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# **1 Visual Place Recognition**



# 2 The Challenges

### Seasons





Viewpoints

Occlusions, **Dynamics** 

Weather, Lighting, Shadows













# PLACE RECOGNITION WITH CONVNET LANDMARKS: VIEWPOINT-ROBUST, CONDITION-ROBUST, TRAINING-FREE

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### **3 ConvNets for Place Recognition** 64,896 dimensional feature vectors AlexNet Cosine distance for **similarity** layer 8 layer 7 fully connected layer 6 fully connected 384 x 13 x 13 layer 5 layer 4 layer 3 conv3 layer 2 pooling layer 1 nonlinear convolution

4 Which Layer	IS Best? appearance changes: come					
Dataset	Variatio	ons in	n			
	Appearance	Viewpoint	ewpoint Best Layer			
Nordland seasons	severe	none	conv3			
GP day-right vs night-right	severe	none	conv3			
GP day-left vs night-right	severe	medium	conv3			
St. Lucia	medium	medium	conv3			
Campus	medium	medium	conv3			
GP day-left vs day-right	minor	medium	fc6			
Nordland synthetic	none	varied	fc6			



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# **5** ConvNet Landmarks

- EdgeBoxes)
- can be done simultaneously using **Fast R-CNN**



1 0	Nordland: spring vs. winter				1 0	Gardens Point: day-left vs. day-right					
0.8-					0.8	- 256 bits - 512 bits					
0.6 - 0.4 -	<ul> <li>— 1024 bits</li> <li>— 4096 bits</li> </ul>			Prorision	0.6	- 1024 bits - 4096 bits					
0.2	— 8192 bits — full feature				0.2	- 8192 bits - full feature					
0.0	0.0 0.2 0.4 0.6 0.8 0.0 Recall				0.0	0 0.2 0.4 0.6 0.8 1.0 Recall					
	7 Sem	ant	ic S	earc	h S	Space	e Pa	rtiti	onin	g	
ecision	Campus: human vs. robot with search space partitioning use semantic information from higher layers (fc7) to reduce the search space							er ace			
Pre	0.2 0.2 - conv3	conv3	with partition		S	mall loss in	perforr	nance b	out 76%		

0.8

0.2

0.4

0.6

Recall



• use **object proposal** methods to extract landmarks (e.g.

• extract one ConvNet (conv3) descriptor for each landmark • find matchings from **descriptor and shape similarity** • new datasets from Mapillary (see tinyurl.com/vprice-challenge)

 $\frac{1}{10}$ speed-up during NN search