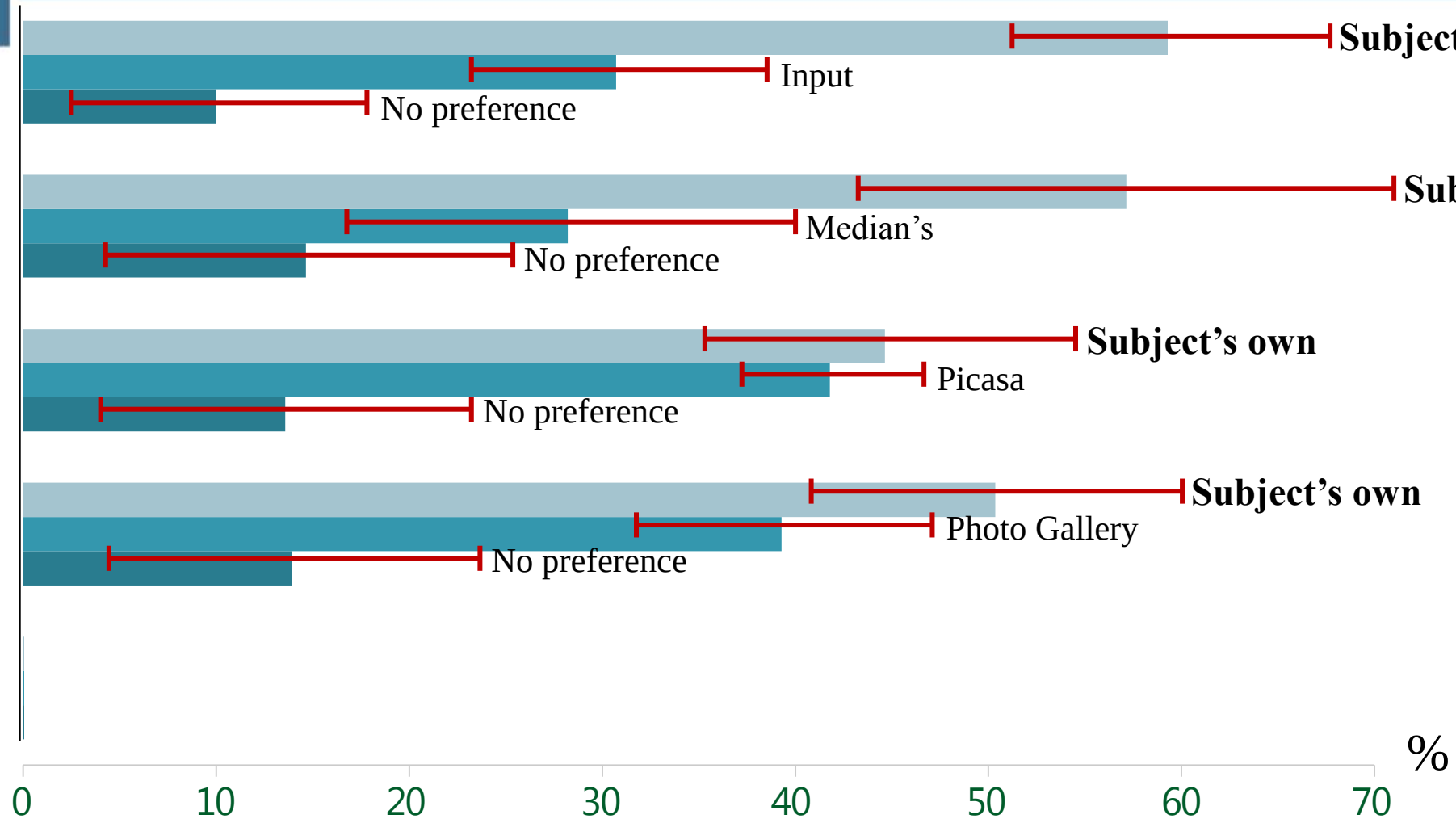
- 14 subjects
  (5 females, 9 males)
- Training (25-45 mins)
- Pairwise comparison (10-20 mins):
  - Input
  - Subject's
  - "Median" subject's
  - Windows Live Photo Gallery
  - Picasa

20 test (unseen) images

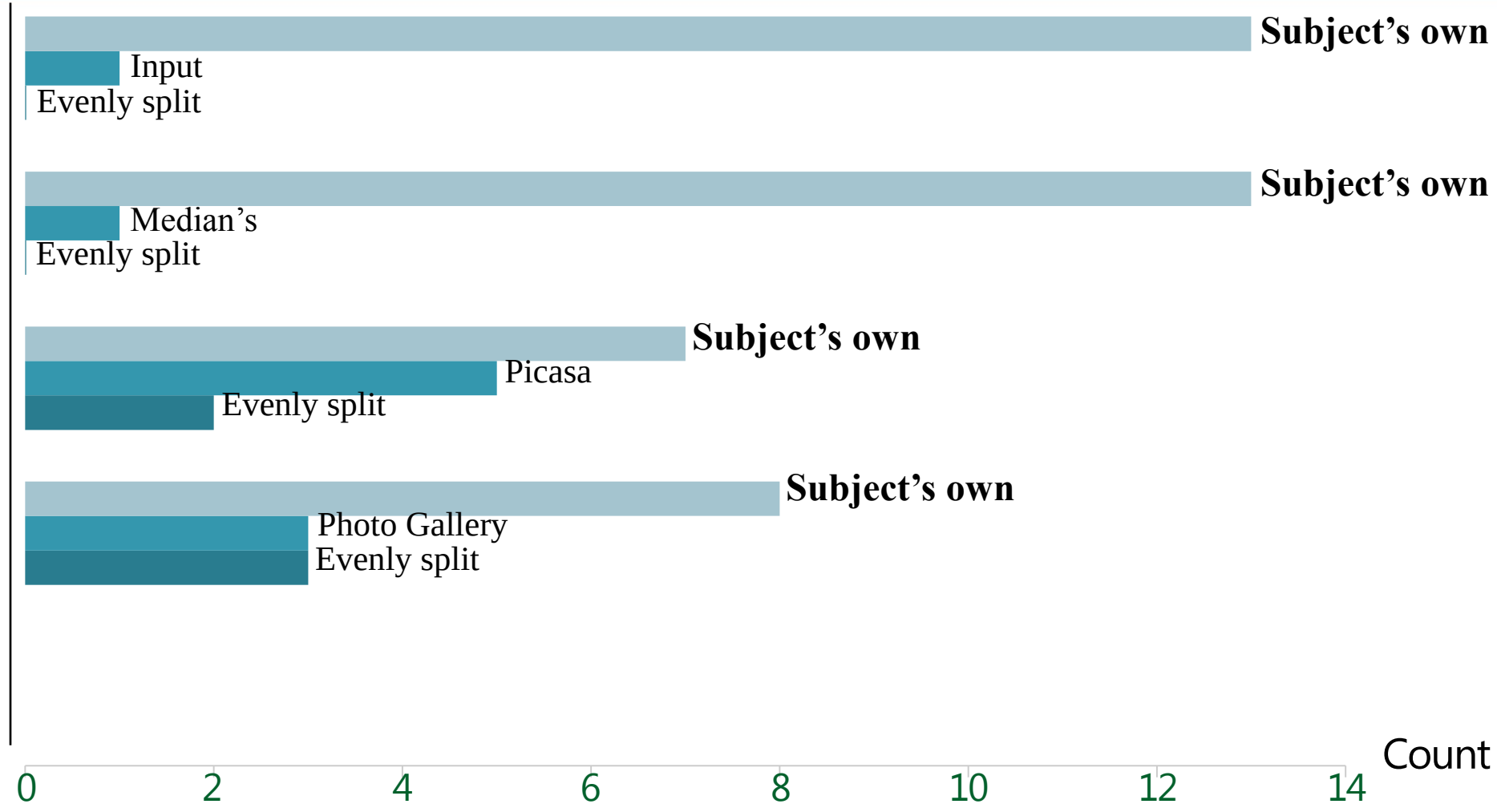


User study interface

User study results (% images preferred)



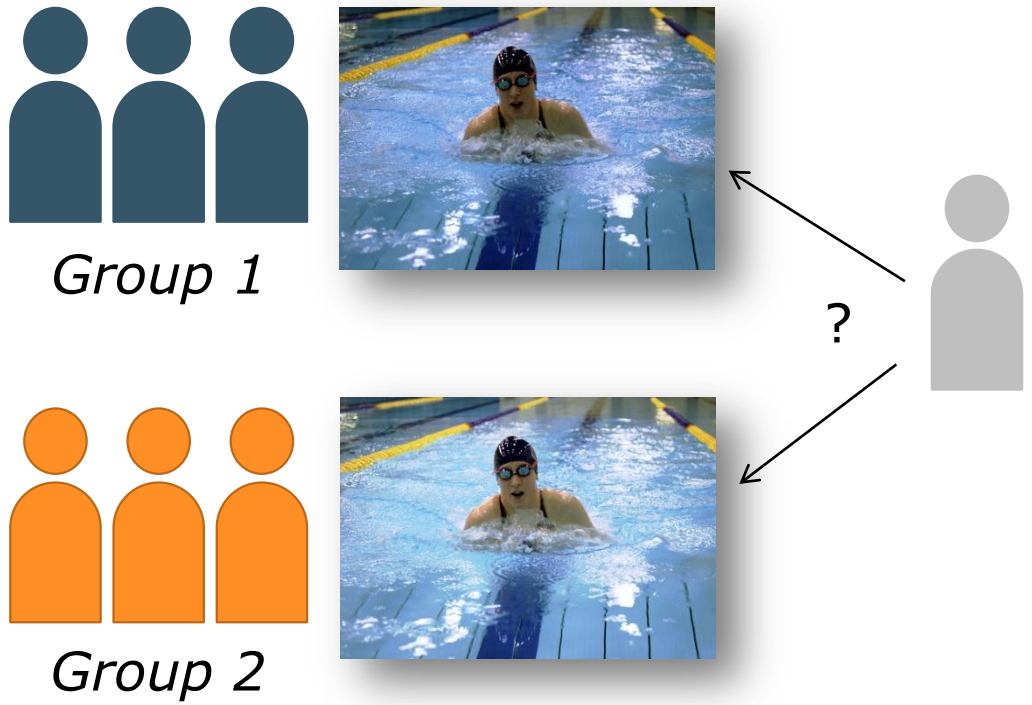
User study results (predominant preference)



Next step: finding clusters of preferences

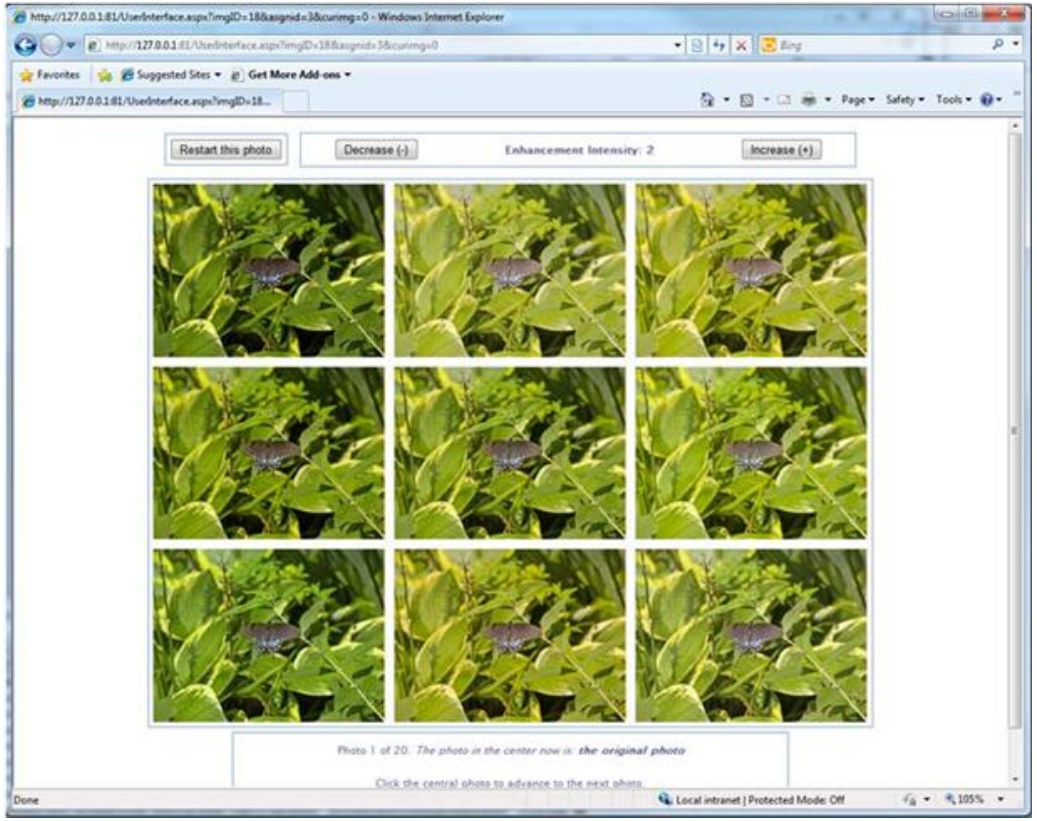
Existence of clusters simplify:

- Training (fewer images)
- Tool interface (only a few buttons)



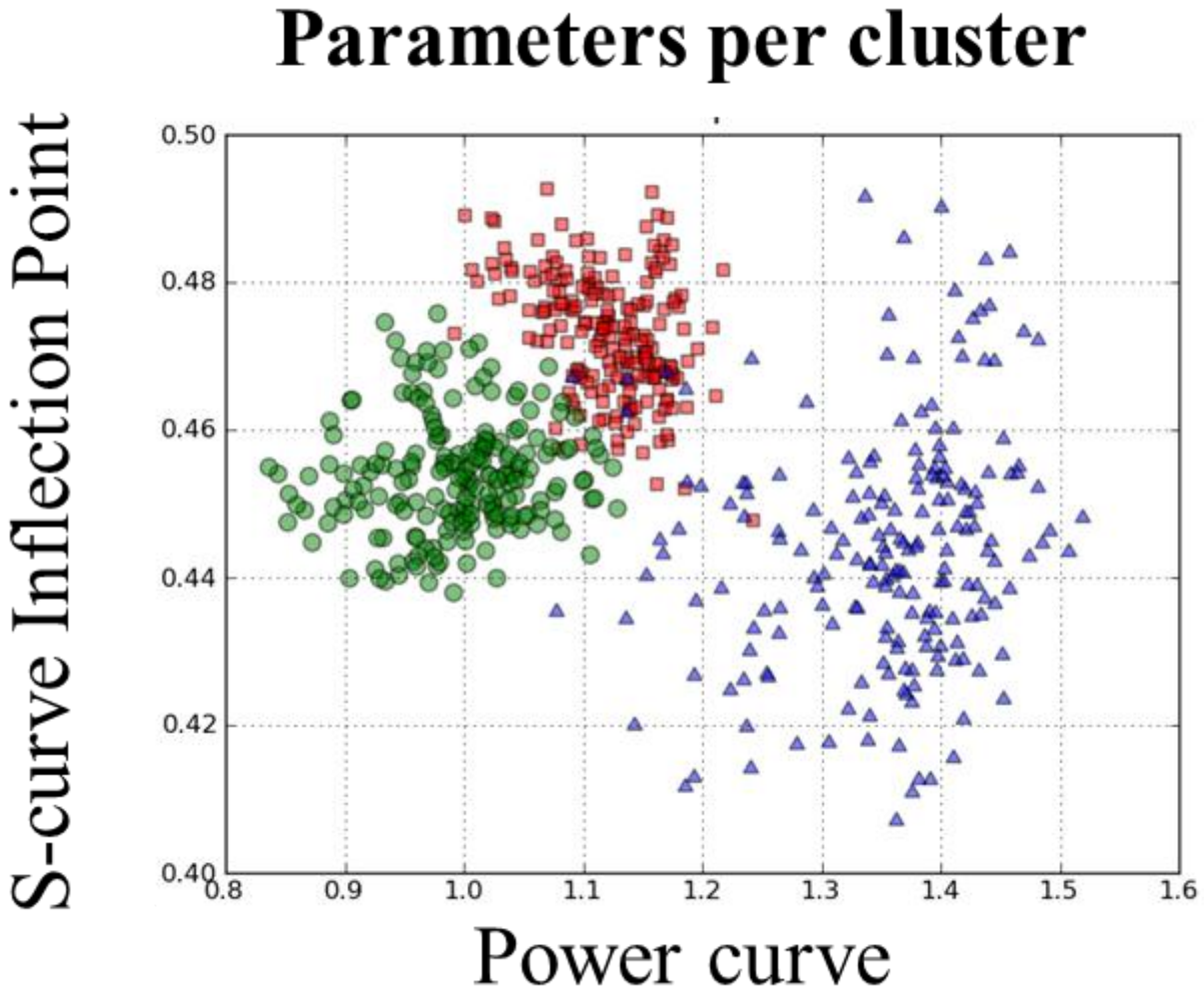
User study using Mechanical Turk

Larger set of people (>300 people)

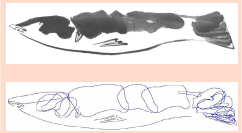
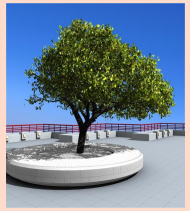


Web interface

Results


Parameters per cluster
S-curve Inflection Point
0.50
0.48
0.46
0.44
0.42
0.40
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
Power curve

Summary

		Computer vision	Machine learning
	**Animating Chinese paintings**	Segmentation	Prior on brush stroke shapes
	**Free viewpoint (“3D”) video**	Camera calibration, multi-view stereo	
	**Plant/tree modeling from images/sketches**	Structure from motion, multi-view stereo	Data-driven prior on branching
	**Personalized image enhancement**	Auto image correction	Metric learning (“image distance”) Collaborative filtering

Acknowledgments


Juan Caicedo


Dani Lischinski

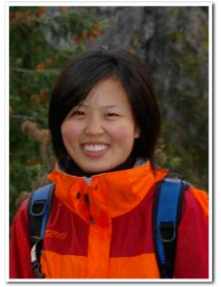

Oliver Deussen


Long Quan


Ping Tan


Rick Szeliski


Ashish Kapoor

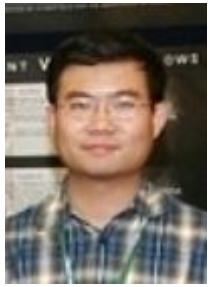

Xuejin Chen


Boris Neubert


Lu Yuan


Simon Winder


Larry Zitnick


Songhua Xu


Yingqing Xu

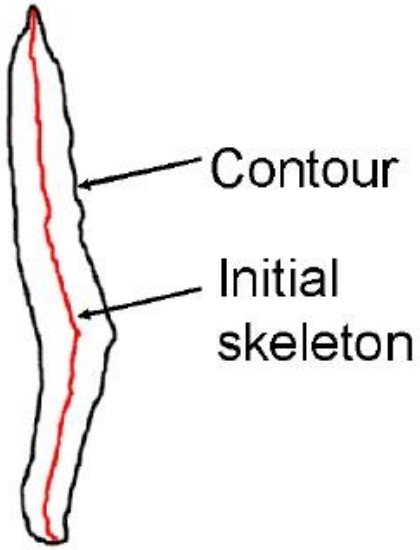

Gang Zeng

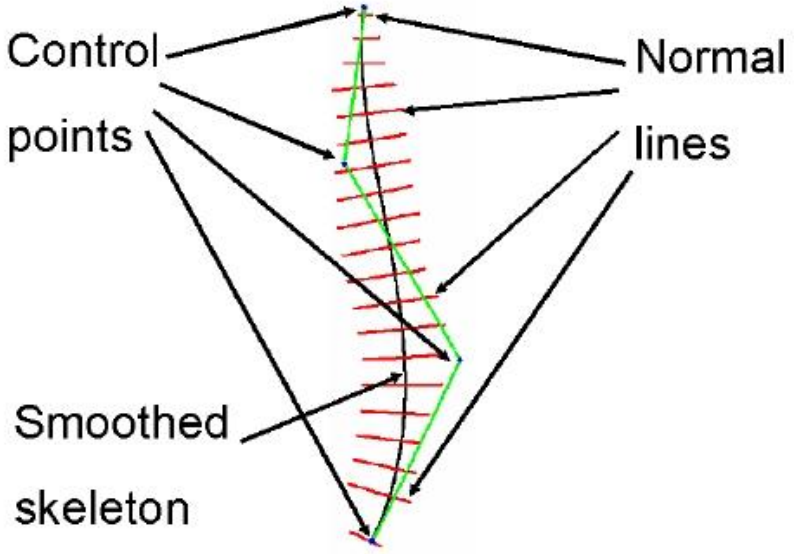

Jingdong Wang


Matt Uyttendaele

Microsoft®

Brush stroke appearance model





Input

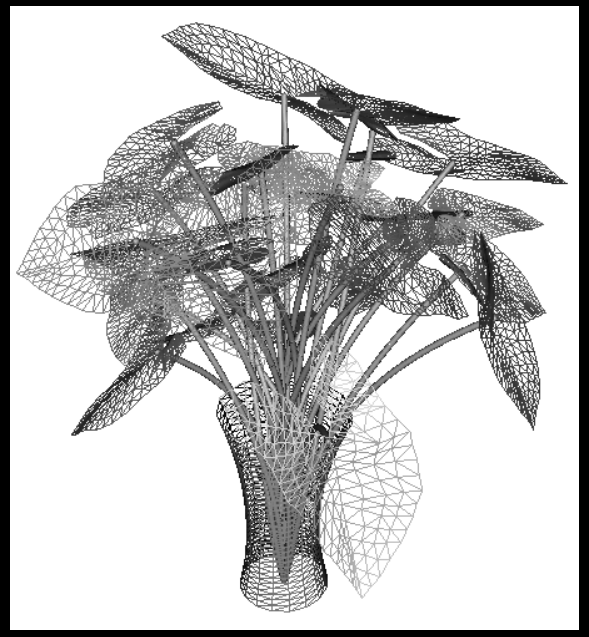
Synthesized

Calibration

Segment tree

Nephthytis

one source image
(1 from 35)



mesh model

rendering result

Poinsettia

one source image
(1 from 35)

recovered model

novel viewpoint

Schefflera

one source image
(1 from 40)

recovered model