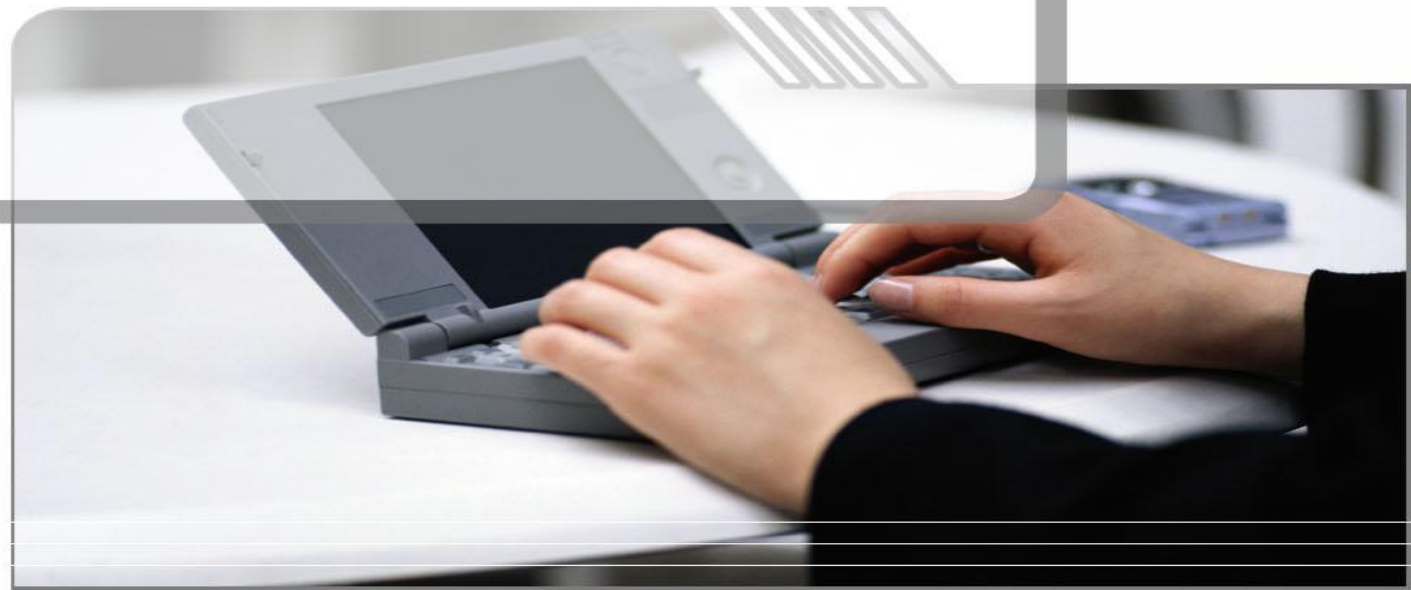
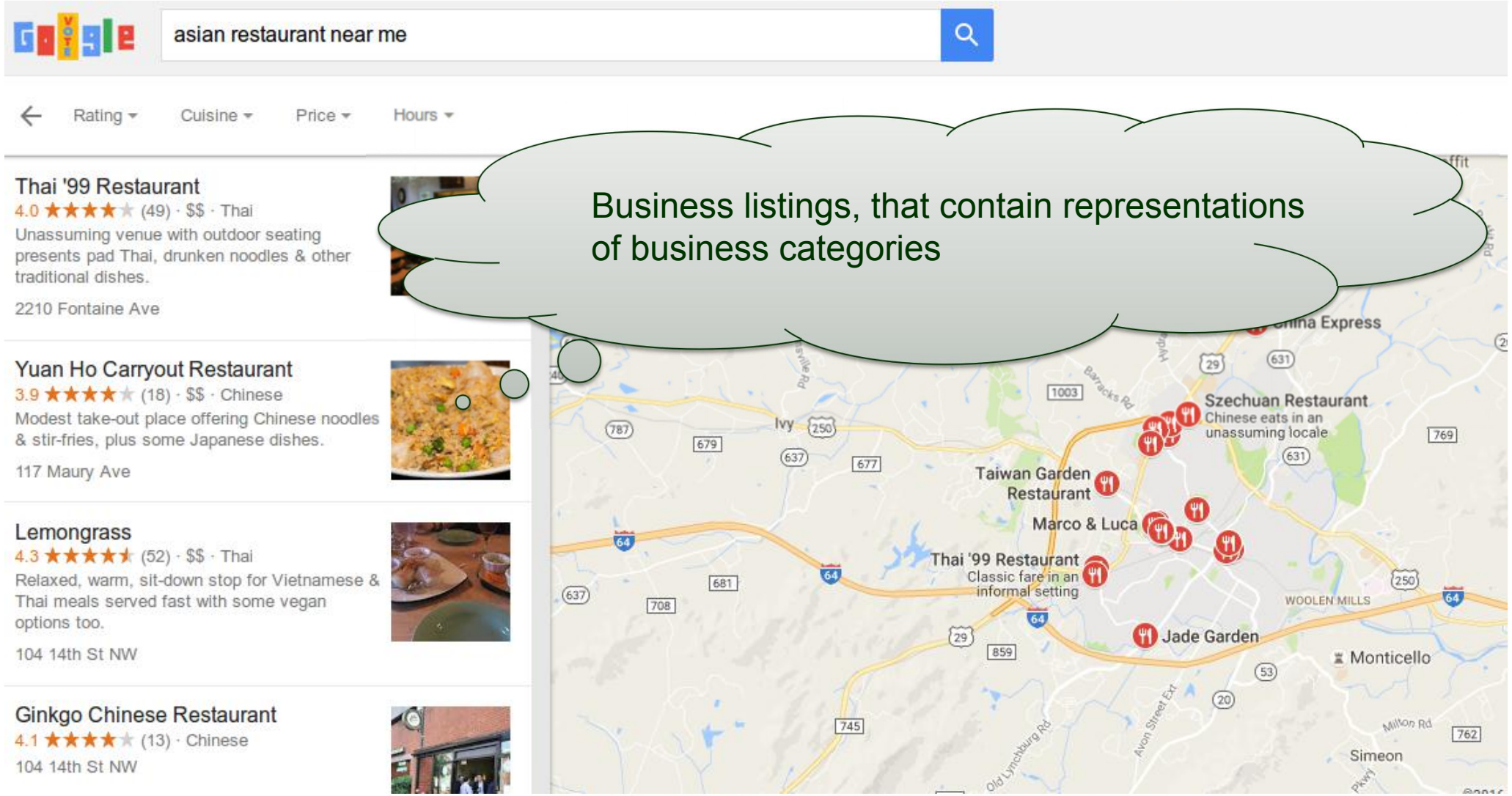
Ontological Supervision for Fine Grained Classification of Street View Storefronts

CVPR 2015 by Yair Movshovitz-Attias, Qian Yu, Martin C. Stumpe, Vinay Shet, Sacha Arnoud, Liron Yatziv



Presenter: Minghua Jiang

locality-aware queries



Introduction & Motivation

- Time-consuming and expensive
- Google Street View to automate the process
- Limited Labeled data for business category

Task

- Fine-grained storefront classification from street level imagery
- Create a large, multi-label, training dataset
- Multi-label
- Fine-grained

Grocery

Plumbing store

Outline for the paper

- Challenges in storefront classification
- Ontology based generation of training data
- Model Architecture and Training
- Evaluation

Large within-class variance

Sushi Restaurant

Bench store

Pizza place

Misleading extracted text

(a) Unexpected Language

(b) Misleading Text

(c) Stitching Errors

Business Category Distribution

- 300,000 images for Food and Drink
- 13,000 images for Laundry Services

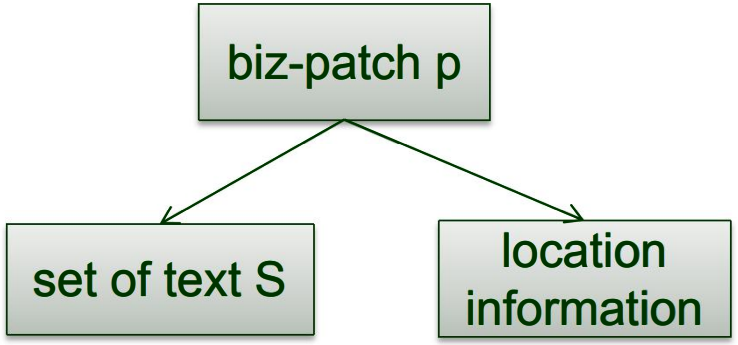
Labeled Data Acquisition

(a) Area Too Small (b) Area Too Large (c) Multiple Businesses

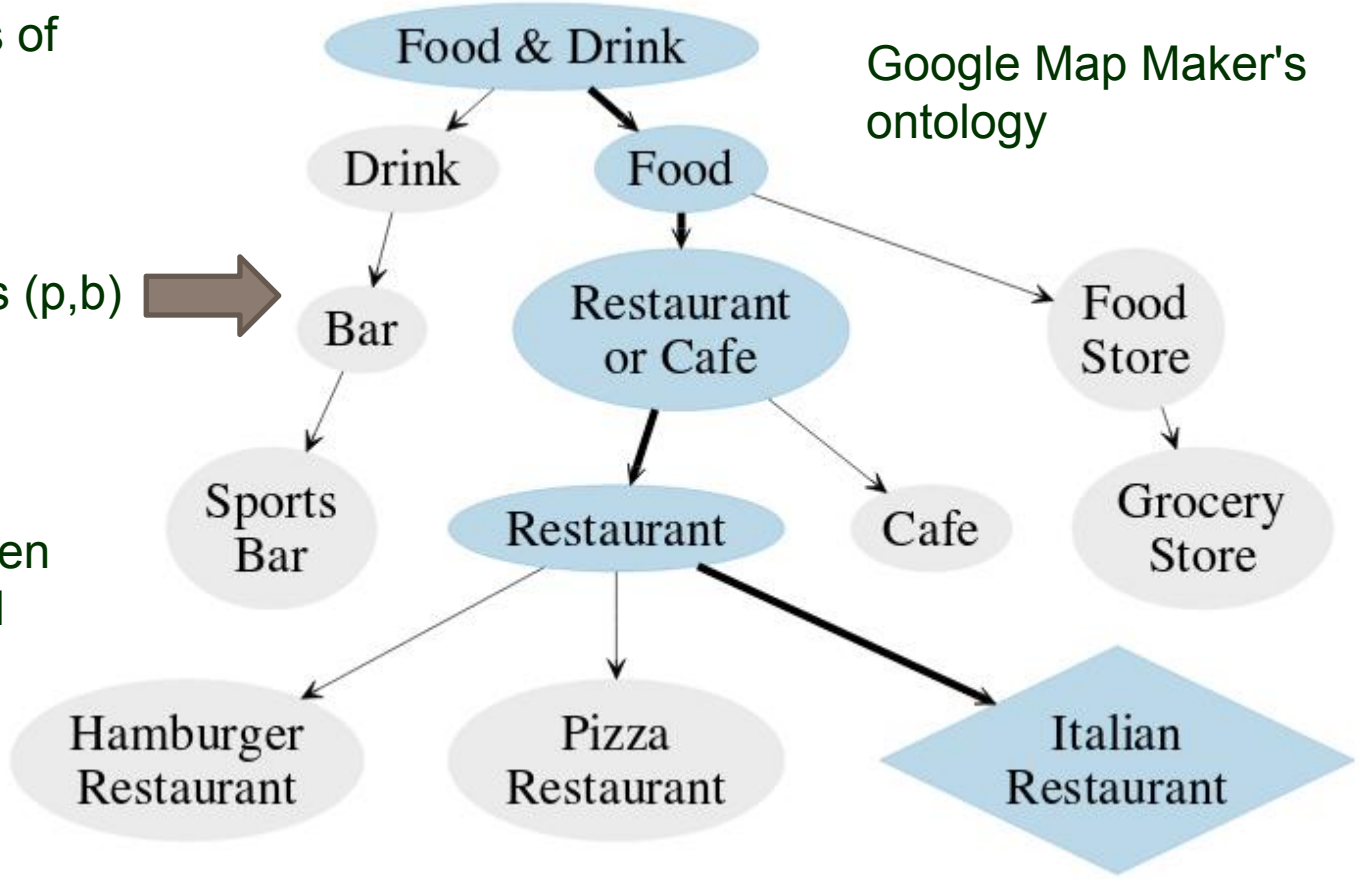
The operators are asked to mark image areas that contain business related information from the google street view panoramas offered to them which are called biz-patches

Ontology based generation of training data

Goal: Matching extracted biz-patches p and sets of relevant category labels

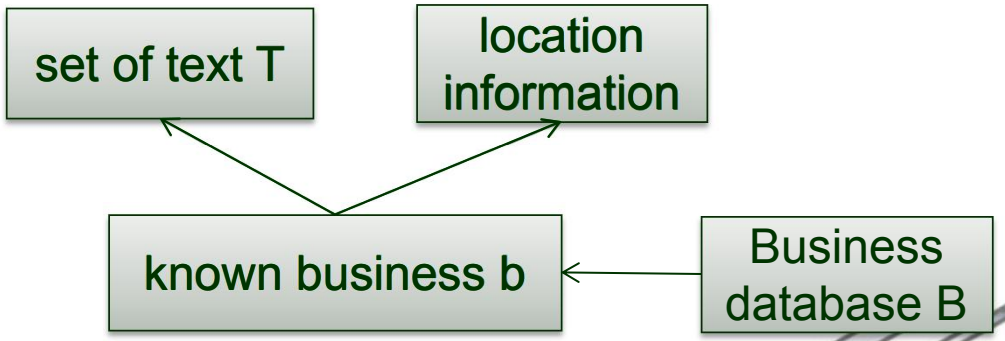


3 millions (p,b)



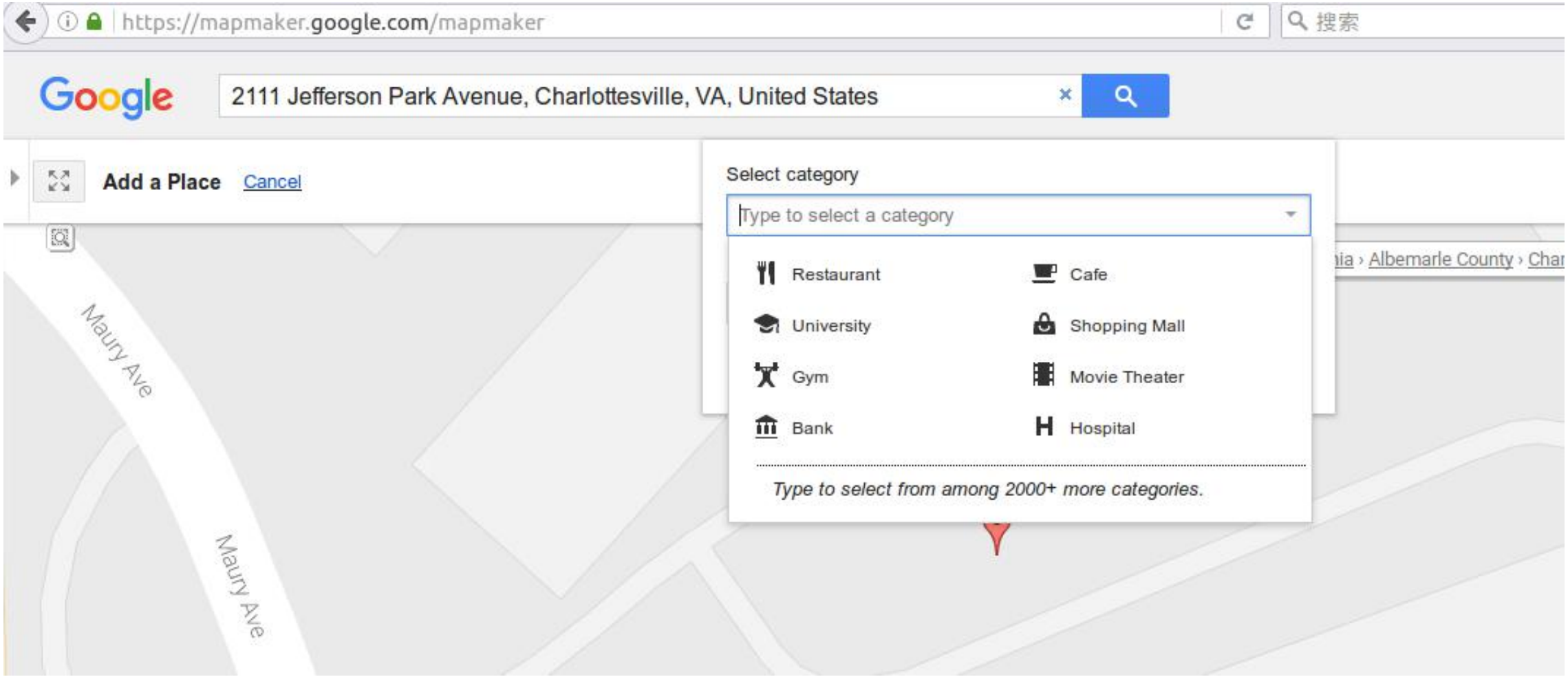
Google Map Maker's ontology

p is a biz-patch of b if geographical distance between them is less than approximately one city block, and enough extracted text from S matches T



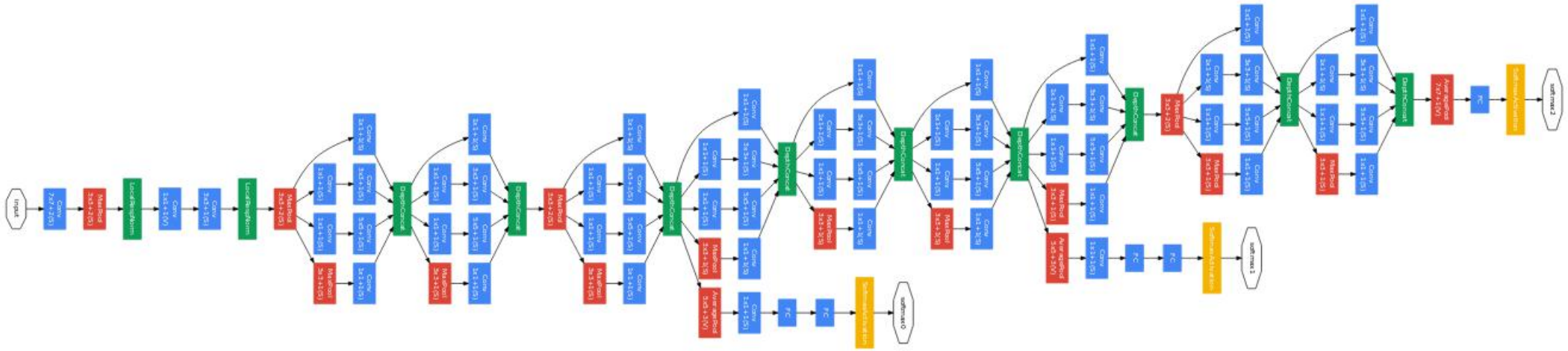
(p,s) where p a biz-patch and s is a matching set of labels with varying levels of granularity --> 1.3 million p and 208 unique labels

Google Map Maker



Model and Training

- GoogLeNet
- 1.2 Million images for training and 100,000 images for testing
- Splitting is location aware



Model and Training

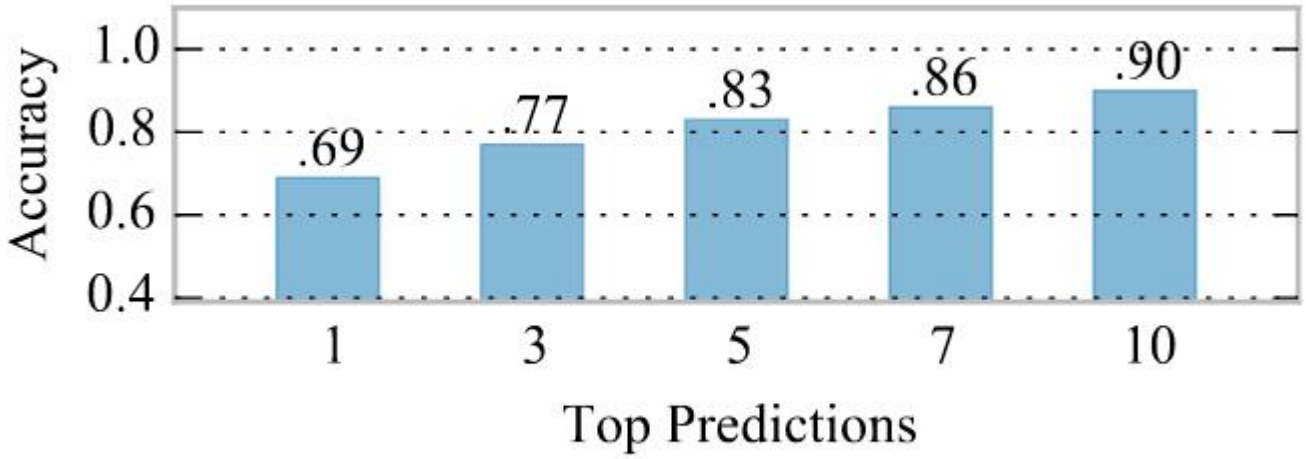
- Covered the globe with big and small tiles (18km and 2km)
- Tiling alternates between two types of tiles
- A boundary area of 100 meters between adjacent tiles
- Panoramas located in big tiles for training set
- Panoramas located in small tiles for testing set

Model and Training

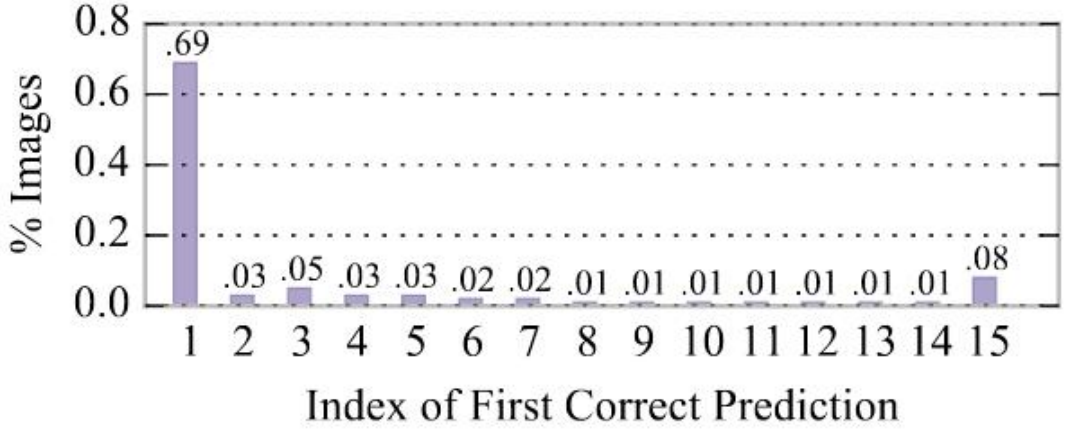
- Pre-trained using ImageNet
- Dropout rate 70%
- Logistic Regression Top Layer
- Training
  - Each image resized to 256 * 256
  - 220 * 220 after cropping
- Testing
  - A central box of 220 * 220

Evaluation

- When building a business listing it is important to have very high accuracy.
- Top-K accuracy (a prediction is correct if $g_i \cap p_i^k \neq \emptyset$.)



(a) Accuracy at K



(b) First Correct Prediction

Evaluation

- recall at certain level of accuracy (90%)

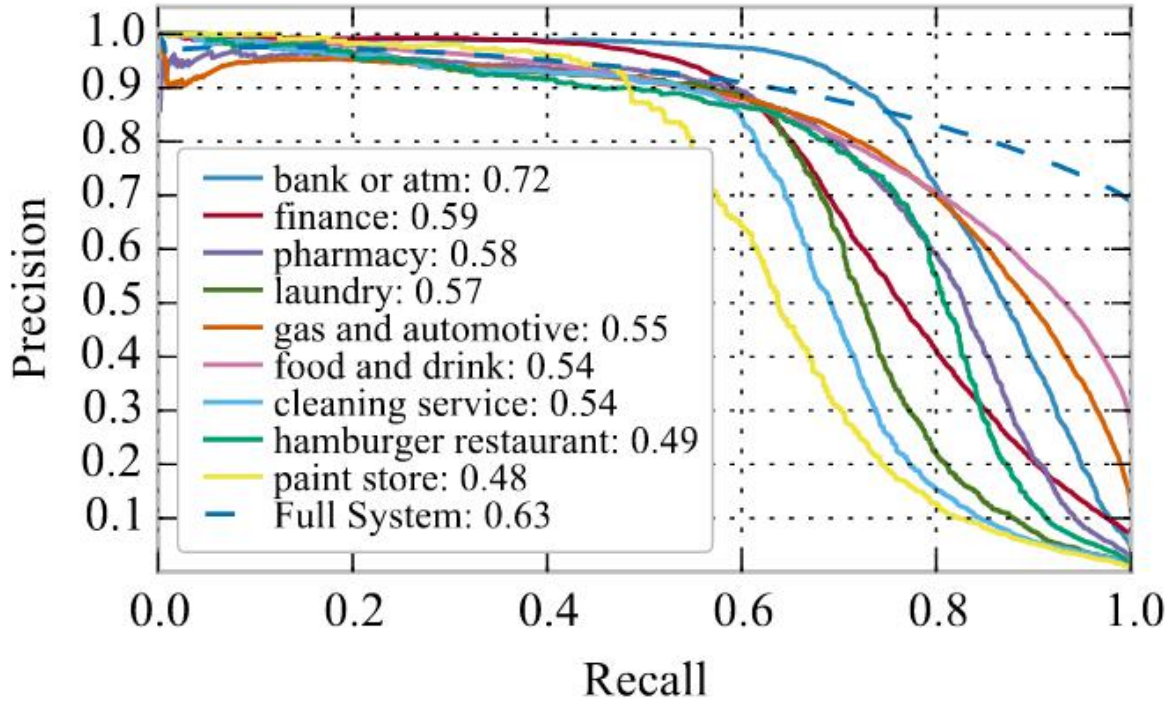


Figure 7. Precision recall curves for some of the top performing categories. The precision curve of the full system is shown as a dashed line. Recall at 90% precision is shown in the legend.

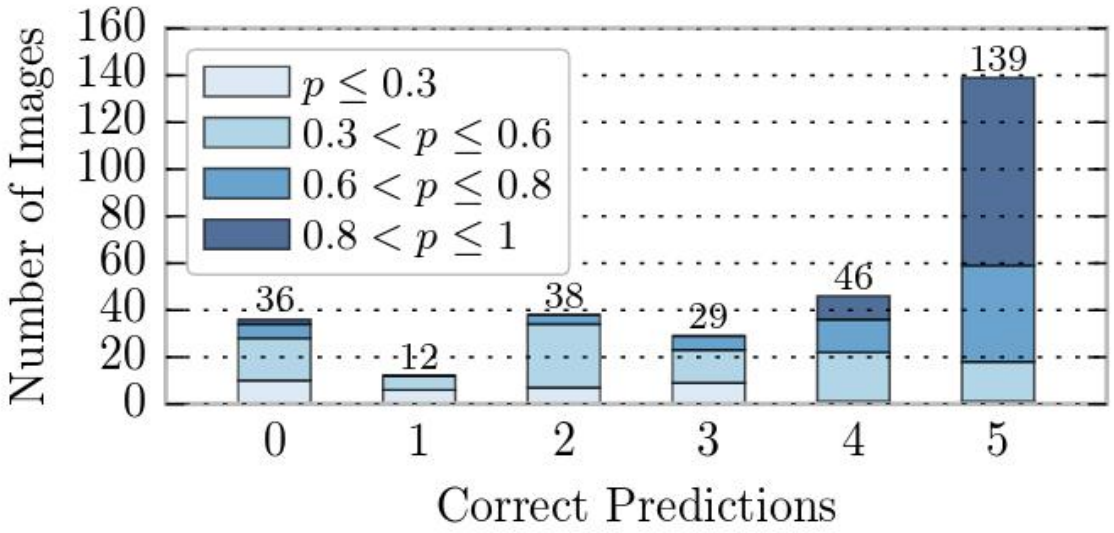


Figure 8. Histogram of correct labels in the top 5 predictions for a set of 300 manually verified images. Color indicates mean prediction confidence. Note that the confidence in prediction is strongly correlated with the accuracy.

Evaluation

- Human Performance Study(agreement of labels for same business)
- 13 Top Level Category
- Full resolution images
- Study 1 two operators
- Study 2 three-four

Operator Agreement	Number of images *Study 1*	*Study 2*
100%	50,425	9,938
75%	-	9
66%	-	8,535
50%	-	133
0%	22,847	1,300
Average Agreement	**69%**	**78%**

Table 1. Human Performance studies. In two large scale human studies we have found that manual labelers agree on a label for 69% and 78% of the images.

Evalution

- What if the text information is blurred

automotive	.999
gas & automotive	.999
shopping	.999
store	.999
vehicle dealer	.998

health & beauty	.992
health	.985
doctor	.961
emergency services	.960
dentist	.945

Dental

health & beauty	.935
beauty	*.925*
cosmetics	*.742*
beauty salon	*.713*
hair care	*.527*

Auto

automotive	.996
gas & automotive	.996
shopping	.995
store	.995
transportation	.985

Conclusion

- Method for fine grained, multi-label, classification of business storefronts from street level imagery
- Using ontology of entities with geographical attributes to generate large labeled data-set
- Demonstrated the system learned to extract text information when necessary
- Achieves human level accuracy

Questions?