



Autotagging to Improve Text Search for 3D Models

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- Motivation: **Keyword search** for 3D models
 - ◆ Unlike images, 3D models are not usually embedded in text content
 - ◆ How can we search unlabeled geometry?
- Challenges
 - ◆ Lack of reliable datasets
 - ◆ Distances are metric but semantics are not
 - ◆ Representations of geometry are nonunique



Autotags

- Solution: **automatic annotation**
 - ◆ Given an unlabeled model, assign descriptive tags
 - ◆ Probabilistically propagate tags and confidences between similar models
 - ◆ Perform keyword search on autotags
- We use **Google 3D Warehouse** as a corpus
 - ◆ **192,343** user contributed 3D models
 - ◆ Tags are only moderately reliable
 - ◆ Too many tags to train explicit models



Autotagging Algorithm

- **Geometric Similarity**

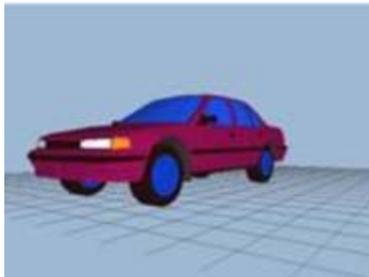
- ◆ Given unlabeled model ω and corpus model ω_x , define $P(\omega \approx \omega_x) = (1 - D(\omega_x, \omega_y))^2$ as their similarity, where D is L^2 on Zernike descriptors

- **Tag Propagation Rule**

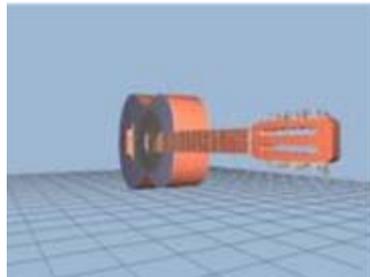
- ◆ Given the N nearest neighbors of ω , and a tag λ^i

$$P(\lambda^i, \omega) = \bigcup_{n=1}^{|N|} P(\omega \approx \omega_n) \wedge P(\lambda^i, \omega_n)$$

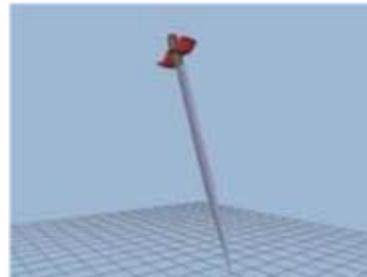
Results on Benchmark Models



car, vehicle,
sedan, dodge,
charger



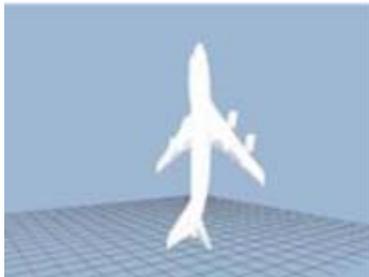
steel string, guitar,
string, seagull,
acoustic guitar



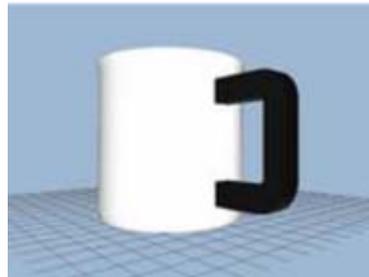
sword, blade,
sign, architecture,
landscape



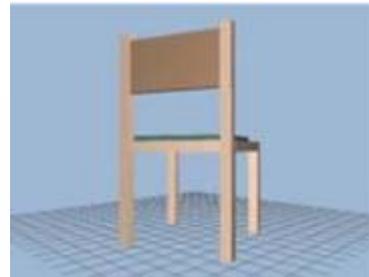
house, instrument,
musical instrument,
musical, piano



airplane, *house,*
aircraft, plane, jet



mug, drink,
beverages, coffee,
interior



chair, wood, furniture,
wooden, simple chair



animal, human,
biped, man, *aircraft*

Images from the Princeton Shape Benchmark

Demo

- Columbia Shape Search

Columbia Shape Search

[Columbia Robotics Lab](#) | [Columbia Vision and Graphics Center](#) | [Google 3D Warehouse](#) | [Corey Goldfeder](#)

<div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 5px;"> <input style="width: 90%;" type="text"/> </div> <div style="display: flex; justify-content: space-between;"> Search Random Model </div>	Search By <input checked="" type="radio"/> Name <input type="radio"/> Original Tags	Search Method <input type="radio"/> Precomputed <input type="radio"/> Raw Zernikes <input checked="" type="radio"/> 3D Warehouse PCA	use for <input type="checkbox"/> 3D Warehouse June 07 Snapshot <input checked="" type="checkbox"/> Princeton Shape Benchmark Train <input checked="" type="checkbox"/> Princeton Shape Benchmark Test
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ResultsAutotag

human_arms_out
Princeton Shape Benchmark Test (see voxels)

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Description:
Original Tags: human arms out, human, biped, animal

50 neighbors found. Autotagged based on 69 neighbors.

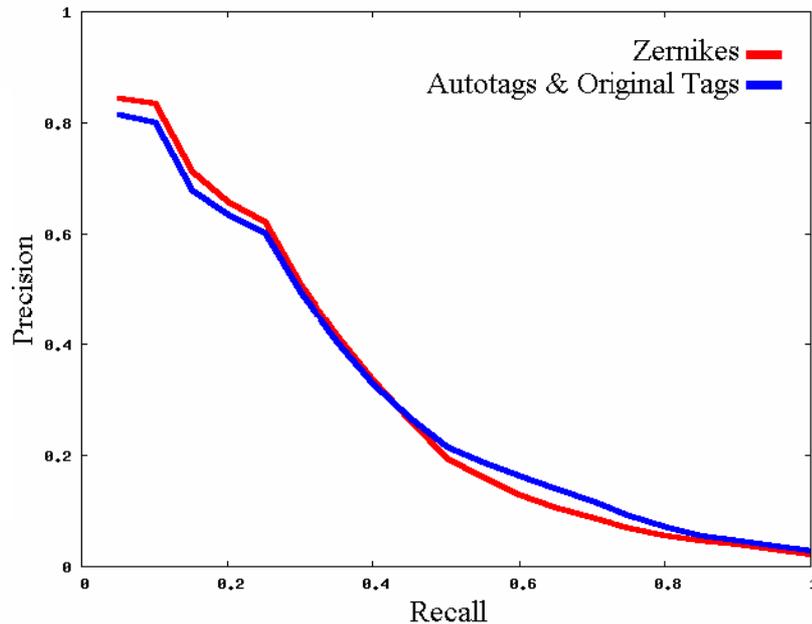
Computed Tags: animal, human, biped, humanarmsout, human_arms_out, arms

0.01052	0.01478	0.02003	0.02193	0.02521	0.02621	0.02777
0.02871	0.02880	0.02893	0.02907	0.02953	0.03019	0.03043

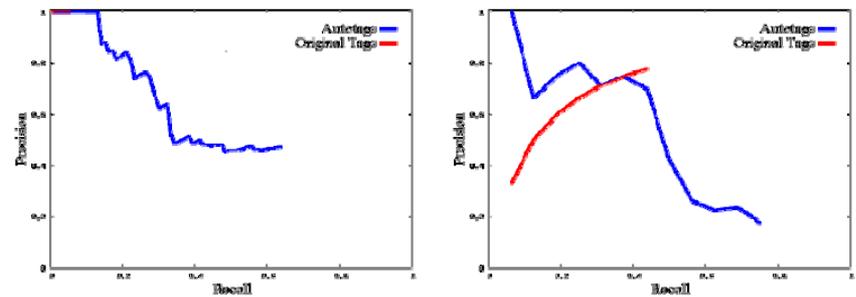
- Try it yourself at shape.shorturl.com

Experimental Results

Discriminative Power

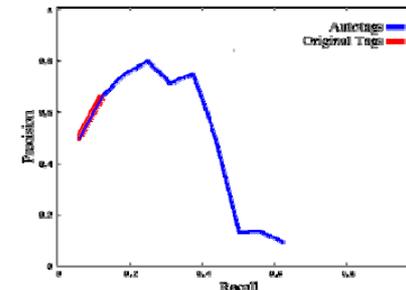


Tag Quality



(a) Search for "airplane"

(b) Search for "sword"



(c) Search for "head"



Conclusions and Future Work

- **Conclusions**
 - ◆ Autotags **transfer** most of the discriminative power of Zernike descriptors into text search
 - ◆ Along with anchor text, etc. we can **roughly replicate** the performance of Zernikes using text
- **Future Work**
 - ◆ Different shape descriptors
 - ◆ Finer-grained priors for reliability of corpus tags
 - ◆ Local clustering to reduce sample bias in corpus



- See also our poster in SMI '08 and our winning entry in SHREC '08 (classification track)
- Thanks to Google for providing the dataset
- Questions?