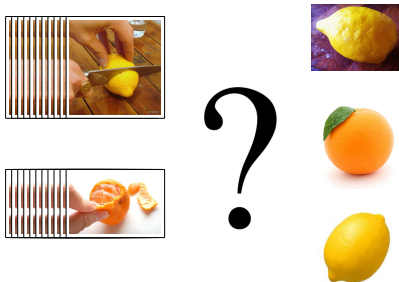


Contextual Modeling with Labeled Multi-LDA

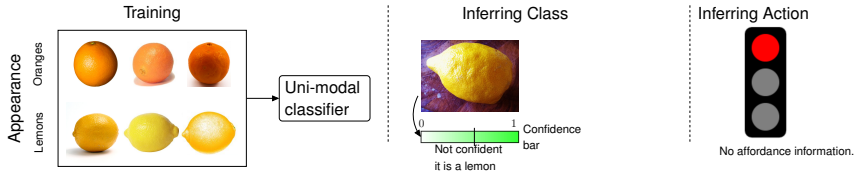
C. Zhang, D. Song and H. Kjellström

CVAP/CAS, KTH Royal Institute of Technology

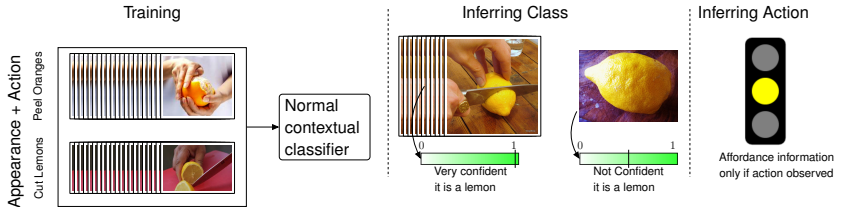


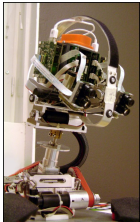
What object classes are observed?

Contextual Modeling



Contextual Modeling





Robot observing objects

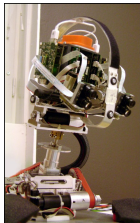


What object classes are observed?

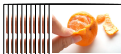
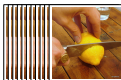


What actions are afforded?

Contextual Modeling



Robot observing objects



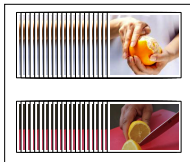
What object classes are observed?



What actions are afforded?

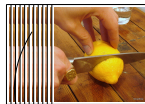
Training

Appearance + Action
Cut Lemons
Peel Oranges



LM-LDA

Inferring Class



0 1
Very confident
it is a lemon

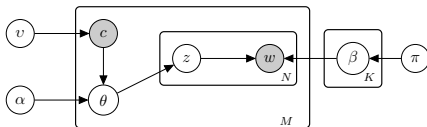


0 1
Confident
it is a lemon

Inferring Action



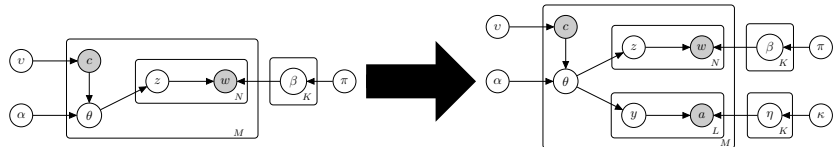
Affordance information
encoded in the model!



Labeled-LDA

1

¹ L. Fei-Fei and P. Perona, "A bayesian hierarchical model for learning natural scene categories," in CVPR, 2005.



Labeled-LDA

Labeled Multi-LDA

Classification of Action from Visual Motion and Object Interaction

Data: Activities of Daily Living (ADL) dataset.²

SVM+bag AO: 38.31%

SVM+ pyramid AO: 38.58%

	Comb hair	Wash h/f	Dry h/f	Drink w/b	Drink w/t	Make c/s	Use o
Combing hair	0.29	0.14	0.14	0.29	0	0.14	0
Washing hands/face	0.04	0.68	0.2	0.08	0	0	0
Drying hands/face	0.06	0.19	0.48	0.1	0	0.1	0.06
Drinking water/bottle	0.15	0	0.08	0.38	0	0.38	0
Drinking water/tap	0	0	0	0	0	0.5	0.5
Making cold food/snack	0	0	0.33	0.67	0	0	0
Using cell	0.2	0.2	0.2	0.1	0	0	0.3

Train STIP

Test STIP

30.49%

	Comb hair	Wash h/f	Dry h/f	Drink w/b	Drink w/t	Make c/s	Use o
Combing hair	0.37	0.06	0.23	0.17	0	0.17	0
Washing hands/face	0.05	0.72	0.14	0.07	0	0.02	0
Drying hands/face	0.05	0.15	0.53	0.07	0	0.11	0.08
Drinking water/bottle	0.14	0	0.06	0.62	0	0.15	0.03
Drinking water/tap	0	0	0.1	0.1	0	0.5	0.3
Making cold food/snack	0	0	0.13	0.67	0	0.2	0
Using cell	0.08	0.22	0.22	0.24	0	0	0.24

Train both

Test STIP

38.23%

	Comb hair	Wash h/f	Dry h/f	Drink w/b	Drink w/t	Make c/s	Use o
Combing hair	0.49	0.2	0.17	0.14	0	0	0
Washing hands/face	0.05	0.78	0.13	0.01	0.02	0	0.01
Drying hands/face	0.08	0.13	0.47	0.09	0	0.12	0.1
Drinking water/bottle	0.11	0	0.03	0.62	0	0.25	0
Drinking water/tap	0	0.3	0.2	0	0	0.5	0
Making cold food/snack	0.03	0	0.1	0.5	0	0.37	0
Using cell	0.04	0.18	0.16	0.12	0	0	0.5

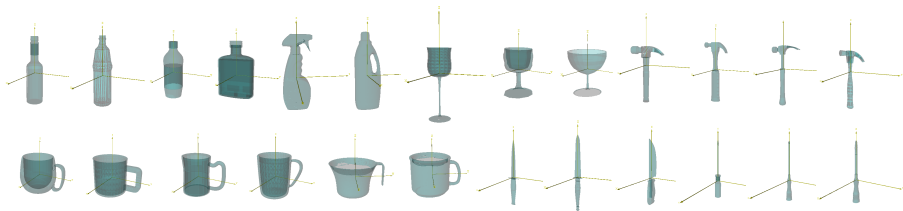
Train both

Test both

46.04%

² H. Pirsiavash and D. Ramanan, "Detecting activities of daily living in first-person camera views", in CVPR, 2012.

Functional Classification of Objects from Appearance and Grasp



All the instances used in the Appearance and Task-Orientated Grasp experiment: 6 Bottles, 3 Glasses, 4 Hammers, 6 Mugs, 3 knives and 3 Screwdrivers.³

³D. Song, K. Huebner, V. Kyriki, D. Kragic, "Learning task constraints for robot grasping using graphical models", in IROS, 2010

Functional Classification of Objects from Appearance and Grasp

	Btl	Gls	Hm	Knf	Mug	SD
Bottle	1	0	0	0	0	0
Glass	0	0.33	0.33	0	0.33	0
Hammer	0	0	1	0	0	0
Knife	0	0	0	0.67	0	0.33
Mug	0	0	0	0	1	0
ScrewDriver	0	0	0	0.33	0	0.67

Train SIFT,Test SIFT: 77.78%

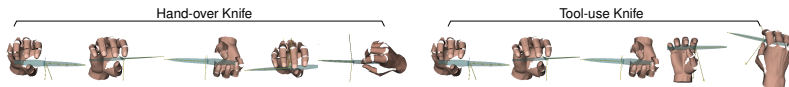
	Btl	Gls	Hm	Knf	Mug	SD
Bottle	1	0	0	0	0	0
Glass	0	0.33	0.33	0	0.33	0
Hammer	0	0	1	0	0	0
Knife	0	0	0	0.67	0	0.33
Mug	0	0	0	0	1	0
ScrewDriver	0	0	0	0	0	1

Train both,Test SIFT: 83.33%

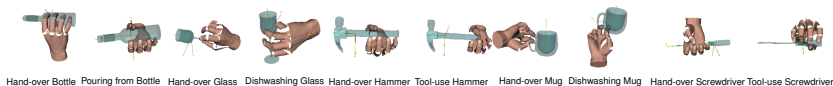
	Btl	Gls	Hm	Knf	Mug	SD
Bottle	1	0	0	0	0	0
Glass	0	0.67	0.33	0	0	0
Hammer	0	0	1	0	0	0
Knife	0	0	0	0.83	0	0.17
Mug	0	0	0	0	1	0
ScrewDriver	0	0	0	0	0	1

Train both,Test both: 91.67%

Functional Classification of Objects from Appearance and Grasp



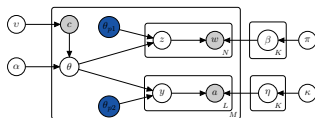
The most probable grasps on an unseen knife with task-oriented grasp Hand-over and Tool-use.



Grasp examples on other objects.

Future Work:

1. Factorized - LMLDA⁴



2. Efficient Learning Algorithm

<http://www.csc.kth.se/~chengz/TopicModelCode.html>⁵

⁴ C. Zhang, C. H. Ek, A. Damianou, and H. Kjellström, "Factorized topic models," in International Conference on Learning Representations, 2013.

⁵ C. Zhang, C.H. Ek, X. Gratal, F.T. Pokorny and H. Kjellström, "Supervised Hierarchical Dirichlet Processes with Variational Inference", In ICCV inferPGM, 2013 .

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Thanks & Questions