# Advanced Computer Graphics
# CS 563: *"Texture-Lobes for Tree Modeling"*

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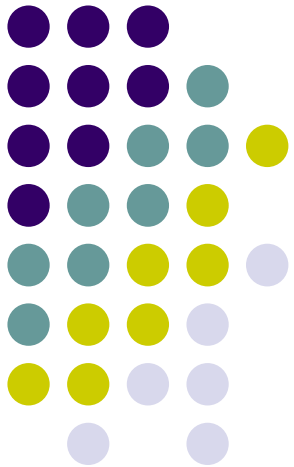
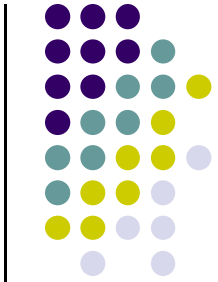
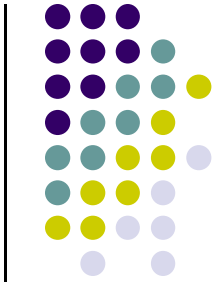


# Introduction



- Trees are very common objects that exhibit a large degree of complexity.
  - Branches, twigs, leaves, etc.
- Necessary to recreate realistic scenes
- Difficult to model in real time

# Key Ideas

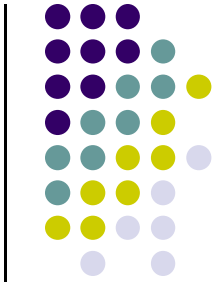


- Break the representation of a tree down by creating abstractions for complex features
  - Lobe-based representation
- Use scans of trees from real-life to collect data
- Classify data sets to identify species
  - Use species information to set model parameters
- Use the model to reconstruct the tree in real-time

# Overview

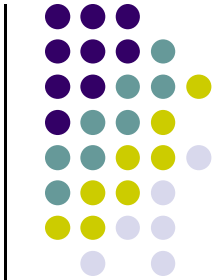



# Creating the representation



- Pre-processing stage – this is done in advance
- Start with a point set
  - Scan or existing 3D model
- Define skeletal structure
- Define lobes

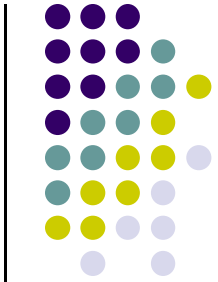
# Skeletal Structure



- Connect neighboring points
- Assign weights to each edge (u,v)
  - Where edge weight = $||u - v||^{\beta}$
- High values of β create a more compact representation
- Also assign branch diameter to each node in the tree

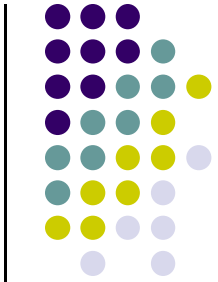
$$d(u) = d_{root}\left(\frac{l(u)}{l(root)}\right)^{\gamma}$$

# Lobe Geometry



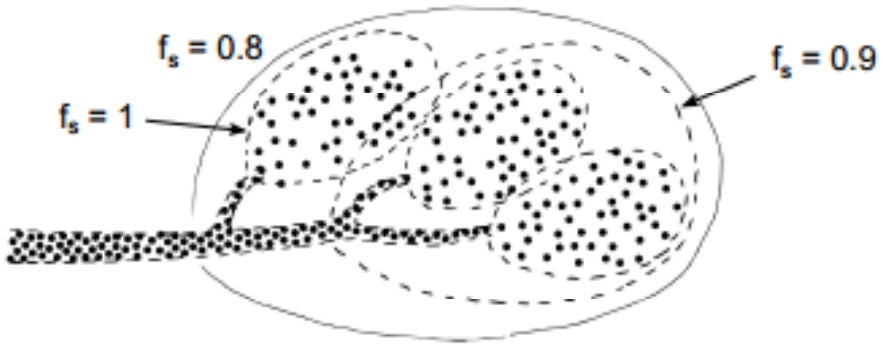
- After a certain point, the distance between points exceeds branch diameter
- Probability that these points belong to the same branch is low
- From this point on, use the remaining tree to construct a lobe

# Lobe Geometry, cont.



- To control the size of the lobes, introduce a new parameter, $f_s$

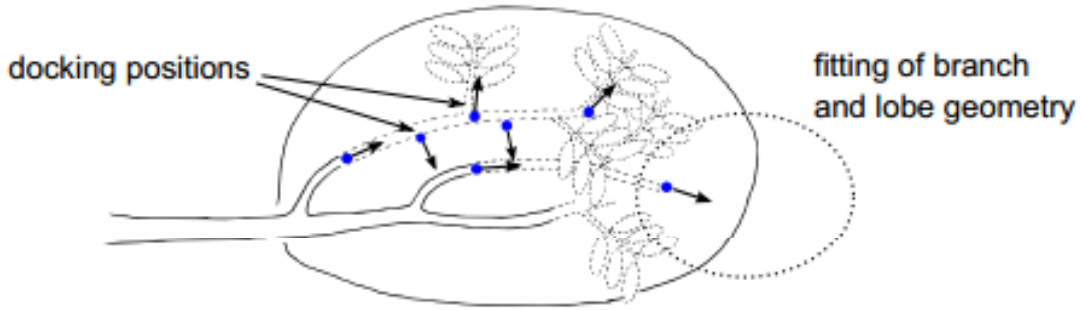
$$d'(u) = f_s \cdot d(u)$$




- Use α-Shapes (extension of convex hull) to create the lobe surface

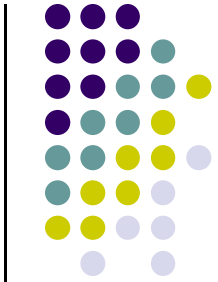
# Reconstruction

- For each tree species, include a premade set of patches that contain docking positions and orientations



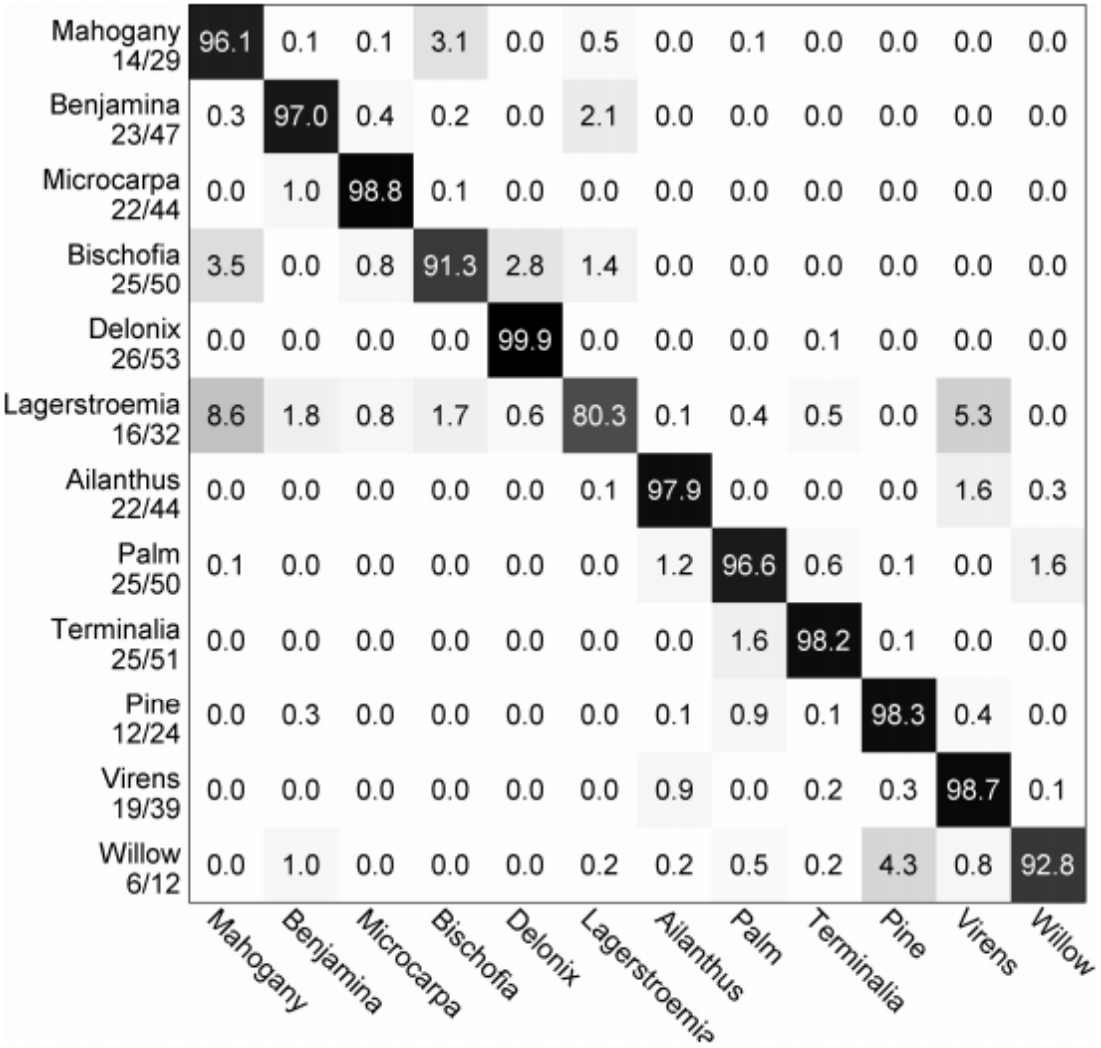
# Texturing Lobes

# Classification

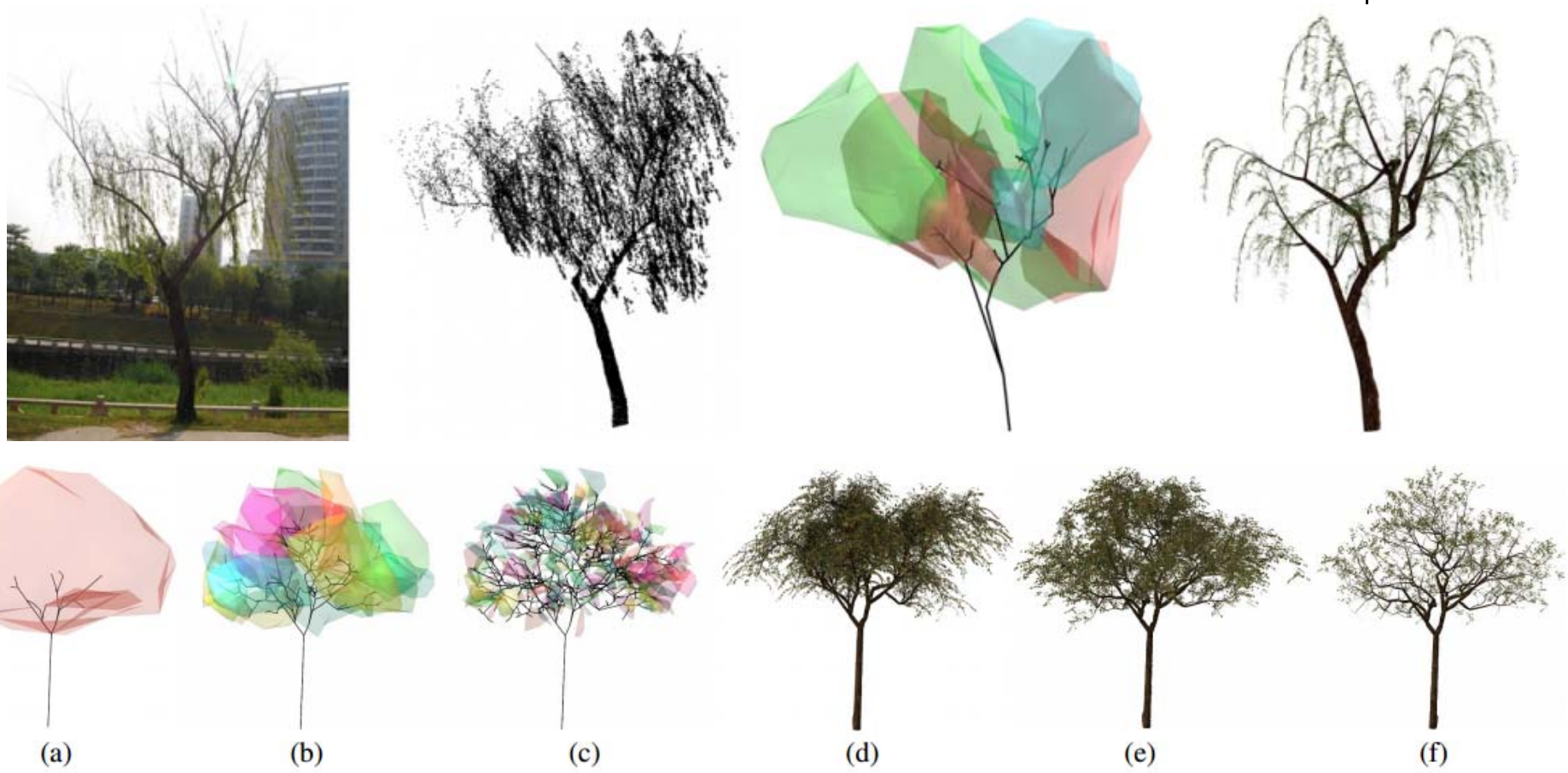


- Raw data is collected
- Compute over 200 features for each input set
  - Height, density, location, etc.
  - Also included geo. location (cheating?)
- Use Joint Boost classifier
  - Results in a vector of probabilities for each tree type
  - Highest probability is the final classification

# Classification Training Results



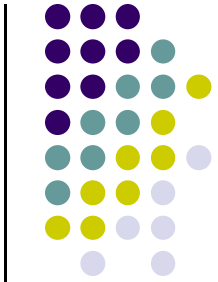
# Results



# Results, cont.

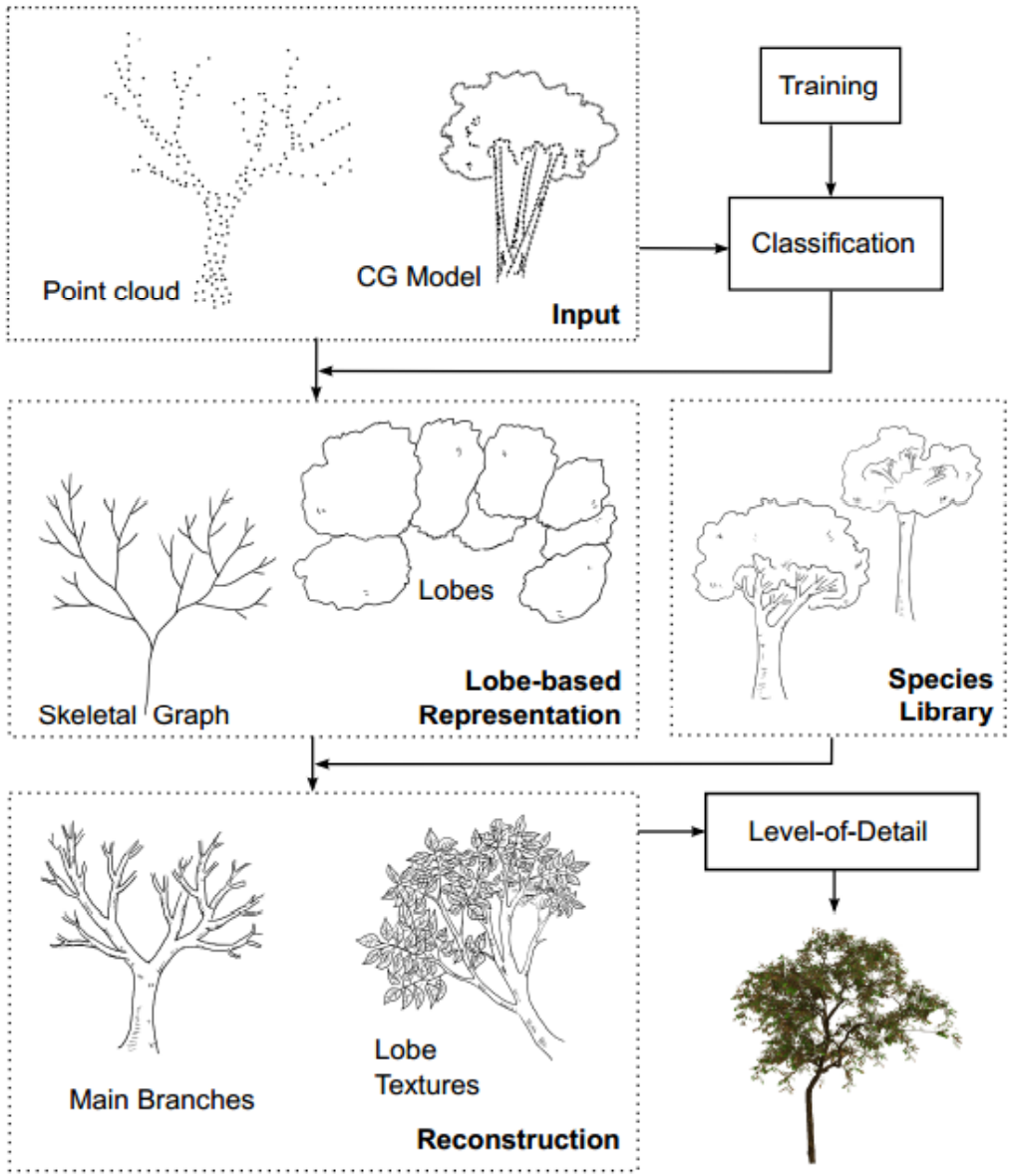
- Xfrog models:
- Approx. 60MB down to 60kB

# Results, cont.

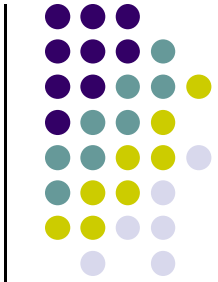


| Species | # of Lobes | Model Size | Time Reconst. | Time LOD |
|---|---|---|---|---|
| Mahogany | 29 | 15 kB | 7 ms | 1 ms |
| Bischofia polycarpa | 31 | 30 kB | 9 ms | 2 ms |
| Delonix | 39 | 39 kB | 3 ms | 0.5 ms |
| Lagerstroemia | 24 | 22 kB | 9 ms | 1.5 ms |
| Ailanthus altissima | 24 | 30 kB | 12 ms | 2 ms |
| Palm | 1 | 3 kB | 4 ms | 0.5 ms |
| Terminalia | 80 | 19 kB | 11 ms | 2.5 ms |
| Pine | 86 | 20 kB | 18 ms | 4 ms |
| Ficus Virens | 72 | 23 kB | 16 ms | 3 ms |
| Willow | 9 | 5 kB | 8 ms | 0.5 ms |

# Recap


Point cloud
CG Model
Input
Training
Classification
Lobes
Skeletal Graph
Lobe-based Representation
Species Library
Main Branches
Lobe Textures
Reconstruction
Level-of-Detail

# Conclusions



- Method enables the display of many highly complex tree structures in real-time
- Lobe-based representation allows for efficient storage and reconstruction
- Some trees have foliage too dense to benefit from point scanning (Pine trees)
- Editing? Animation?

# References


- Yotam Livny, Soeren Pirk, Zhanglin Cheng Feilong Yan, Oliver Deussen, Daniel Cohen-Or, Baoquan Chen. *Texture-Lobes for Tree Modelling.* Proceedings of SIGGRAPH, 2011.
- http://graphics.uni-konstanz.de/publikationen/2011/texturelobesfortreemodeling/website/