Indoor-Outdoor Classification with Human Accuracies: Image or Edge

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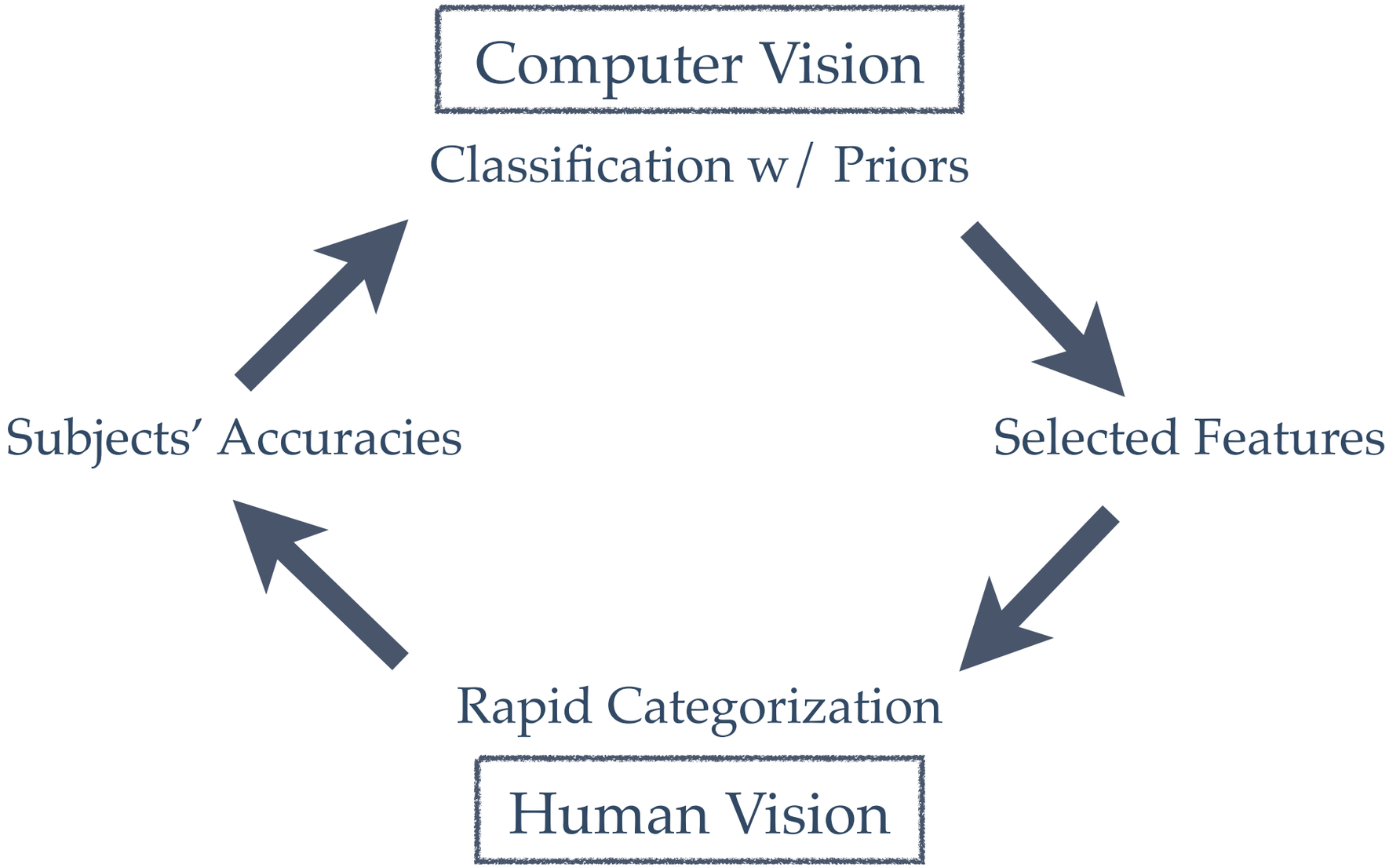
Goal


Computer Vision
Classification w/ Priors
Subjects' Accuracies
Selected Features
Rapid Categorization
Human Vision

Roadmap

- Rapid categorization experiment

  [indoors vs. outdoors using grayscale images and line drawings]

- Model for incorporating human accuracies

- Experimental Evaluation

Ultra-Rapid Categorization

fixation dot
1sec

Ultra-Rapid Categorization

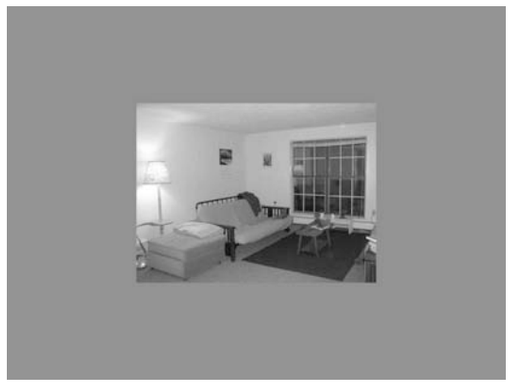
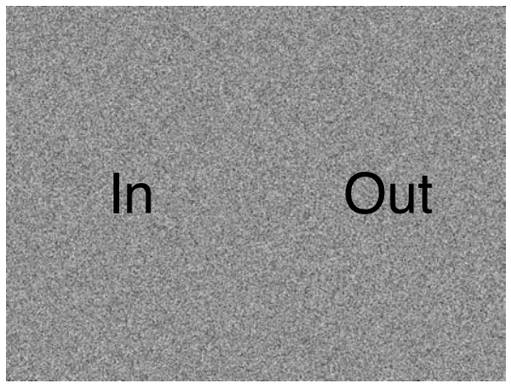


photo or line drawing
16ms or 32ms

fixation dot
1sec

Ultra-Rapid Categorization



choice screen

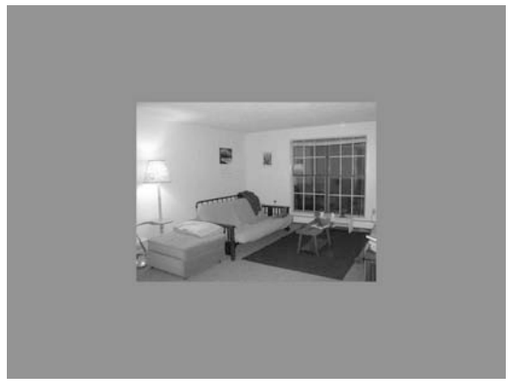


photo or line drawing
16ms or 32ms

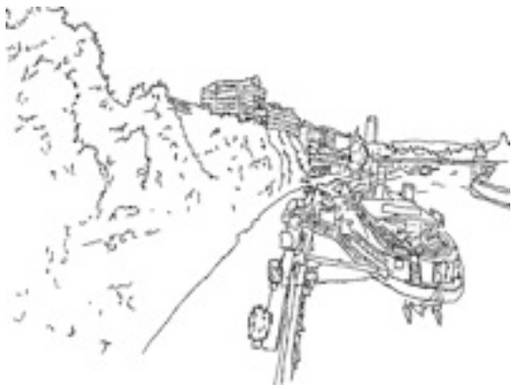
fixation dot
1sec

Example Stimuli

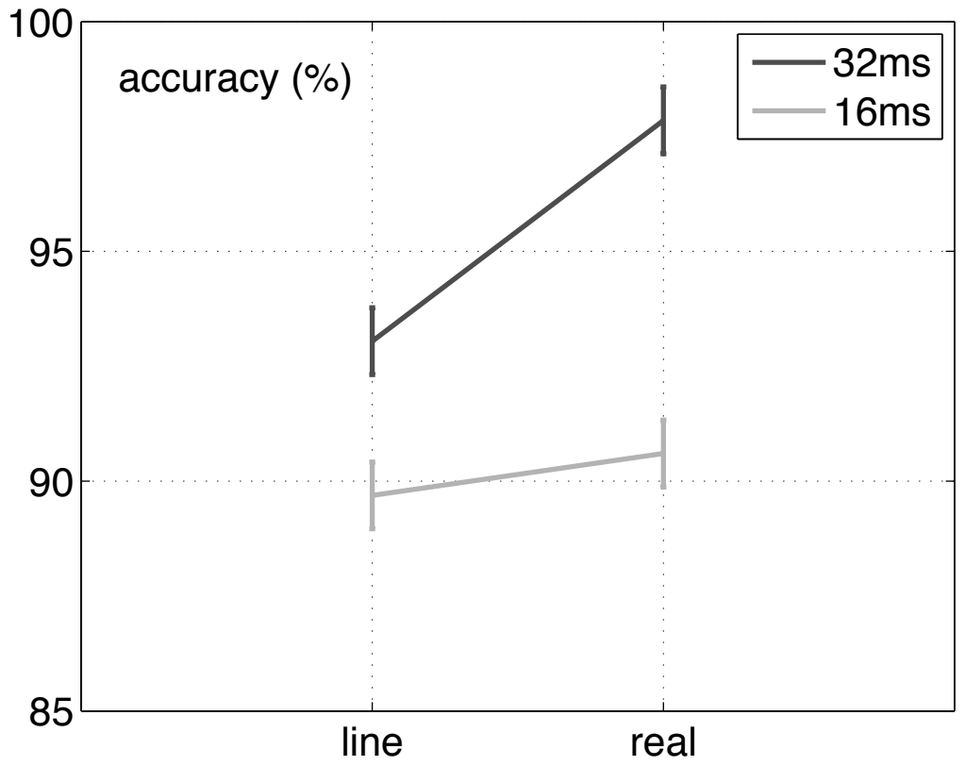




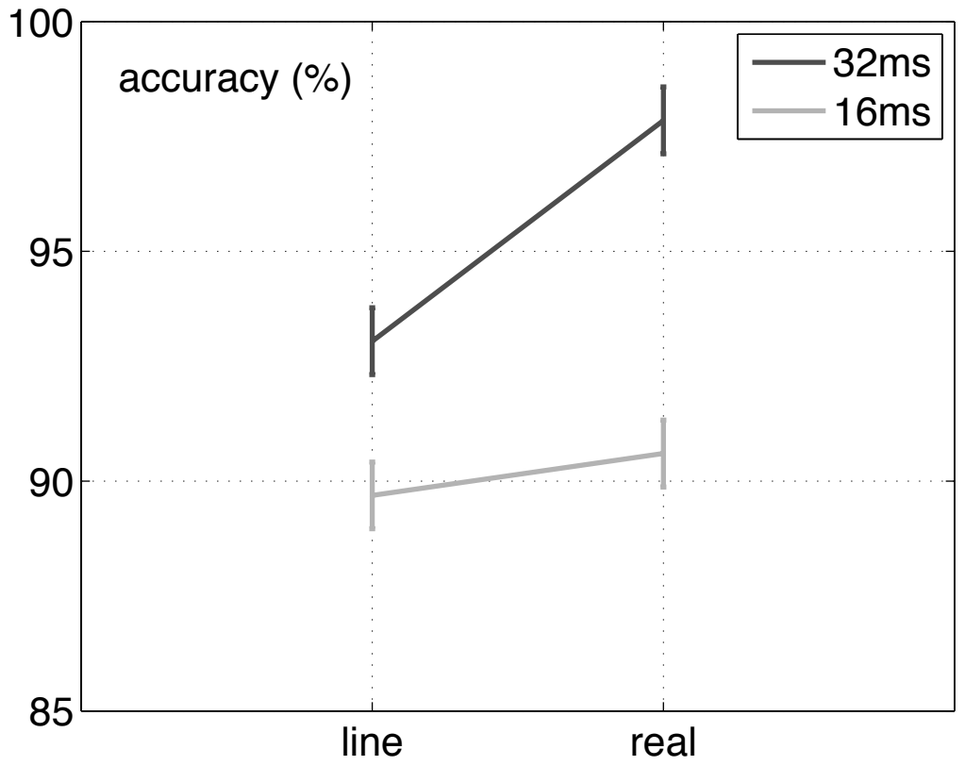





Human Accuracies



Human Accuracies



Small Accuracy Gain

100% → 100%

100% → 100%

100% → 100%

100% → 100%

100% → 100%

100% → 100%

100% → 100%

100% → 100%

Large Accuracy Gain

75% → 100%

65% → 95%

75% → 100%

75% → 100%

75% → 100%

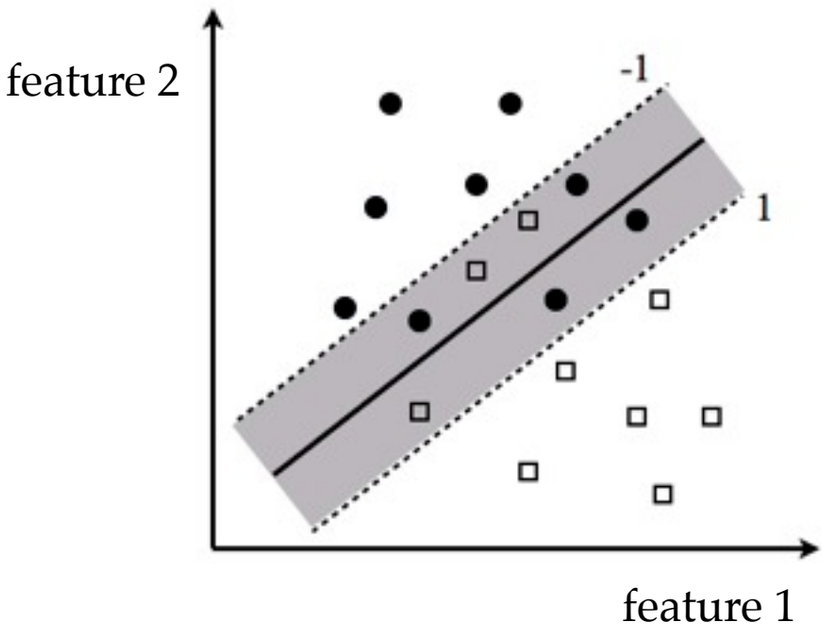
65% → 89%

85% → 100%

85% → 100%

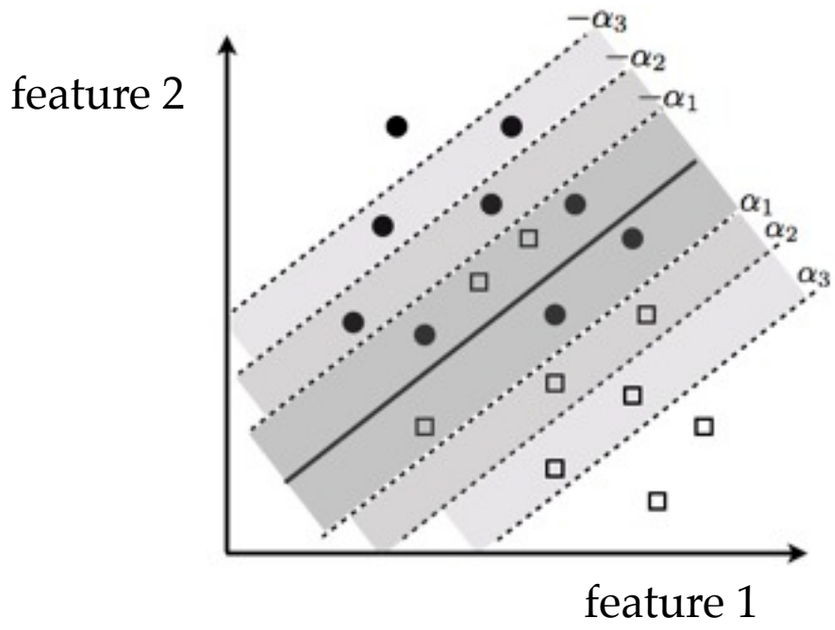
SVM Formulation

$$\begin{aligned} \min \quad & \sum_i \xi_i + \frac{\lambda}{2}||\mathbf{w}|| \\ \text{s.t.} \quad & y_i \left(\mathbf{x_i} \cdot \mathbf{w} + b\right) \geq 1 - \xi_i \\ & \xi_i \geq 0 \end{aligned}$$



DSVM Formulation

$$\begin{aligned} \min \quad & \sum_i \xi_i + \frac{\lambda}{2}||\mathbf{w}|| \\ \text{s.t.} \quad & y_i \left(\mathbf{x_i} \cdot \mathbf{w} + b\right) \geq \alpha_i - \xi_i \\ & \xi_i \geq 0 \end{aligned}$$



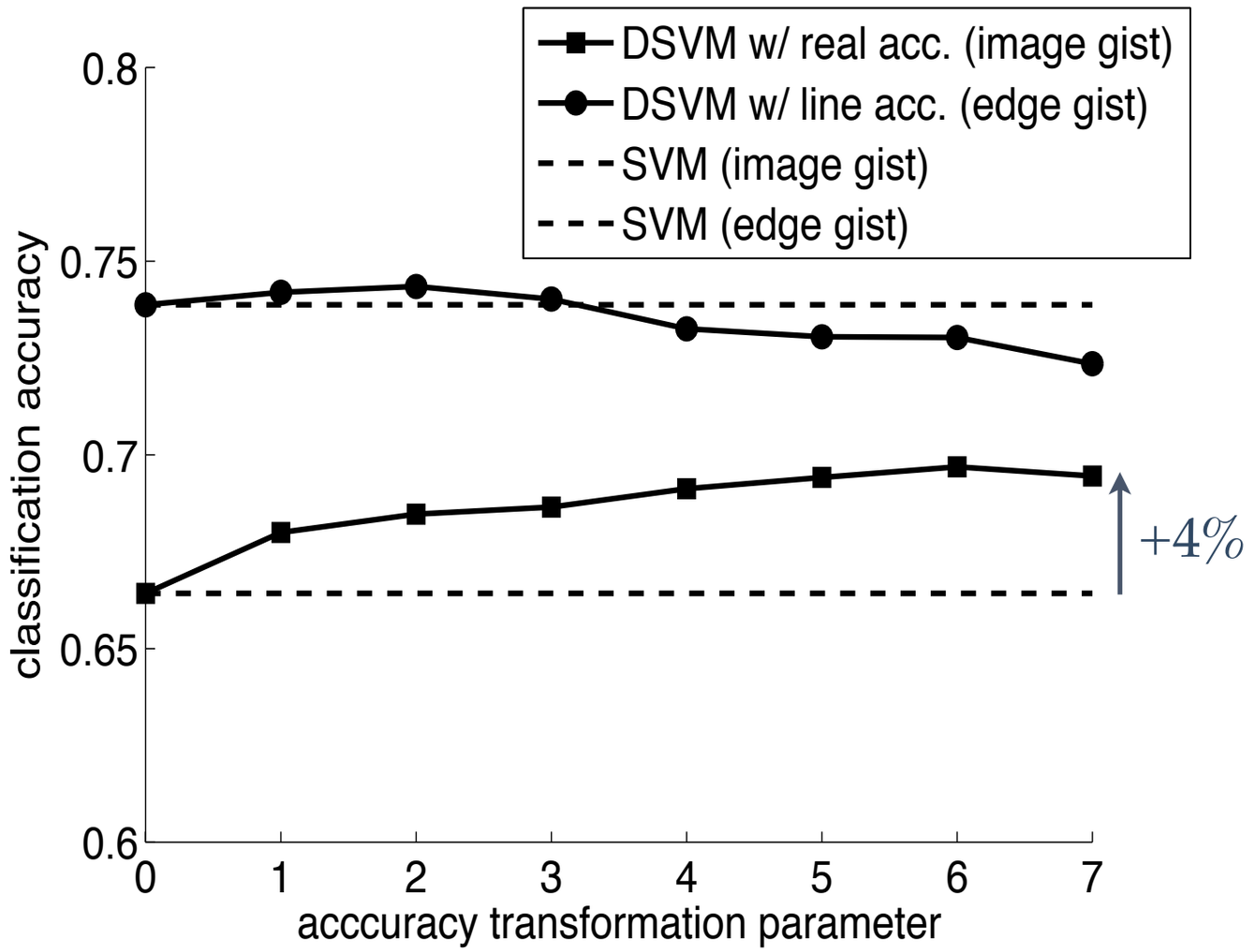
Experimental Evaluation

	indoors	outdoors
training	50	50
testing	10,000	10,000

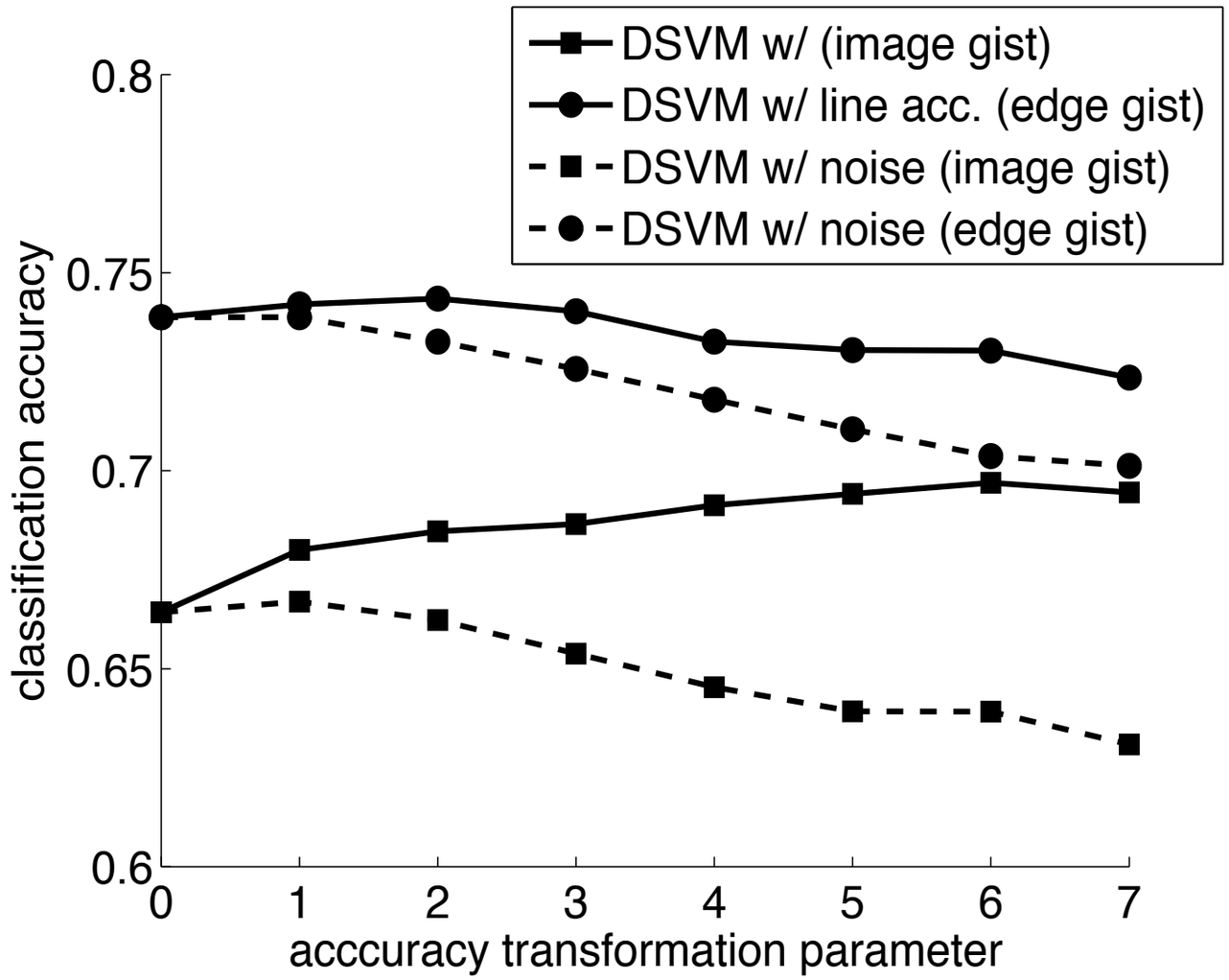
Gain Enhancing Transformation: $e^{\gamma \alpha_i}$

Features: image gist, edge gist

Real vs. Line Accuracy Gain



Accuracies Help



DSVM Generalizes Better

Test images were divided in 10 groups based on their distance from the training images.

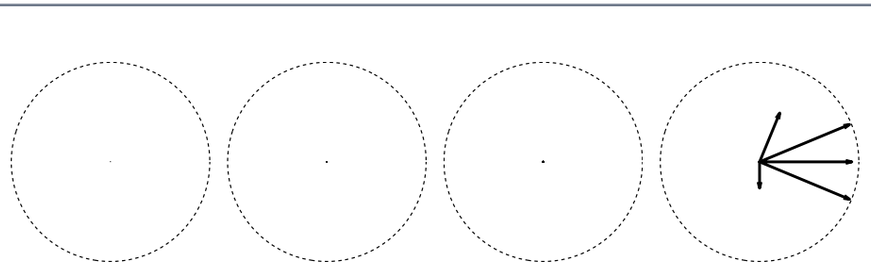
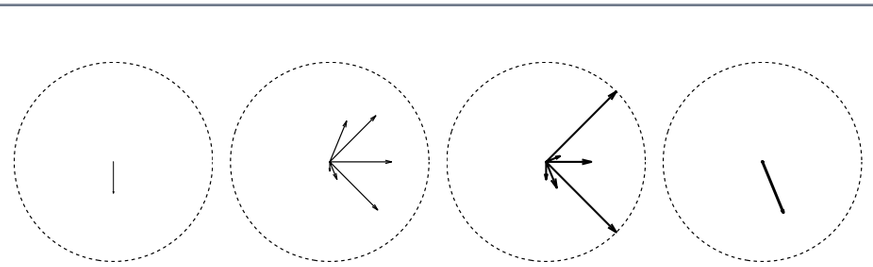
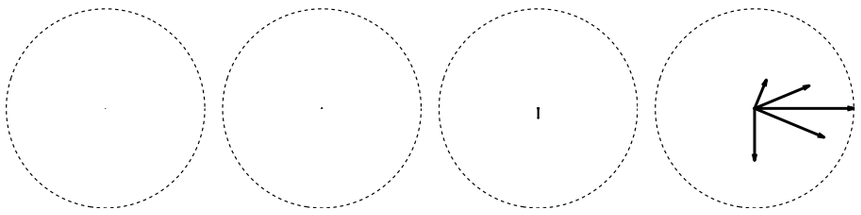
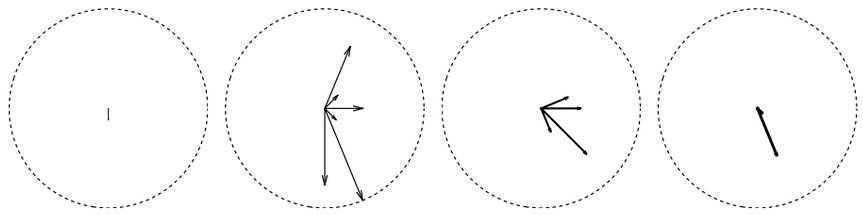
similar

SVM (%)	DSVM (%)
63	+5
72	+2
53	+10
67	+6
65	+1
72	+0
74	+1
69	+3
56	+6
73	+0

dissimilar

Selected Features

- DSVM selects **finer** scale features for outdoors.
- SVM selects **diagonal** features for outdoors.

	indoors	outdoors
SVM		
DSVM	 fine → coarse	 fine → coarse

Indoor Categorization

SVM

Indoor Categorization

SVM

DSVM

Outdoor Categorization

SVM




Outdoor Categorization

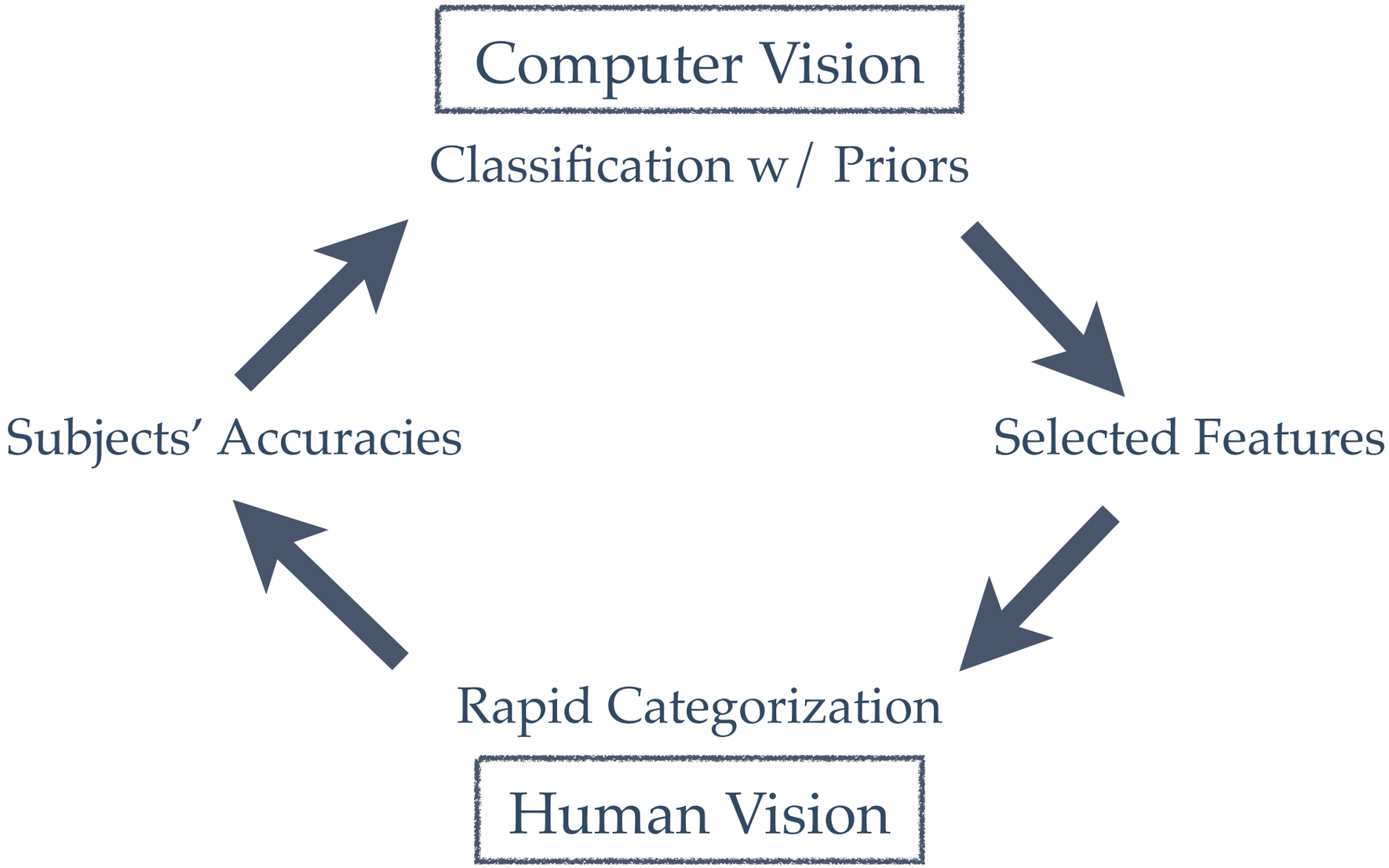
SVM

DSVM

Related Work

- Large amount of training data [Hays '07, Torralba '08]
- Classification Priors [Miller '00, Fei-Fei '06)]
- Semi-supervised Learning [Li '09, Fergus '09]
- Active Learning [Collins '08, Vijayanarasimhan '10]
- ***Our approach: priors based on human accuracies***

Summary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