

The Multidimensional Wisdom of Crowds

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Indigo Bunting



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From prairiedog



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From ajnaturephot...



From Ken...



From R Hanson



From [Christine]



From davidcreebir...



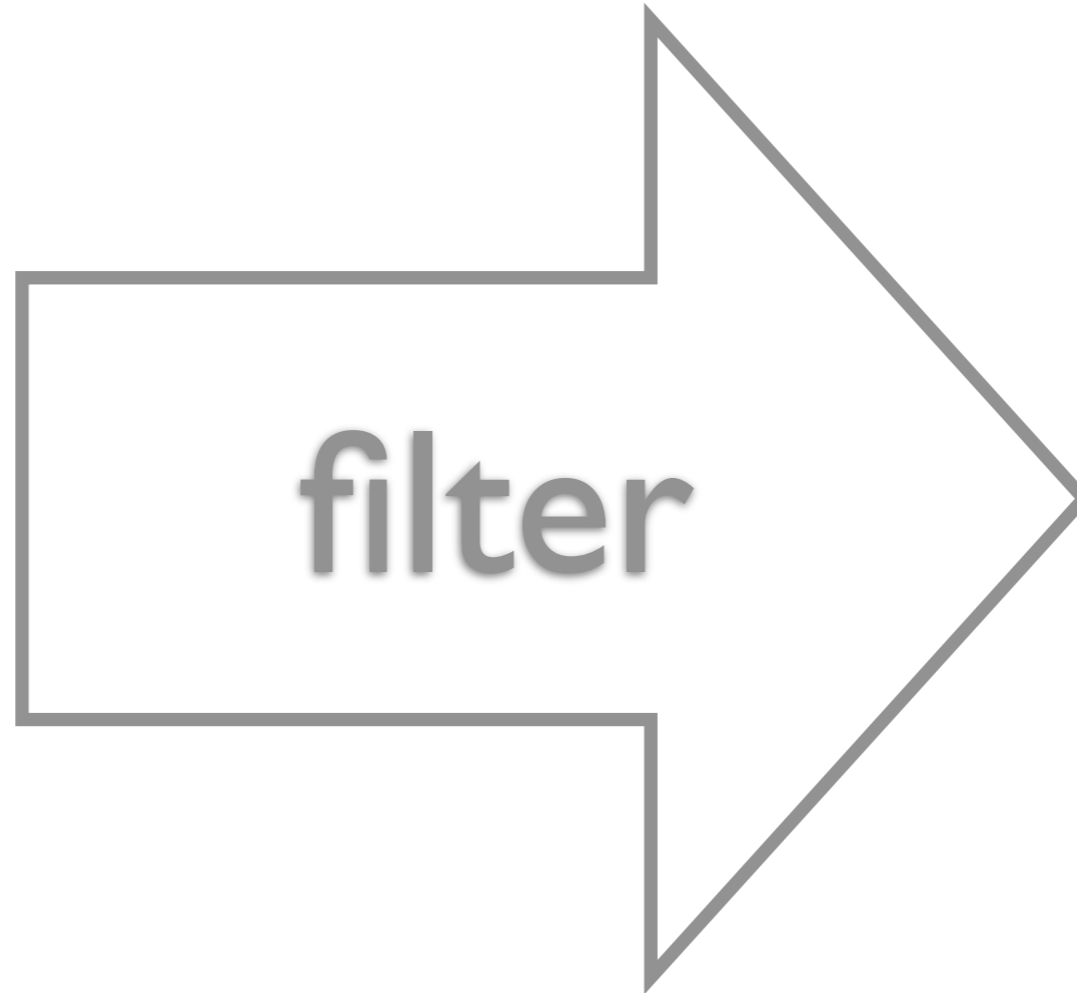
From reemac640

5,926 results

6000 images
from flickr.com



Building datasets



100s of
training images

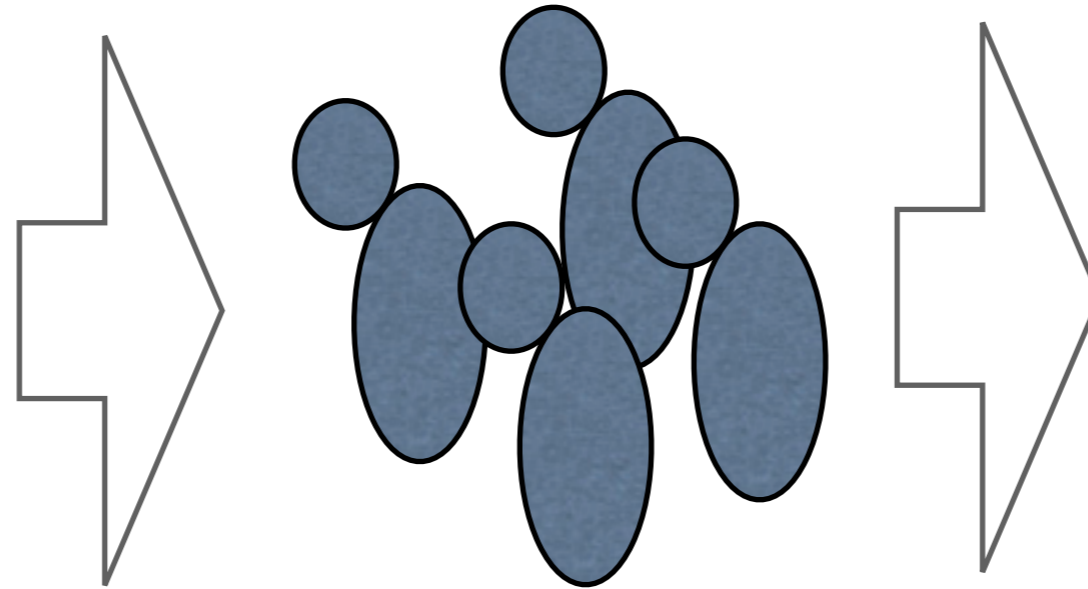


6000 images
from flickr.com

Building datasets

100s of
training images

Annotators



amazonmechanical turk
beta Artificial Intelligence

Is there an Indigo bunting in the image?

Find the Indigo Bunting



Find the Indigo Bunting



A



A



A



A



A



A

Find the Indigo Bunting



A B C D



A B C D



A B C D



A B C D



A B C D



A B C D

Strategies for binary labels

- **Heuristics:**

- Majority
- Traps
- Qualifications

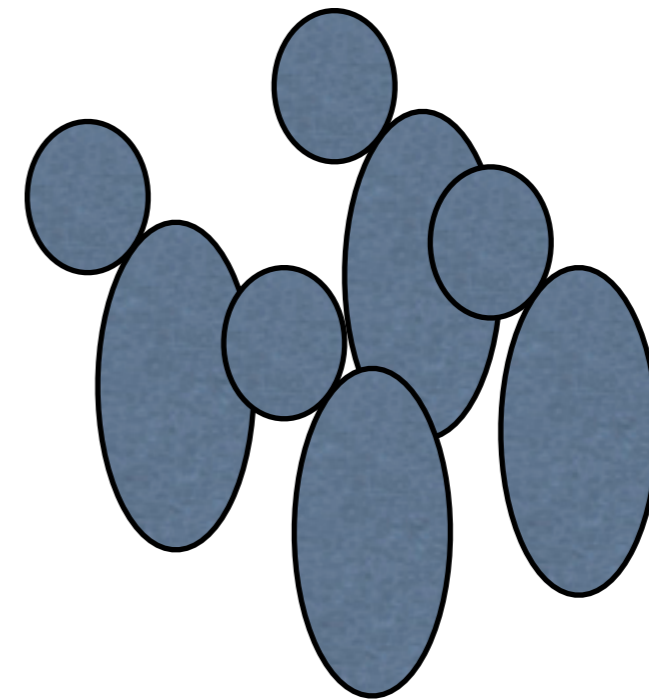


- **Model annotators:**

- Dawid and Skene (1979)
- Raykar et al. (2009)

- **Model image difficulty:**

- Whitehill et al. (2009)



Characterizing annotators: types of errors

Indigo Bunting?

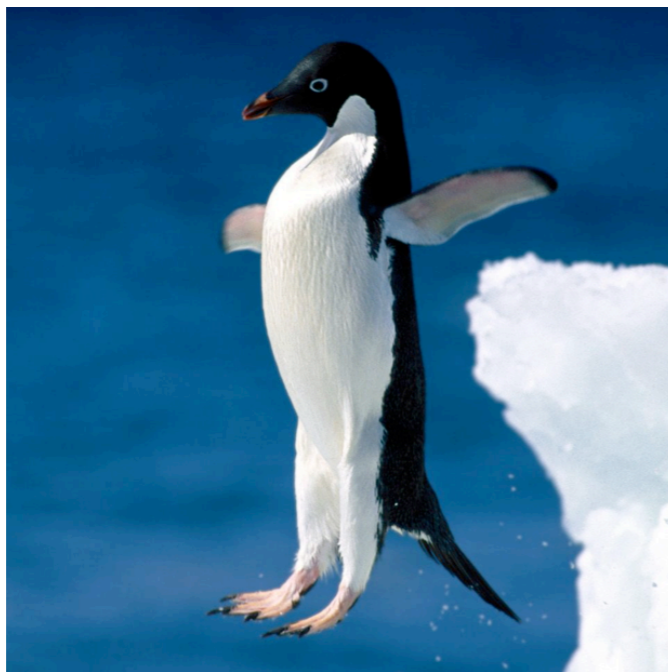
Yes

No



Hit

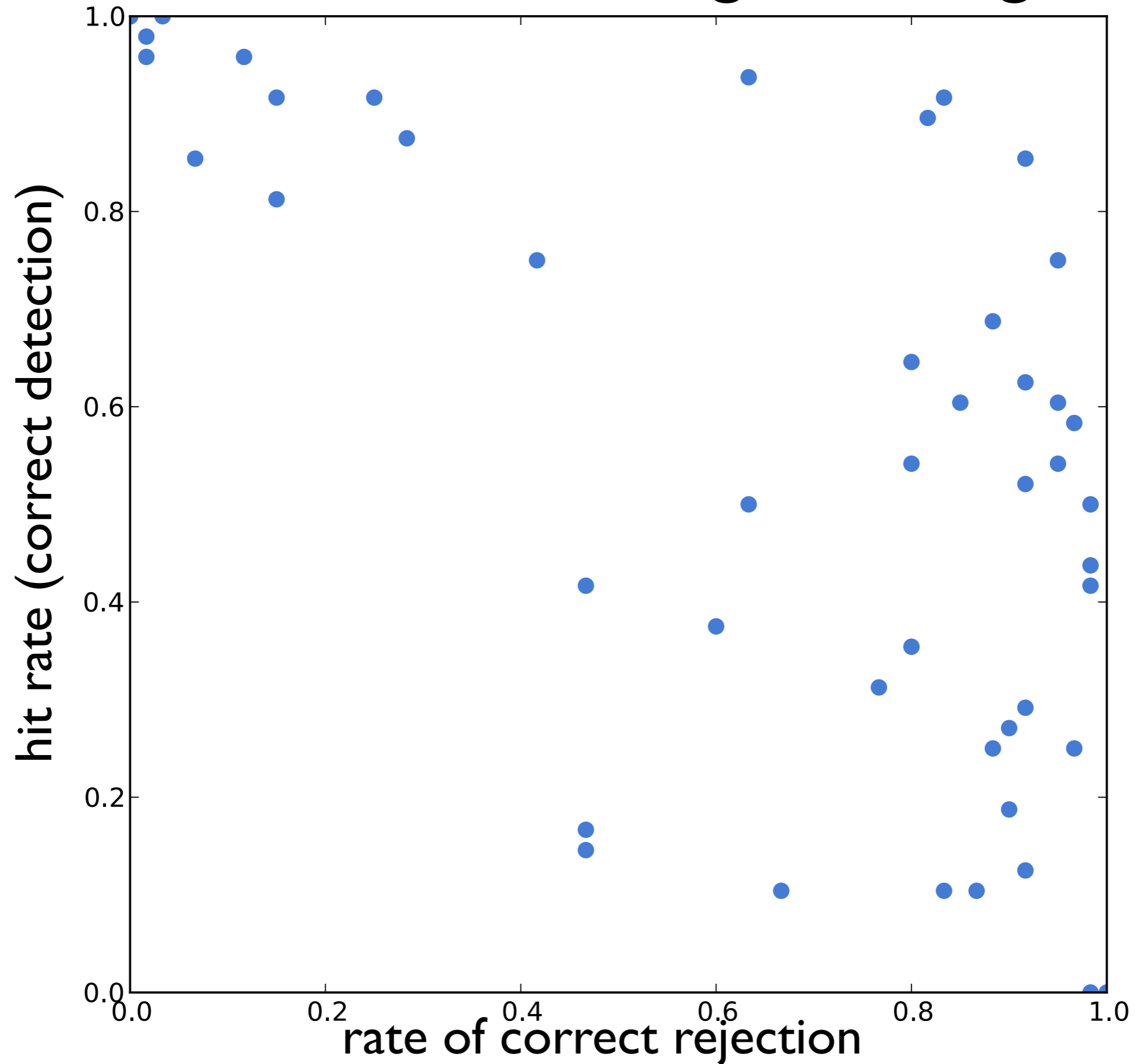
Miss



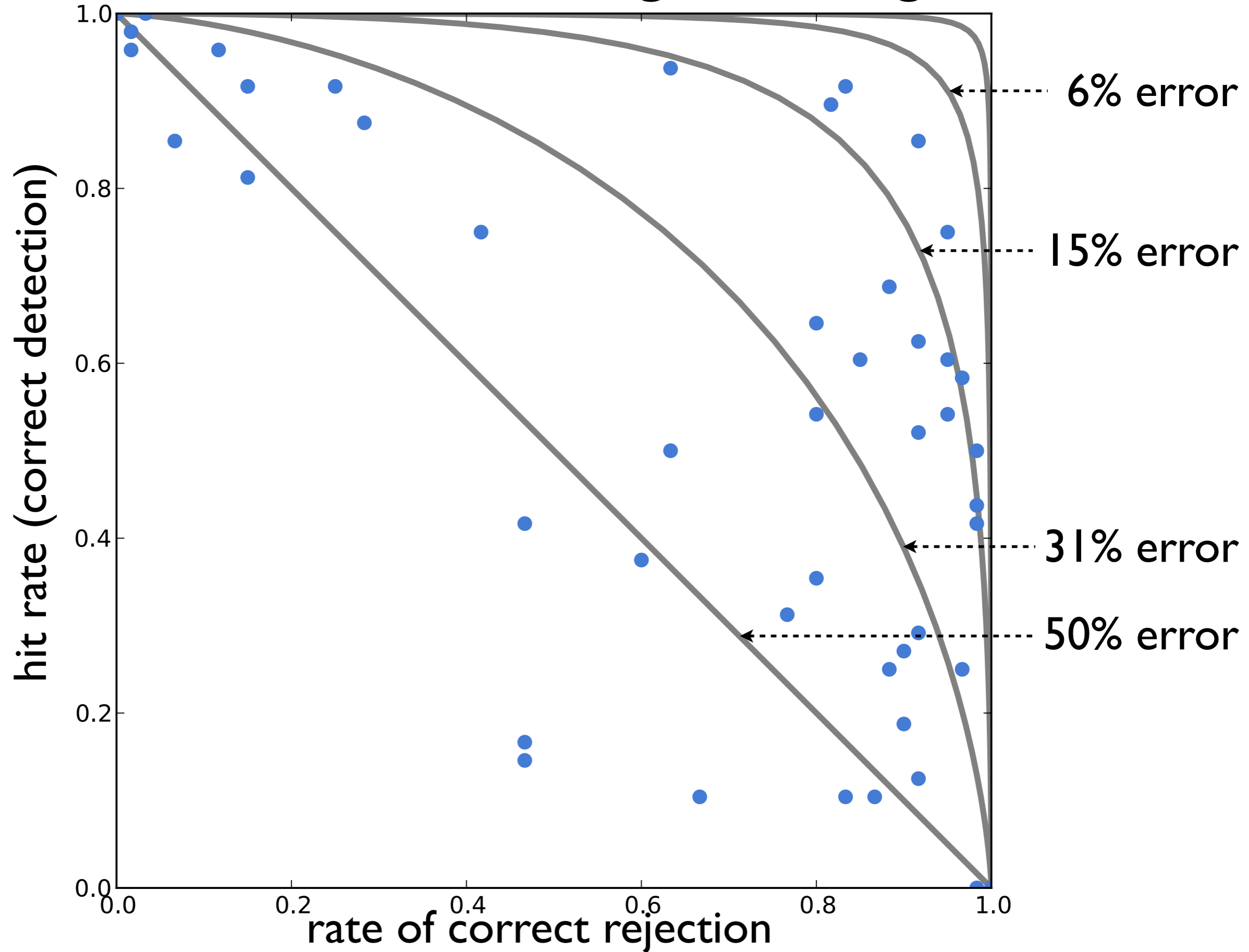
False Alarm

Correct
Rejection

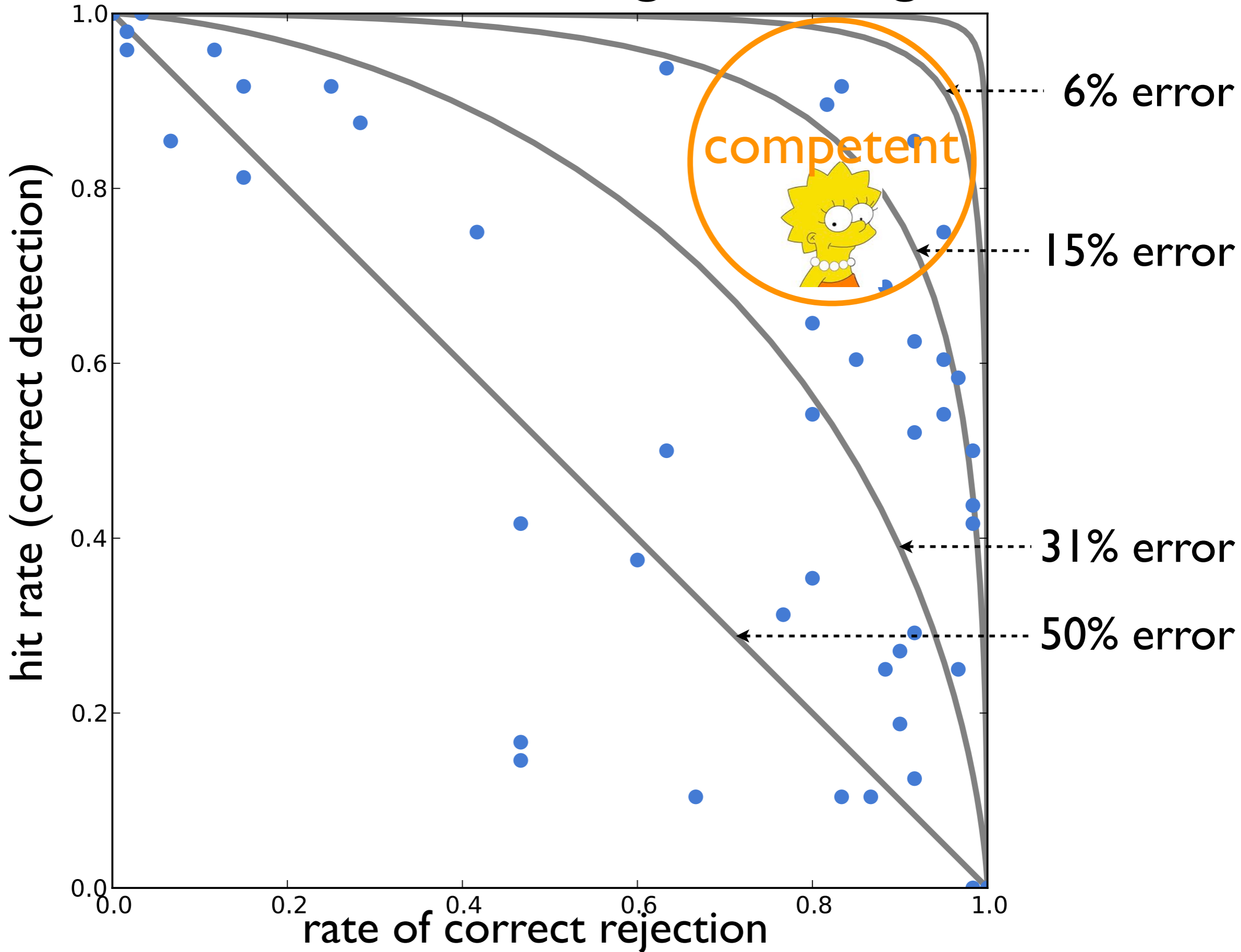
Task: Find the Indigo Bunting



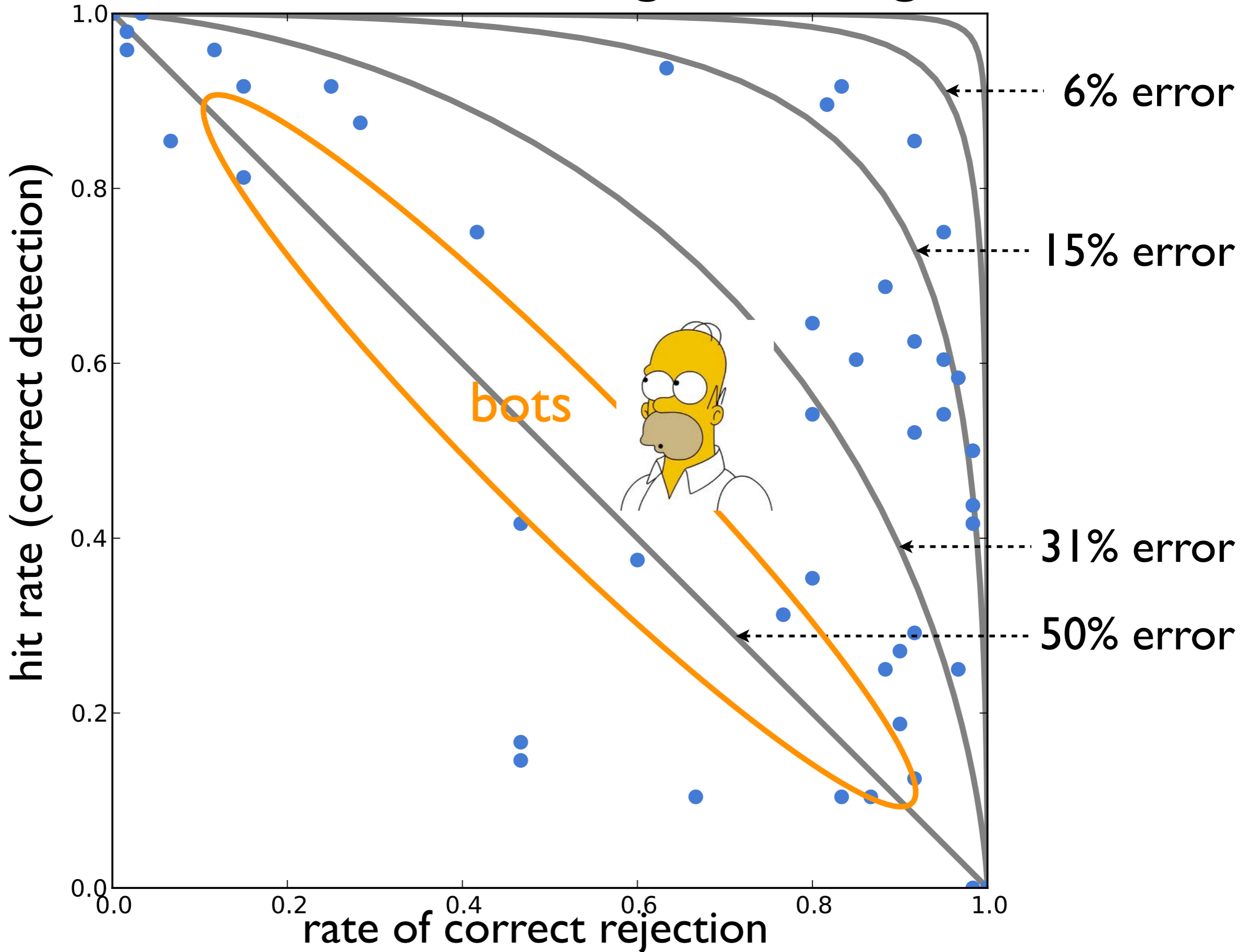
Task: Find the Indigo Bunting



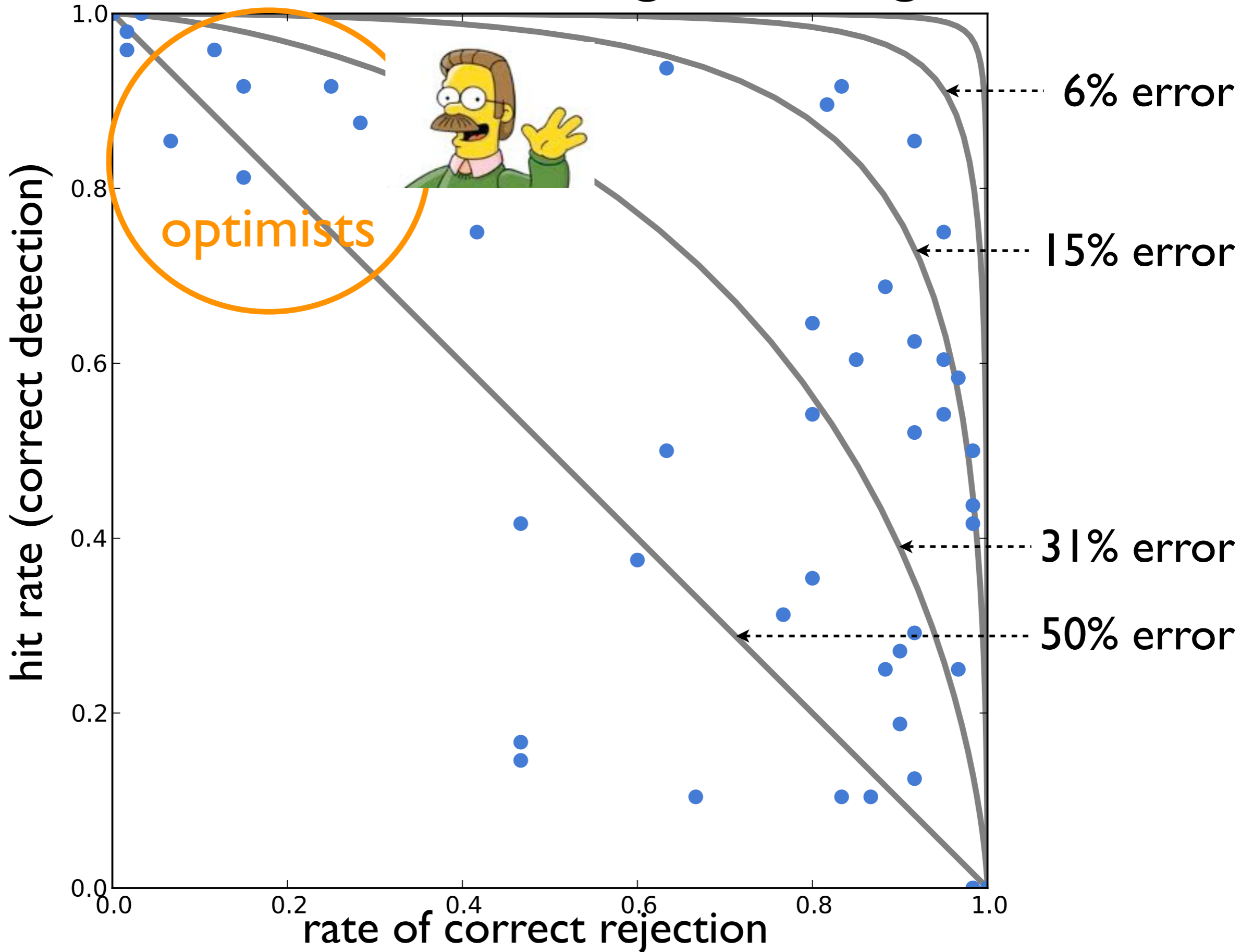
Task: Find the Indigo Bunting



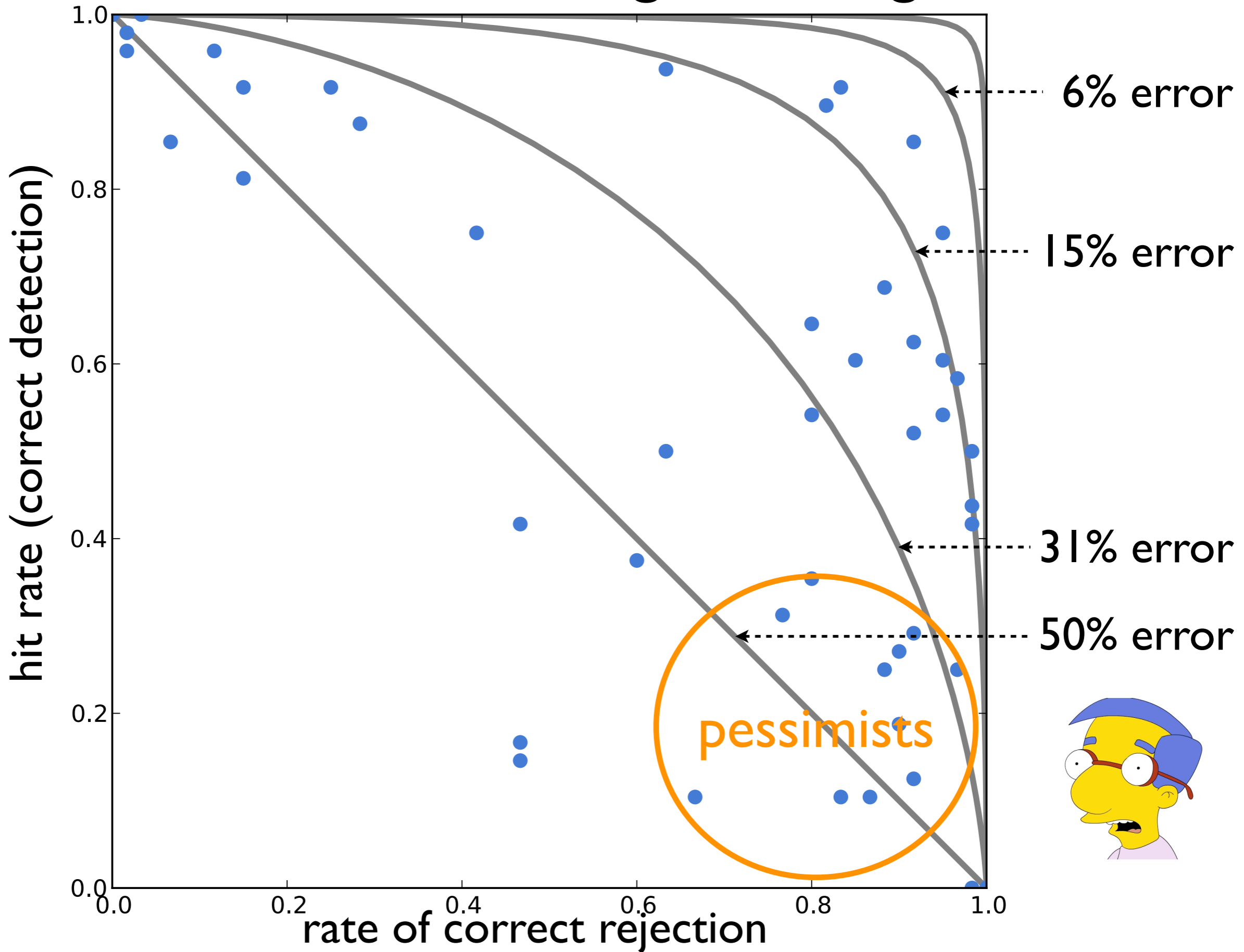
Task: Find the Indigo Bunting



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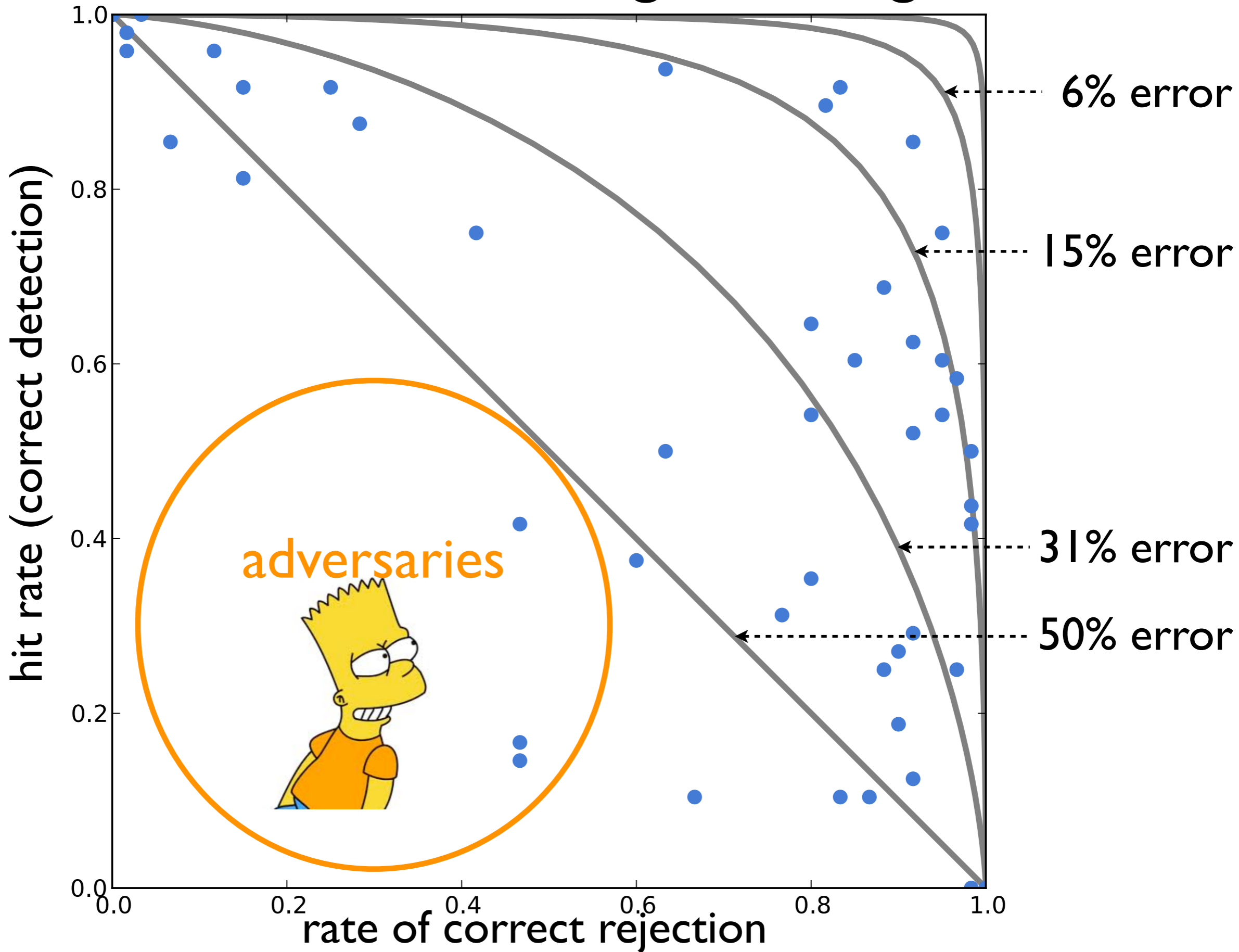


Image difficulty and annotator competence

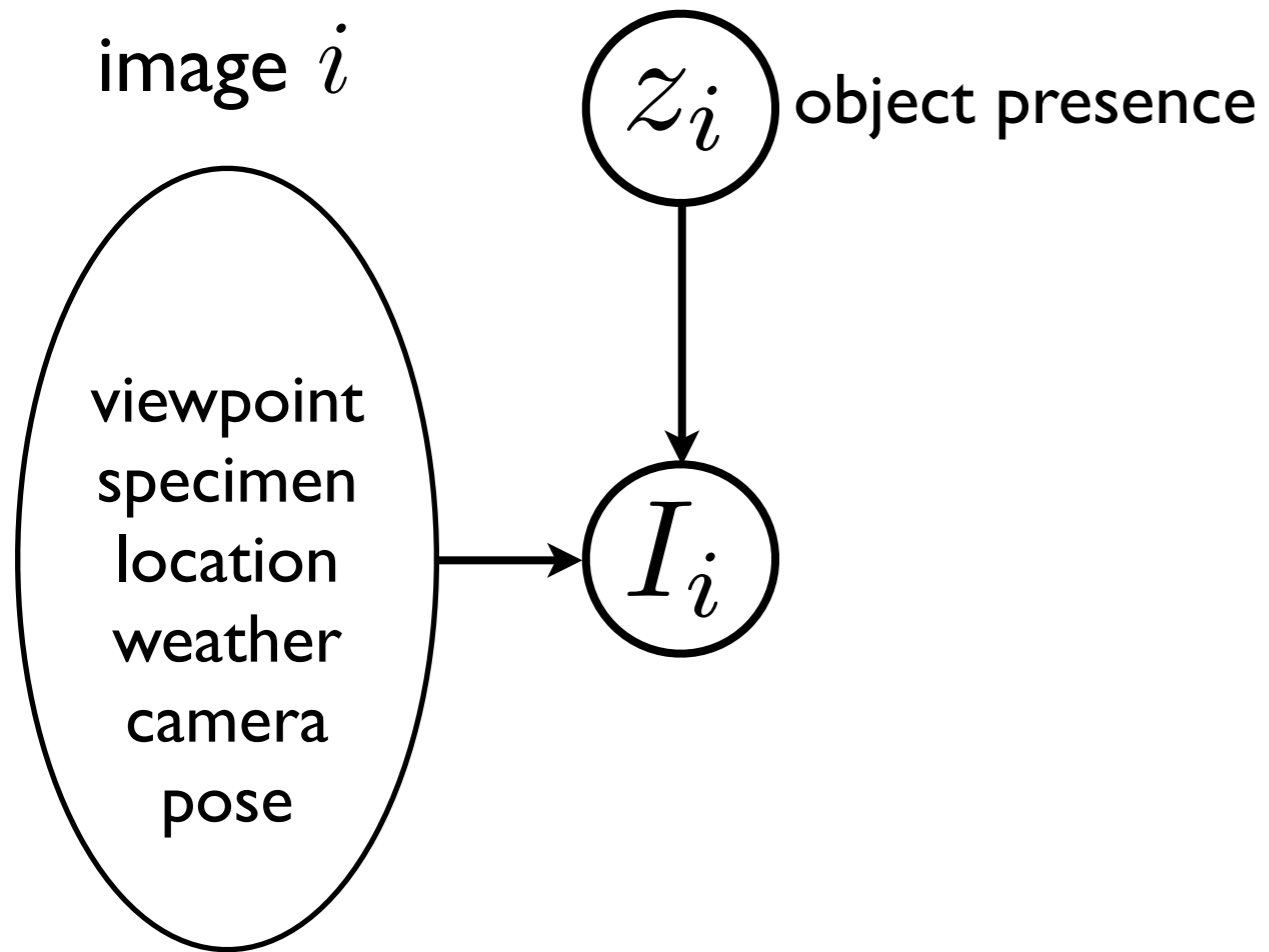


Image difficulty and annotator competence

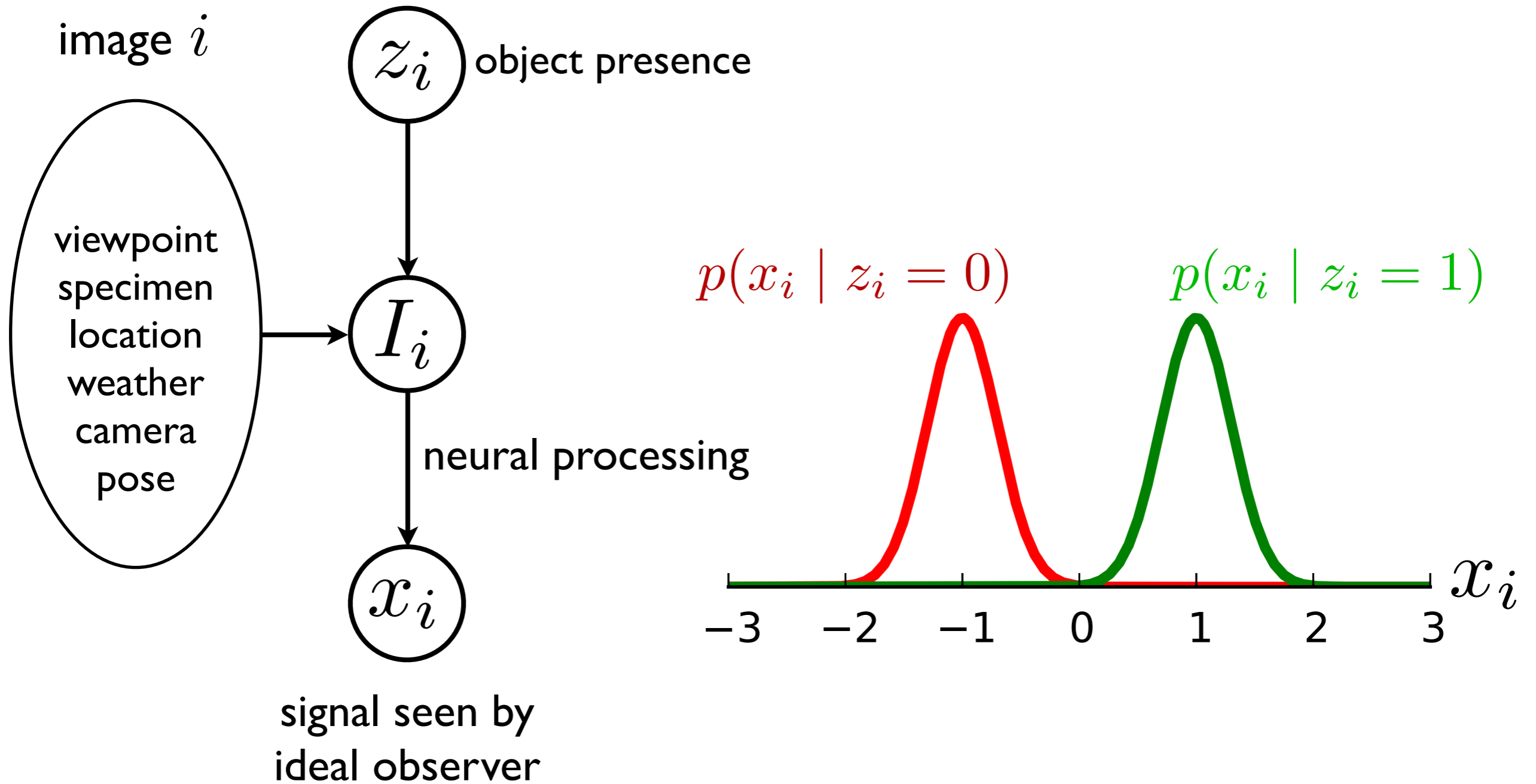
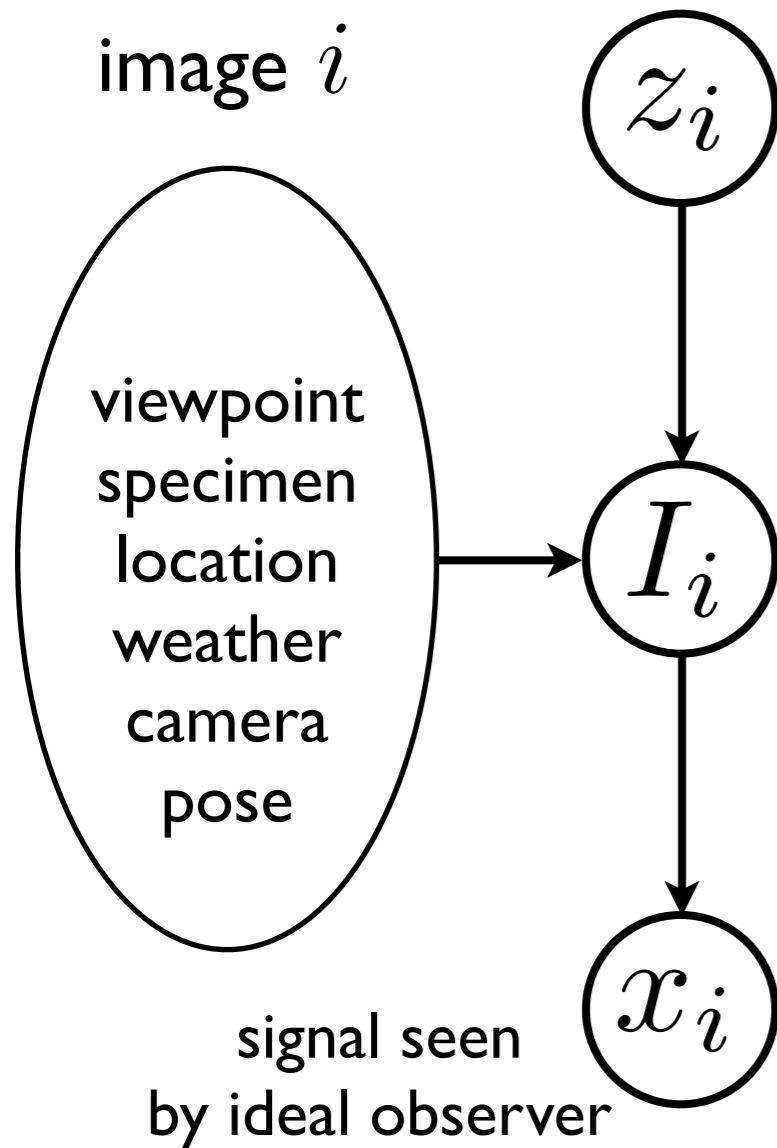


Image difficulty and annotator competence



$$p(x_i | z_i = 0)$$

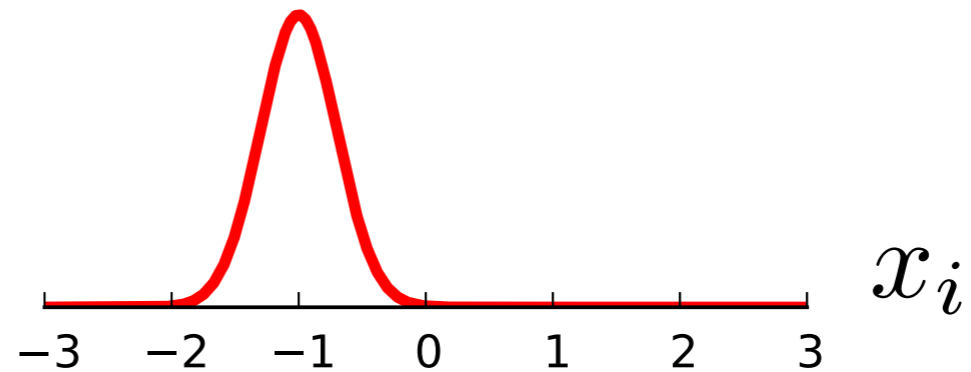
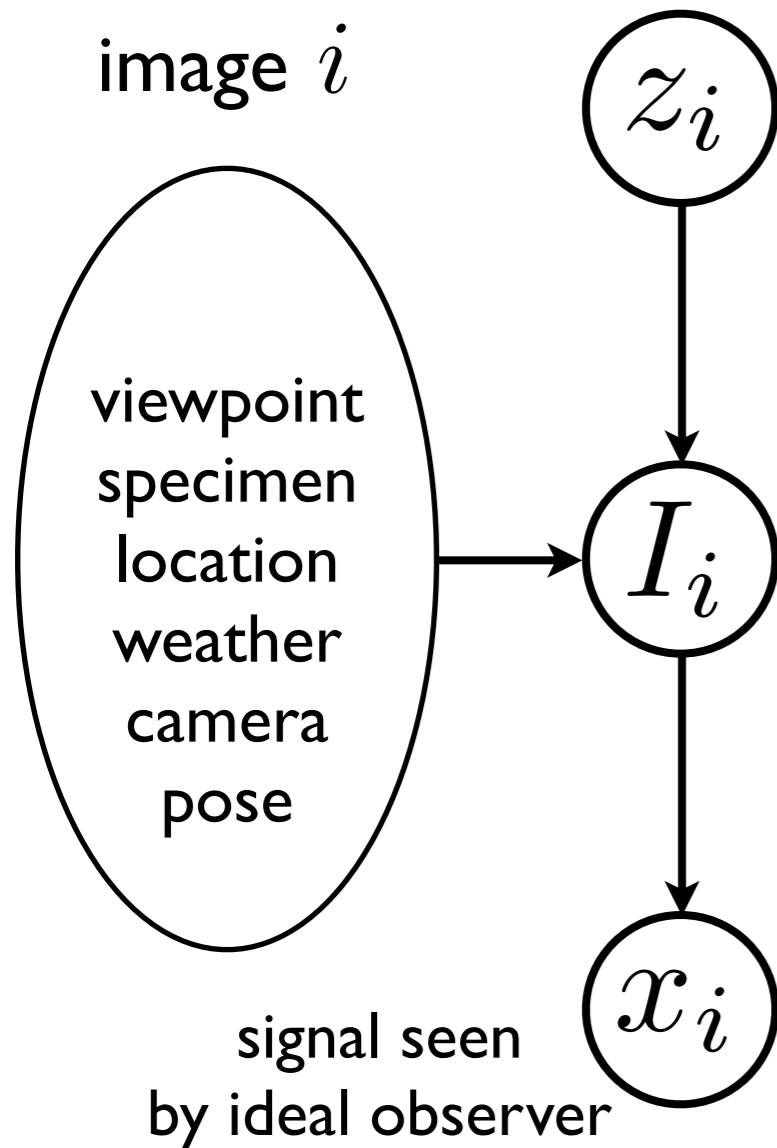


Image difficulty and annotator competence



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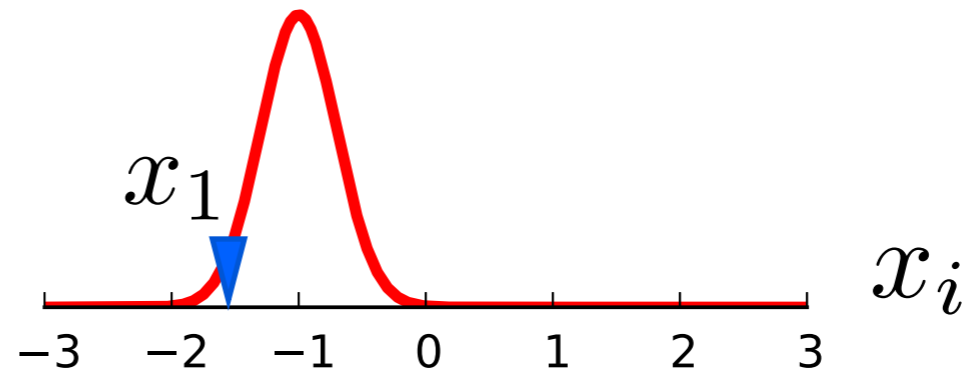
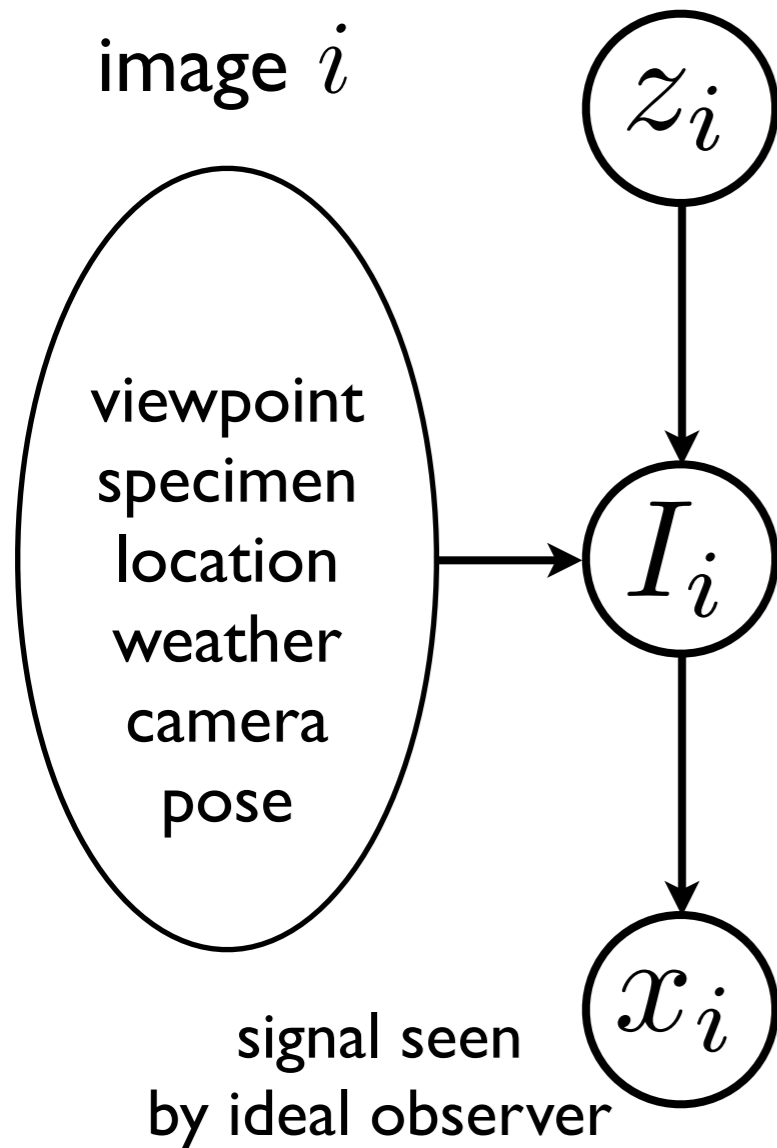


Image difficulty and annotator competence



$$p(x_i | z_i = 0)$$

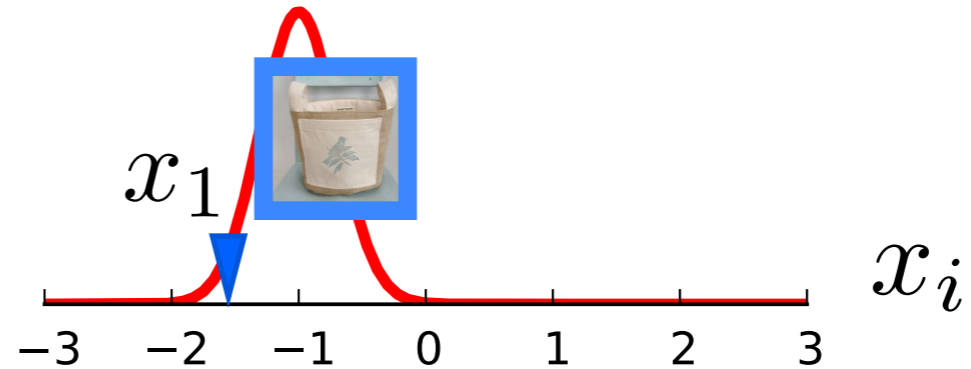
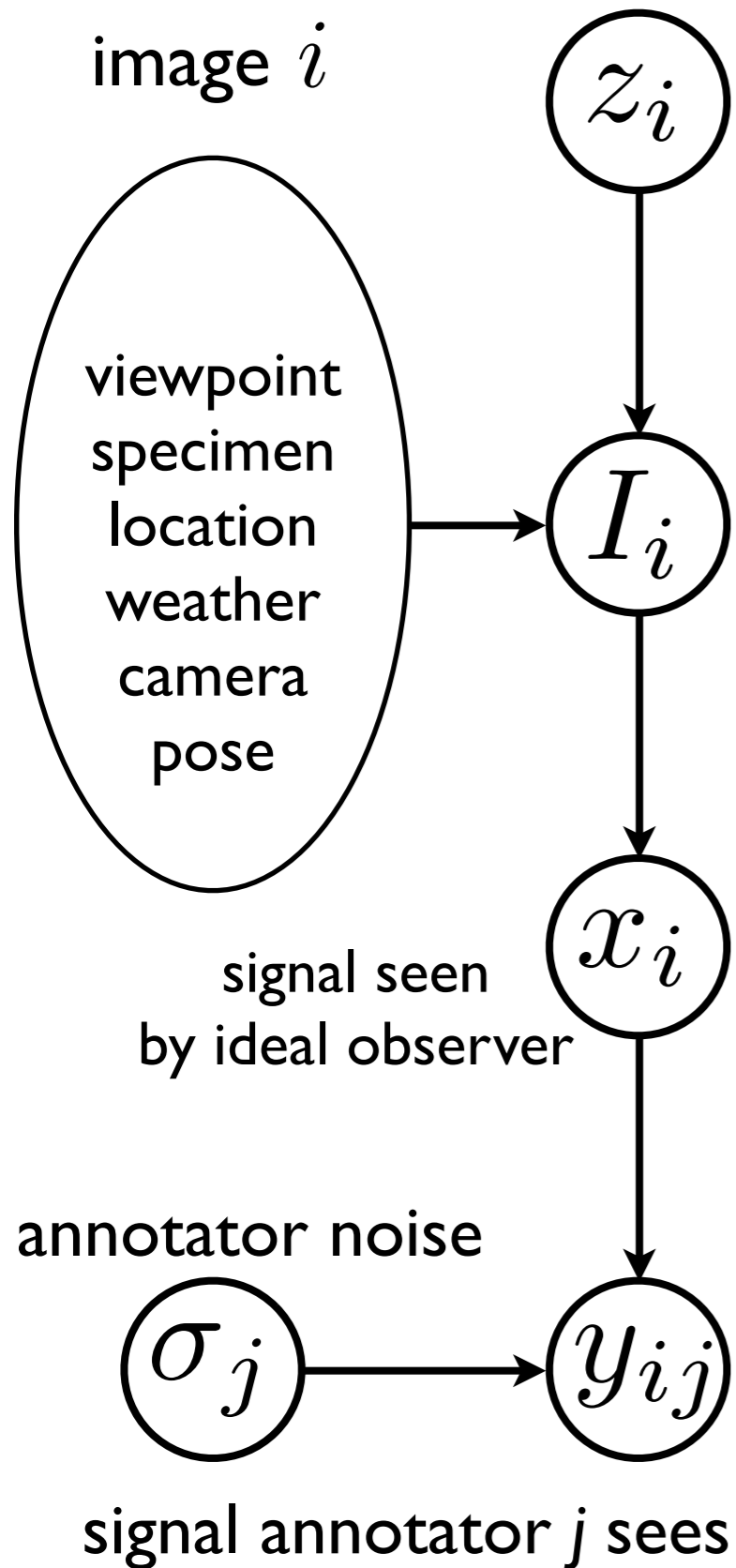


Image difficulty and annotator competence



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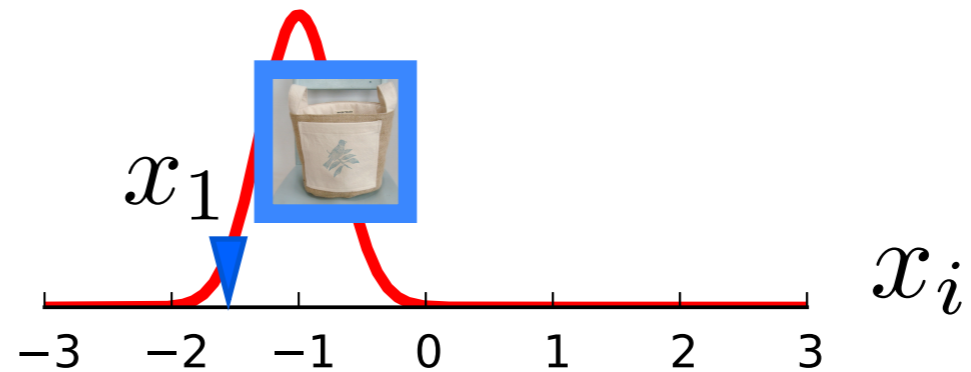
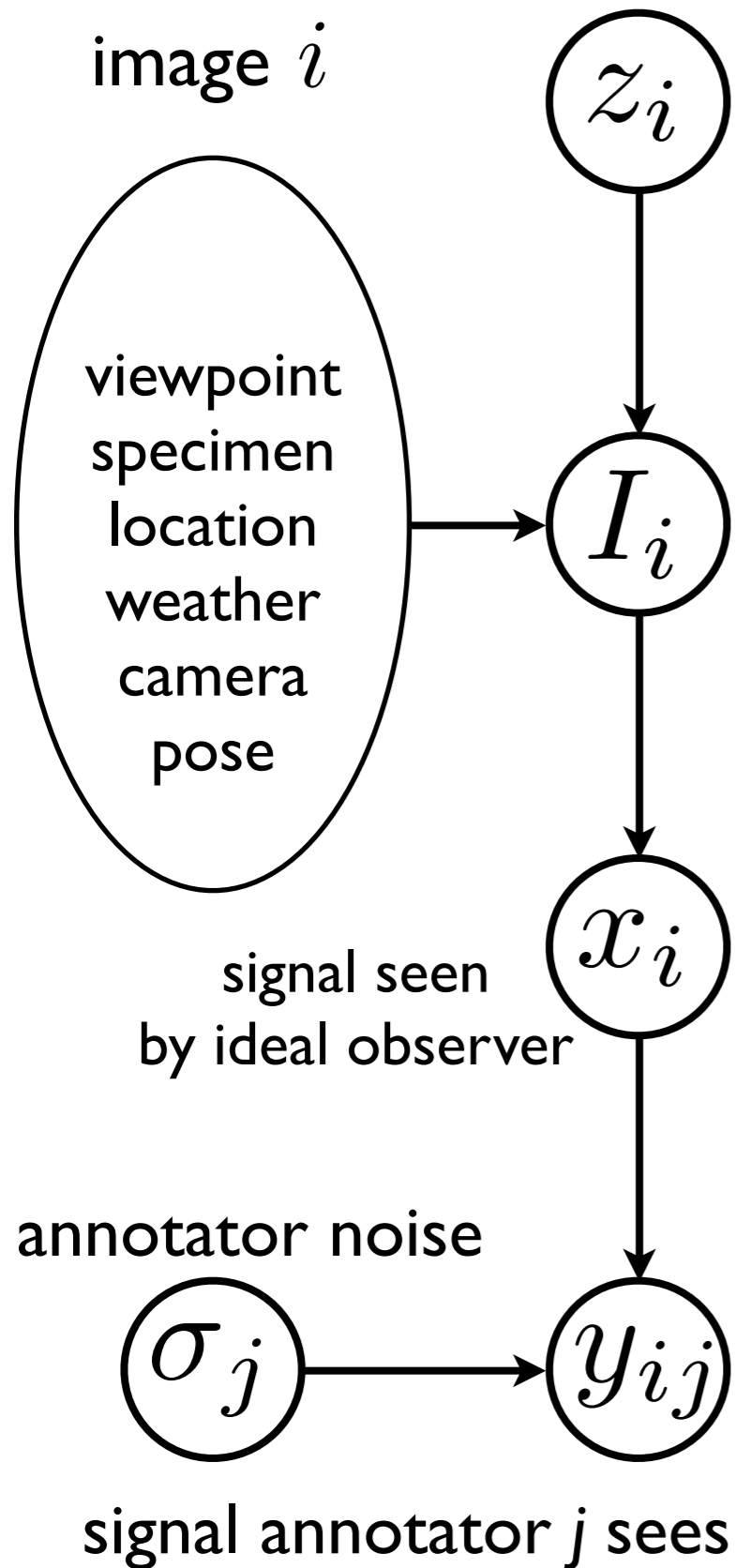
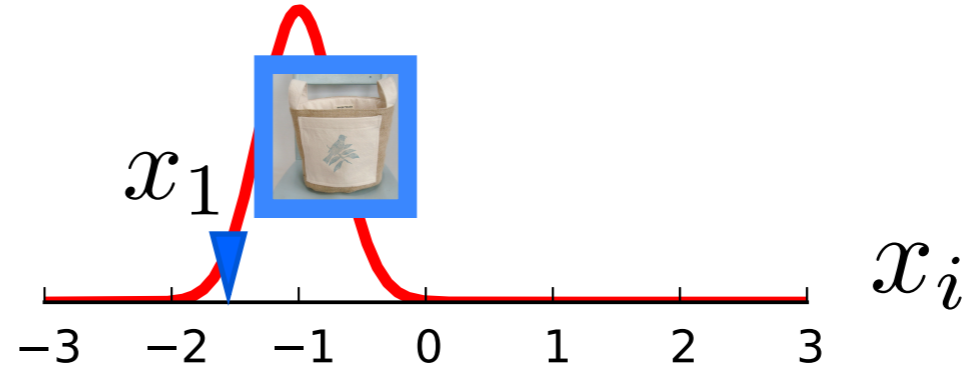


Image difficulty and annotator competence



$$p(x_i | z_i = 0)$$



$$\sigma_1 = 0.2$$

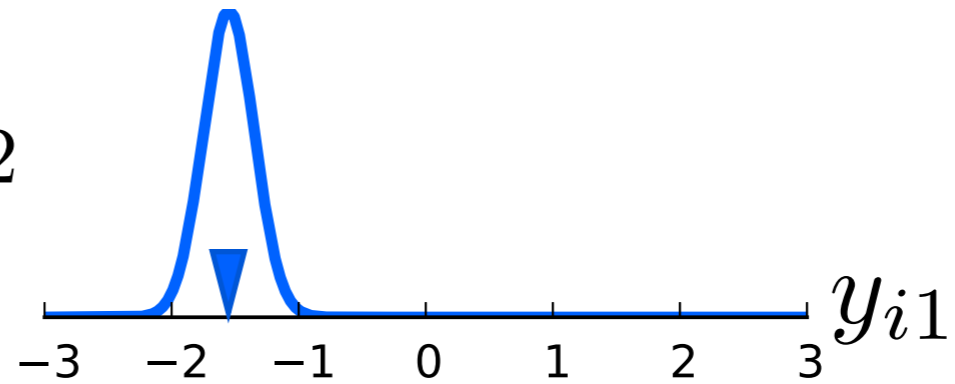
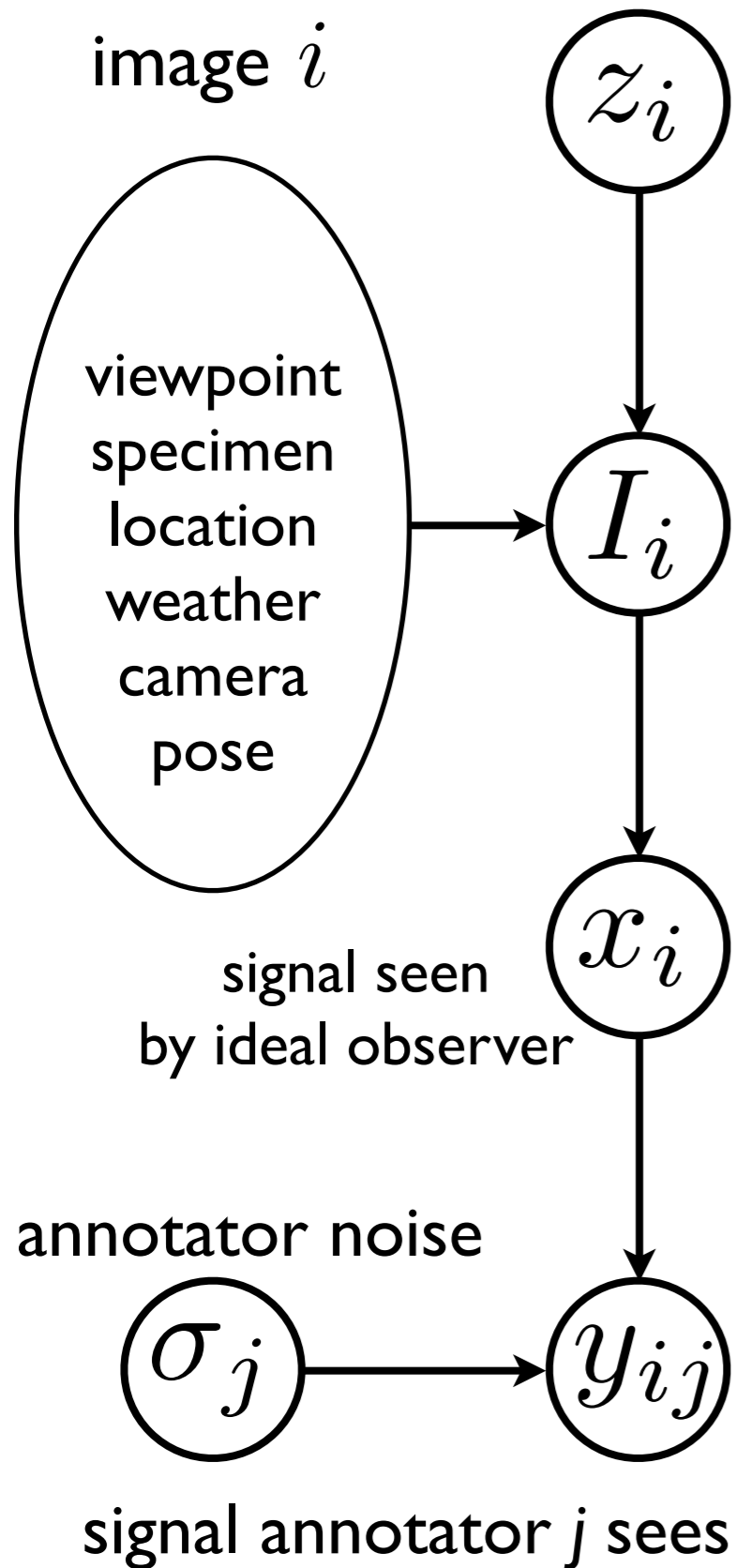
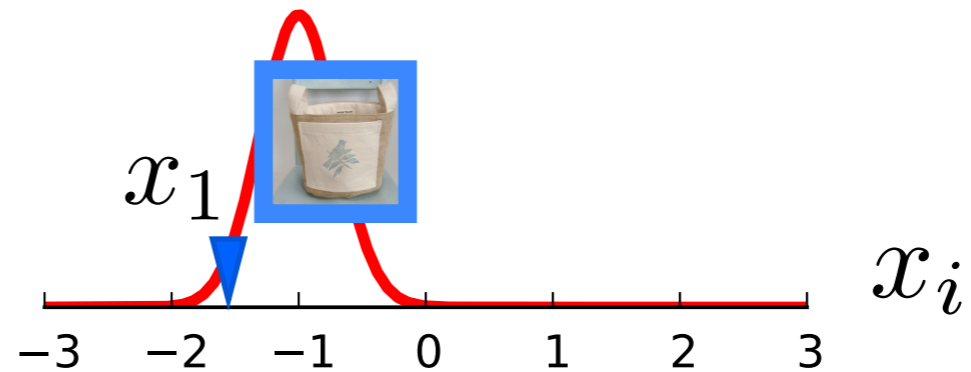


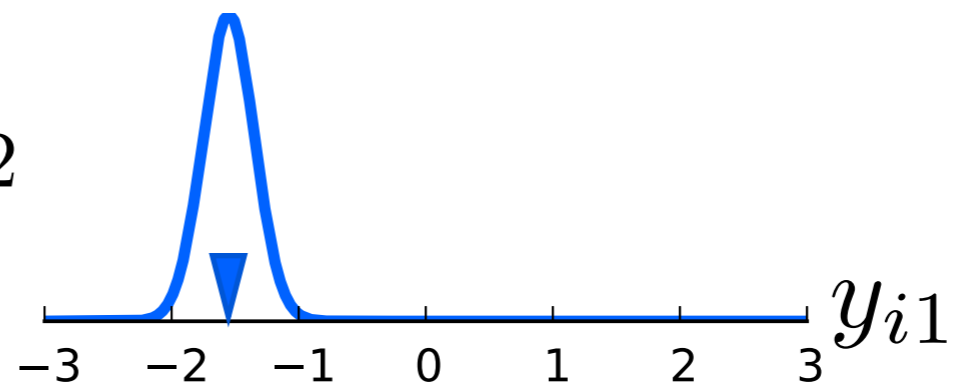
Image difficulty and annotator competence



$$p(x_i | z_i = 0)$$



$$\sigma_1 = 0.2$$



$$\sigma_2 = 0.5$$

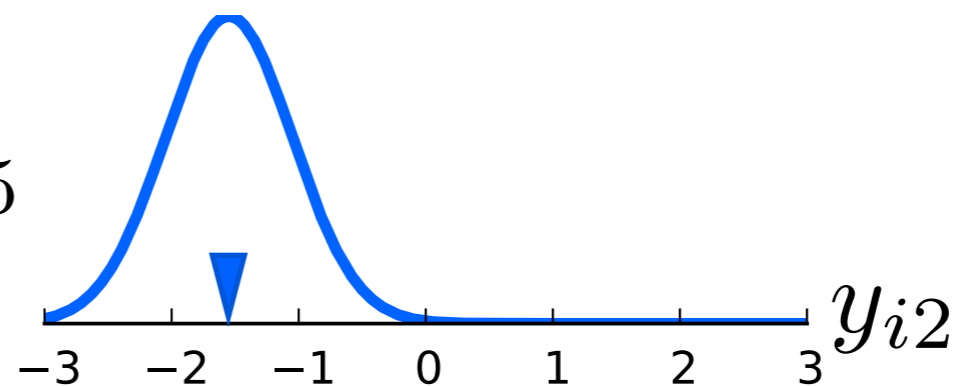
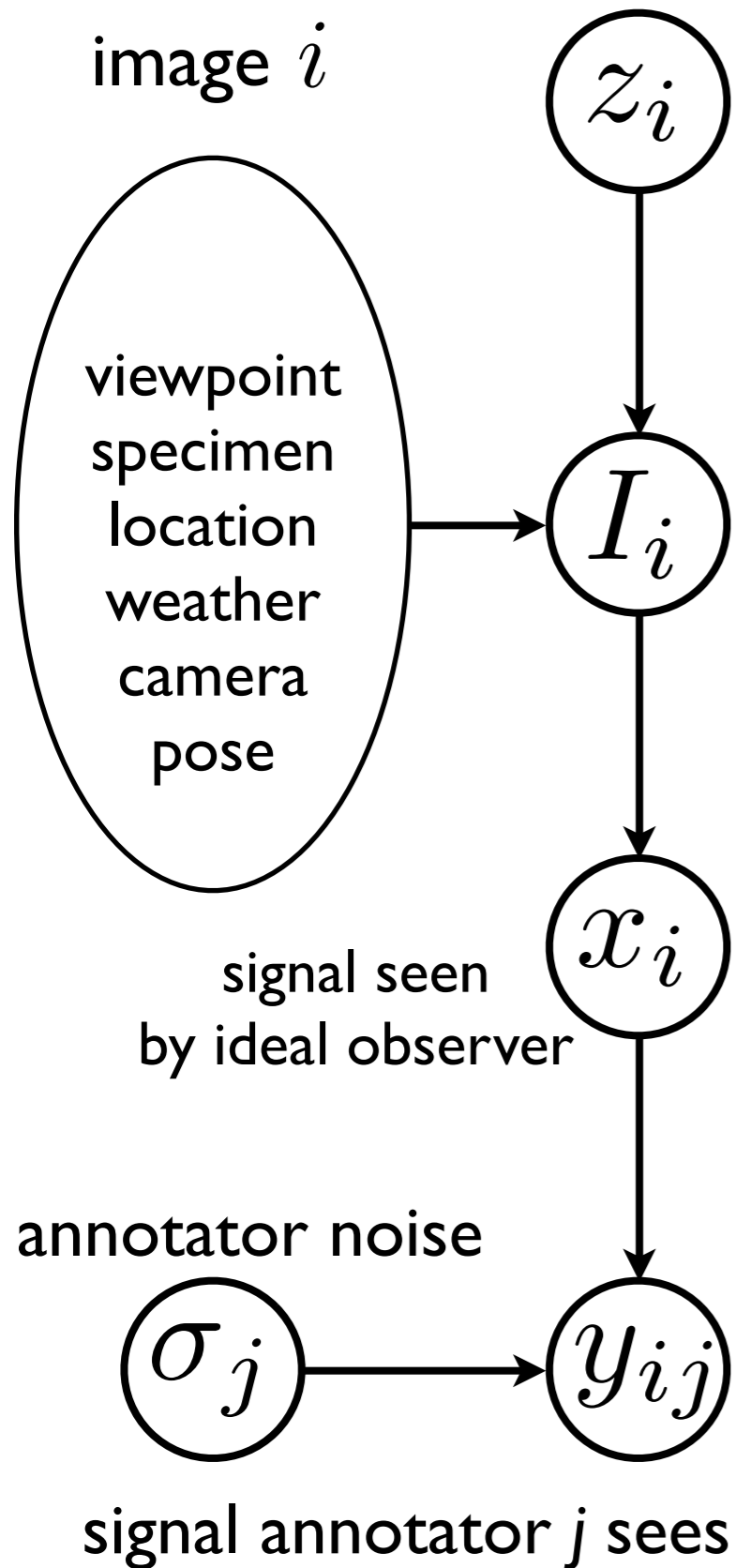


Image difficulty and annotator competence



$$p(x_i | z_i = 0)$$

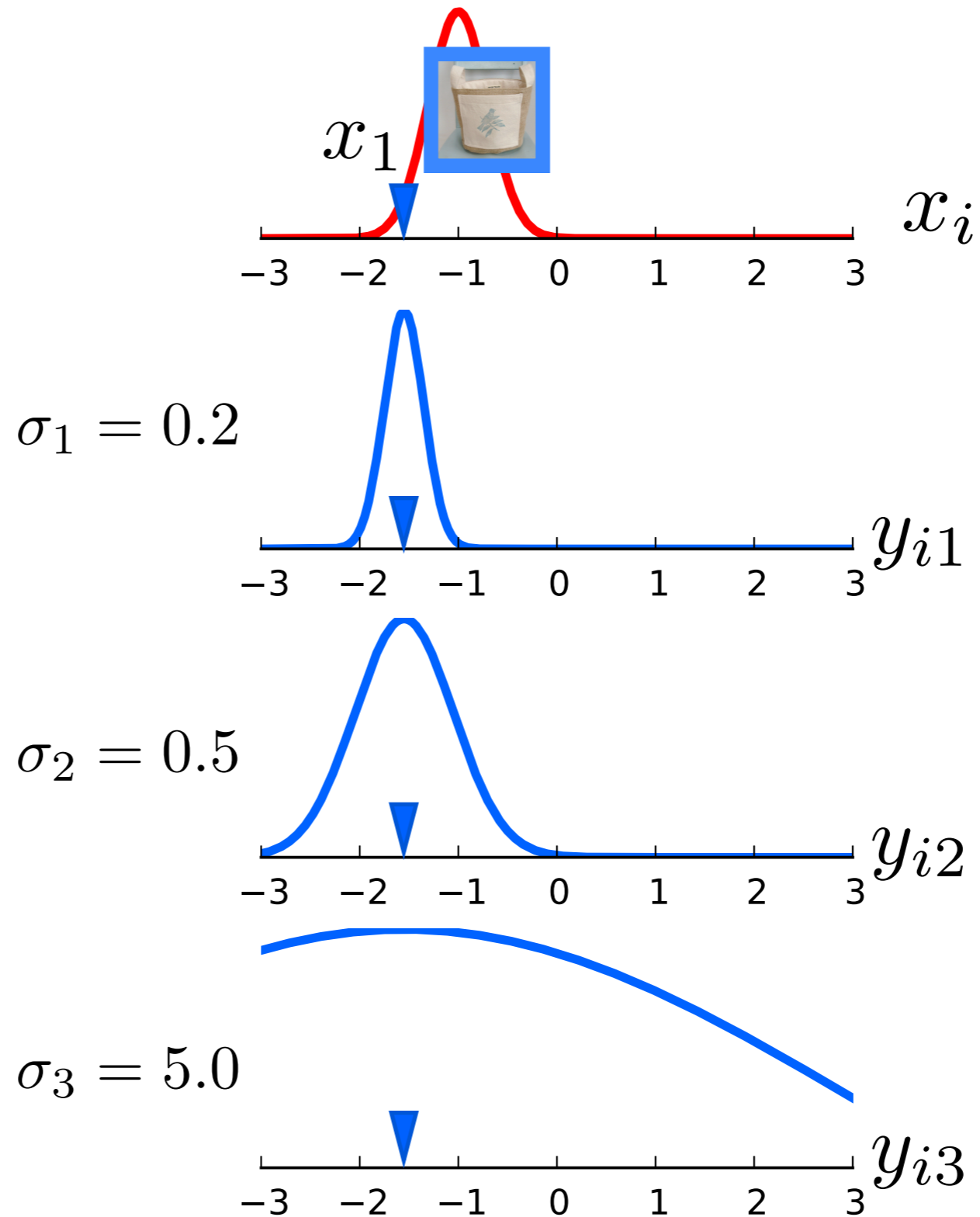
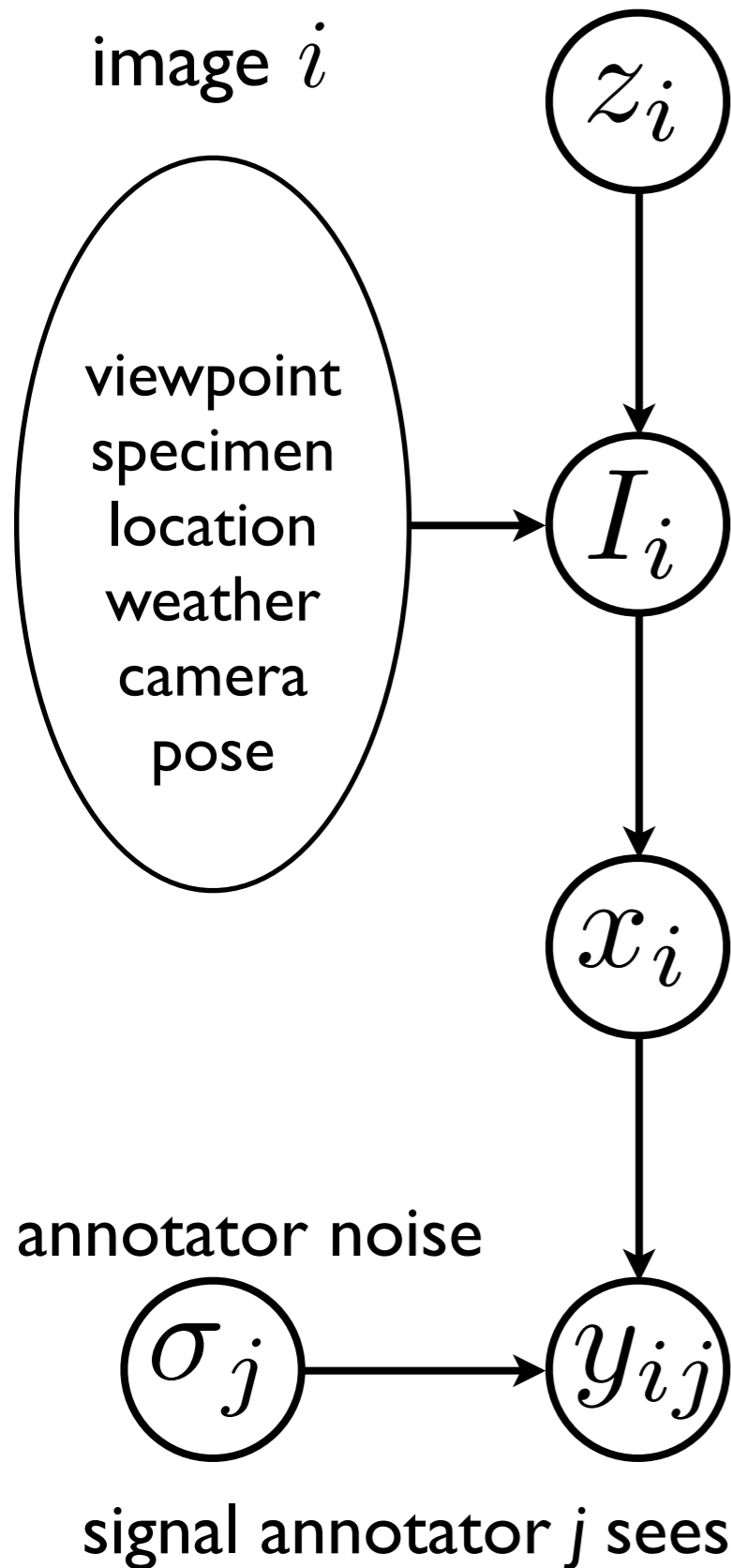


Image difficulty and annotator competence



$$p(x_i | z_i = 1)$$

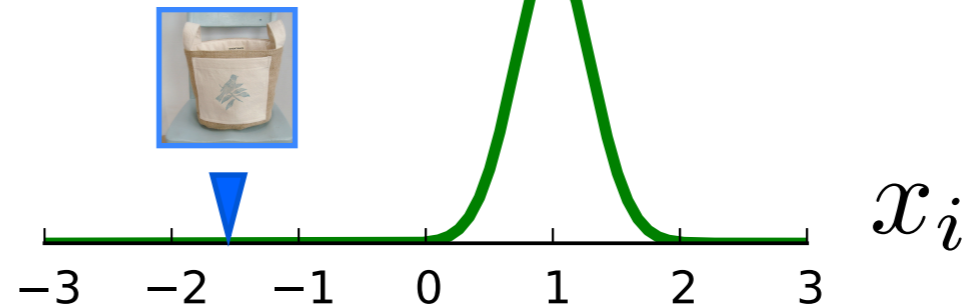
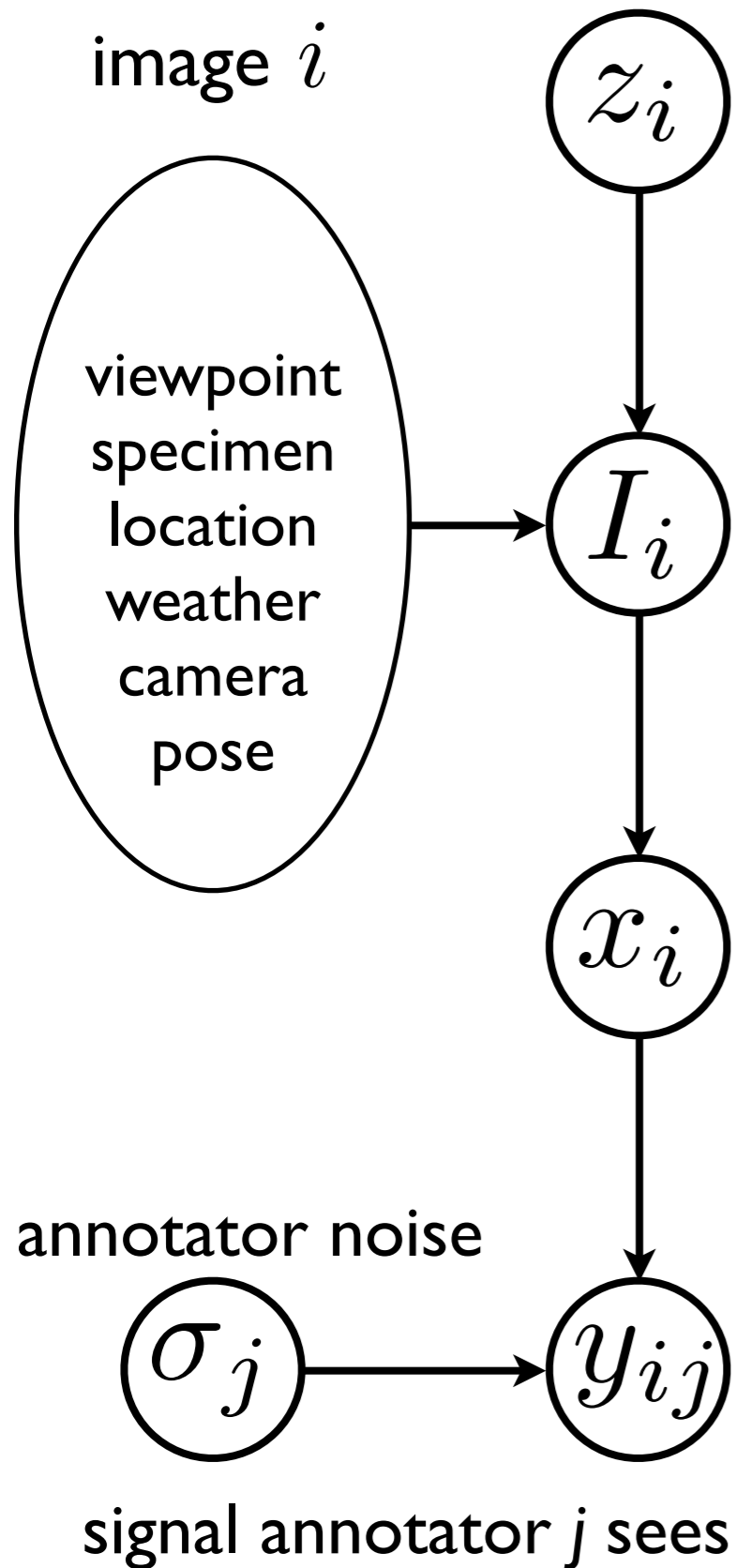


Image difficulty and annotator competence



$$p(x_i | z_i = 1)$$

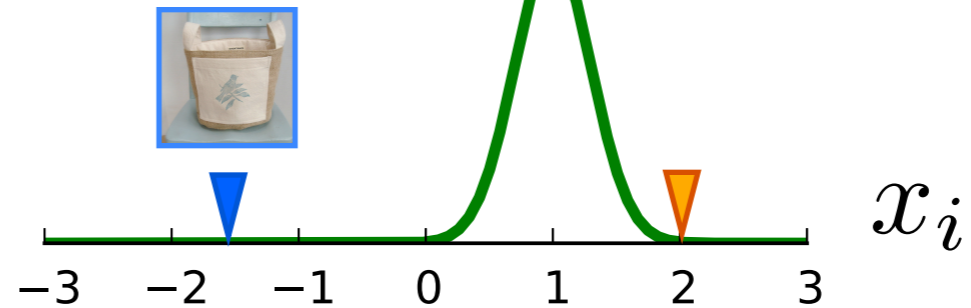
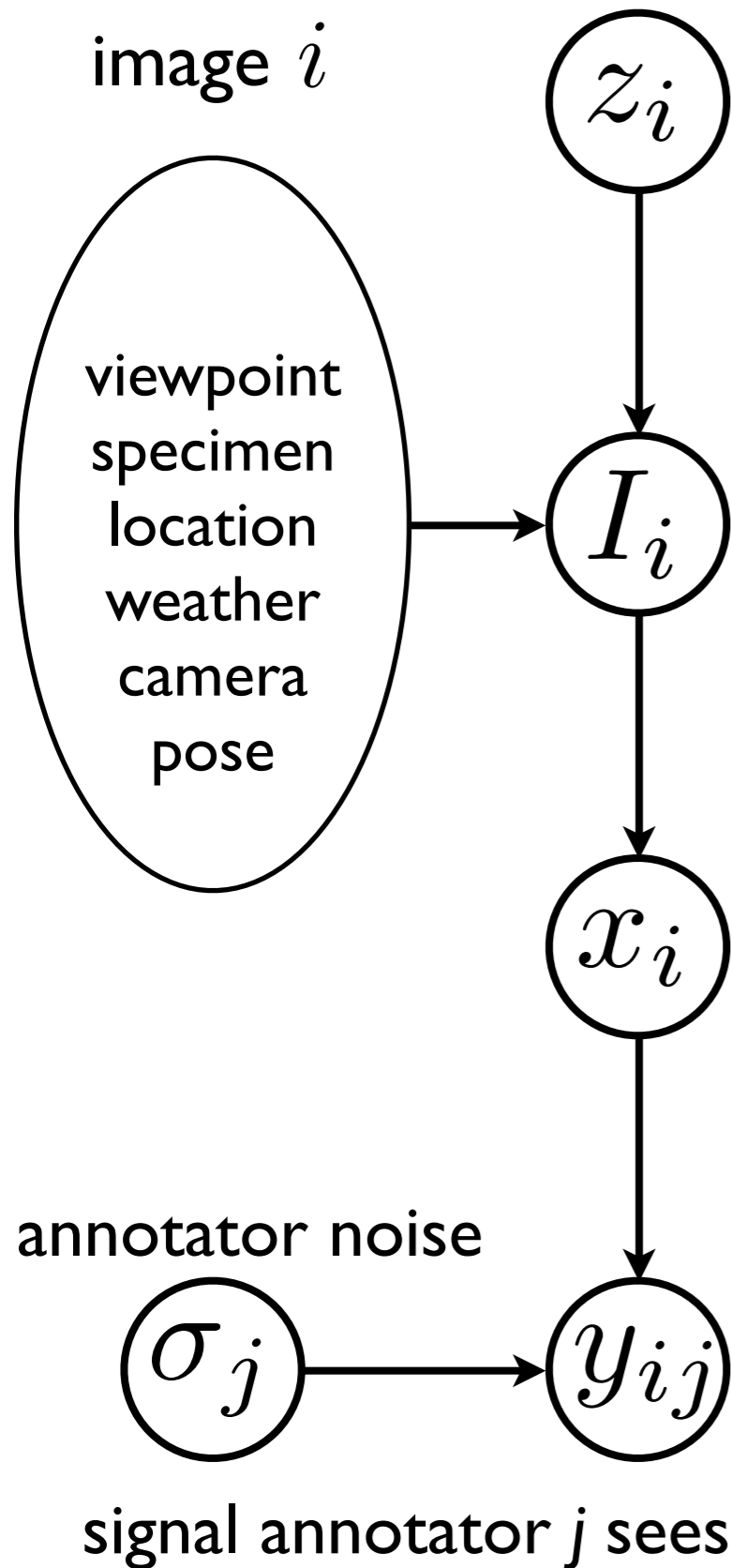


Image difficulty and annotator competence



$$p(x_i | z_i = 1)$$

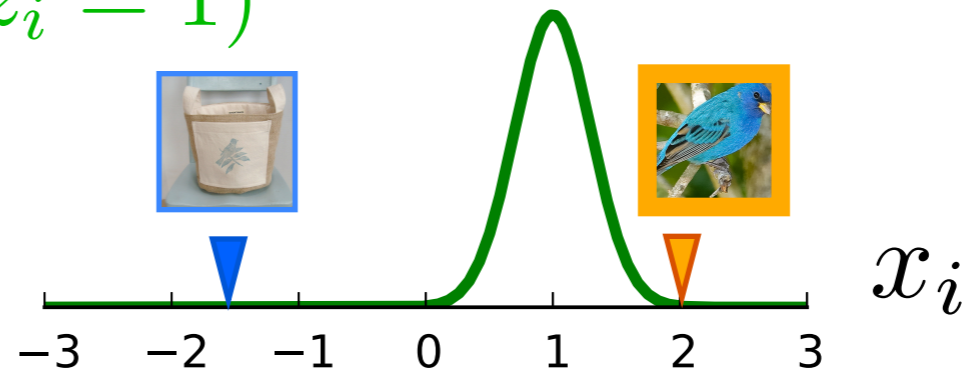
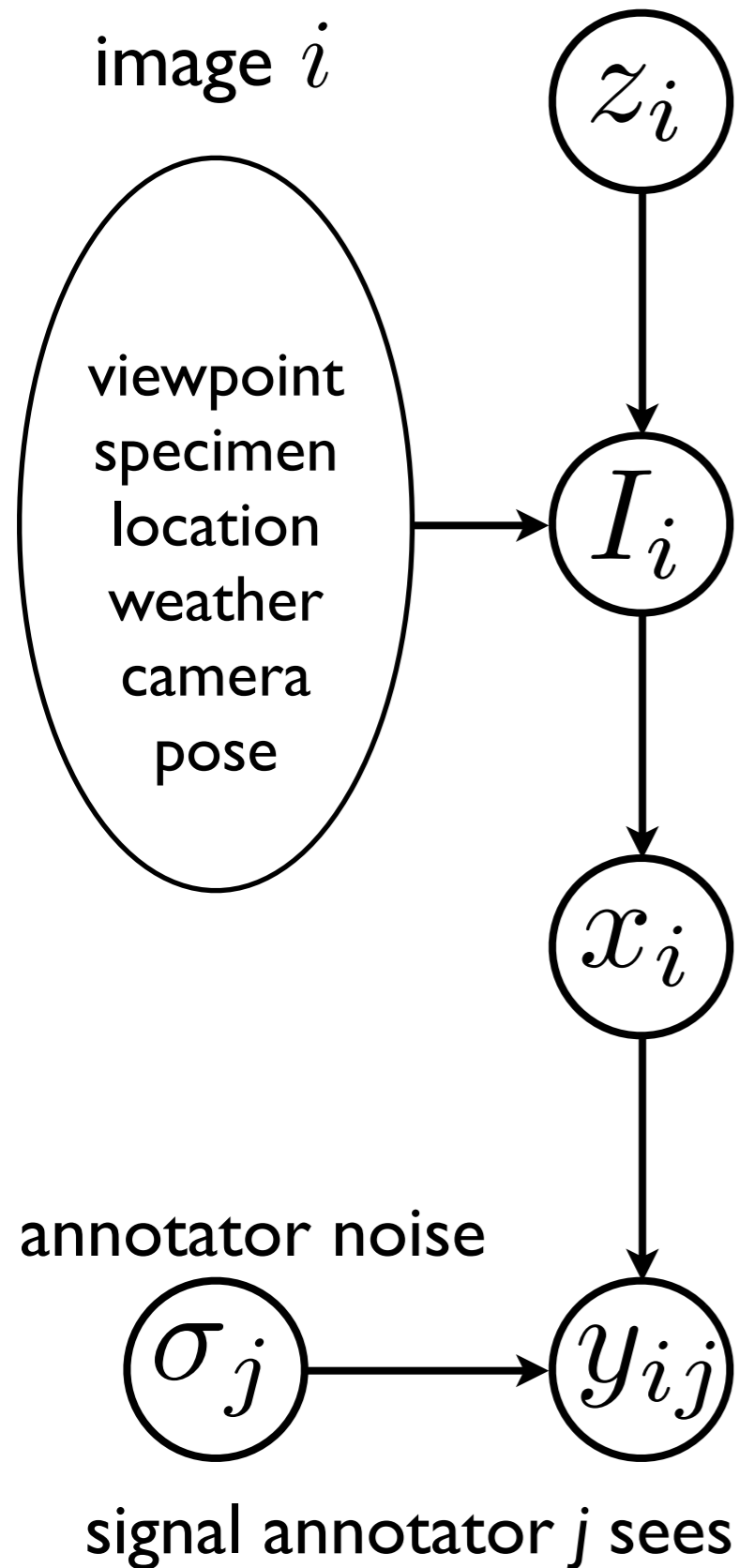


Image difficulty and annotator competence



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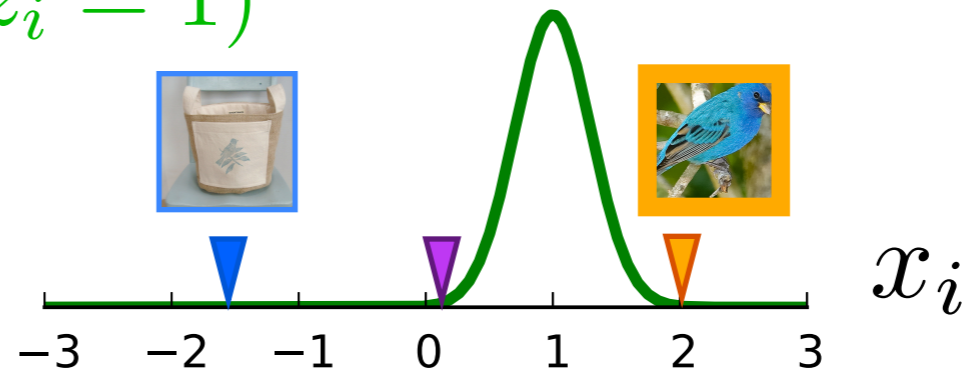
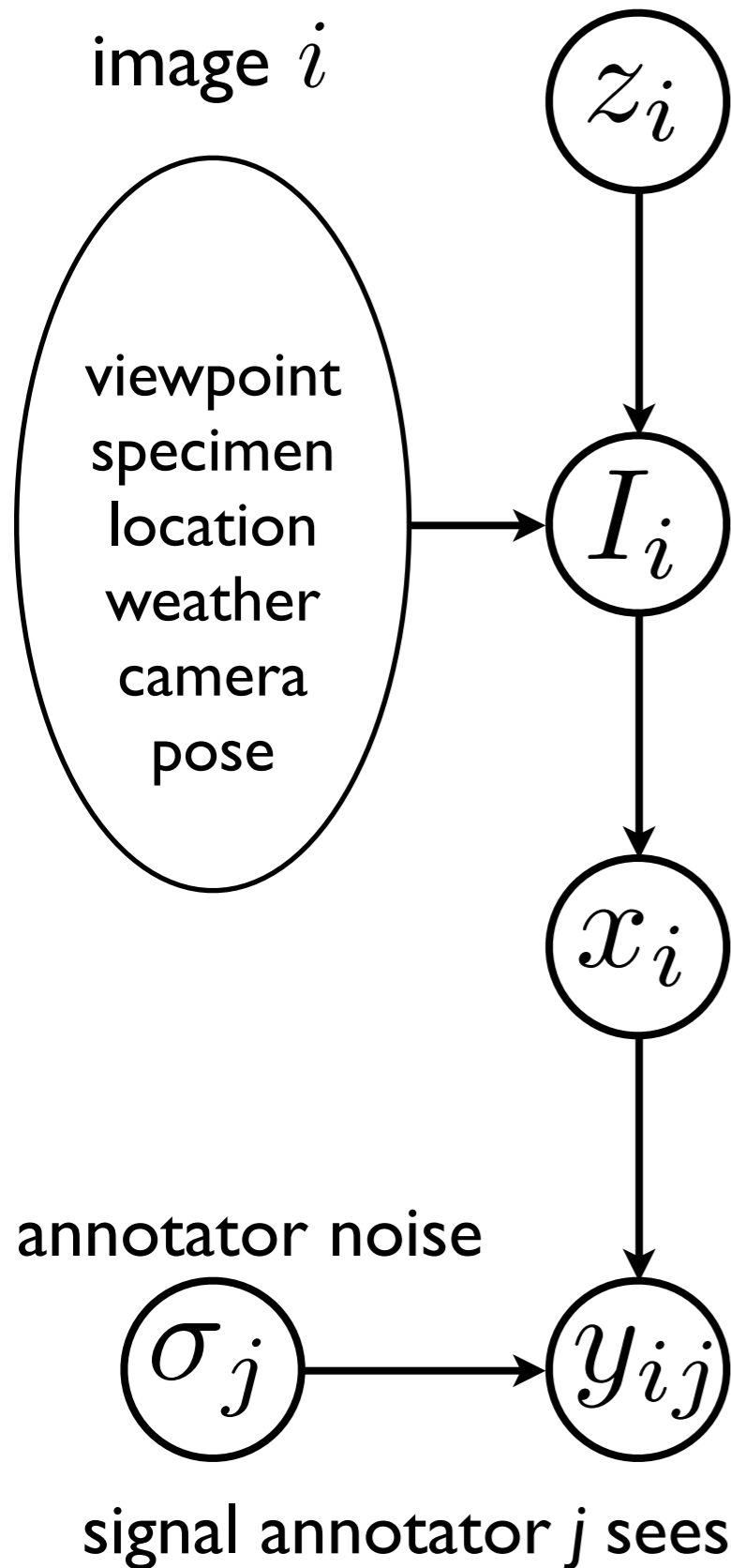


Image difficulty and annotator competence



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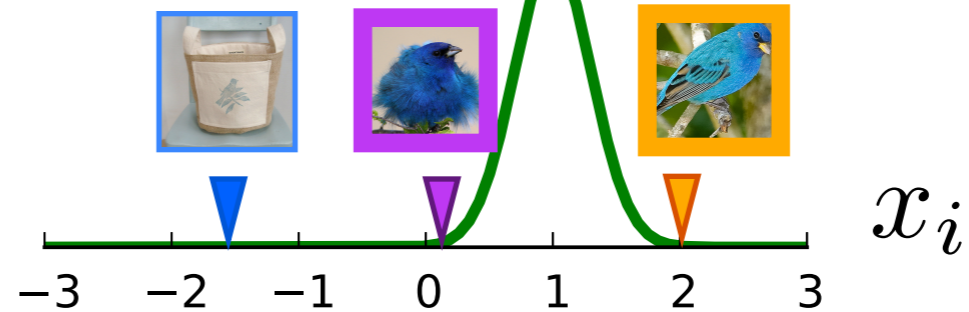
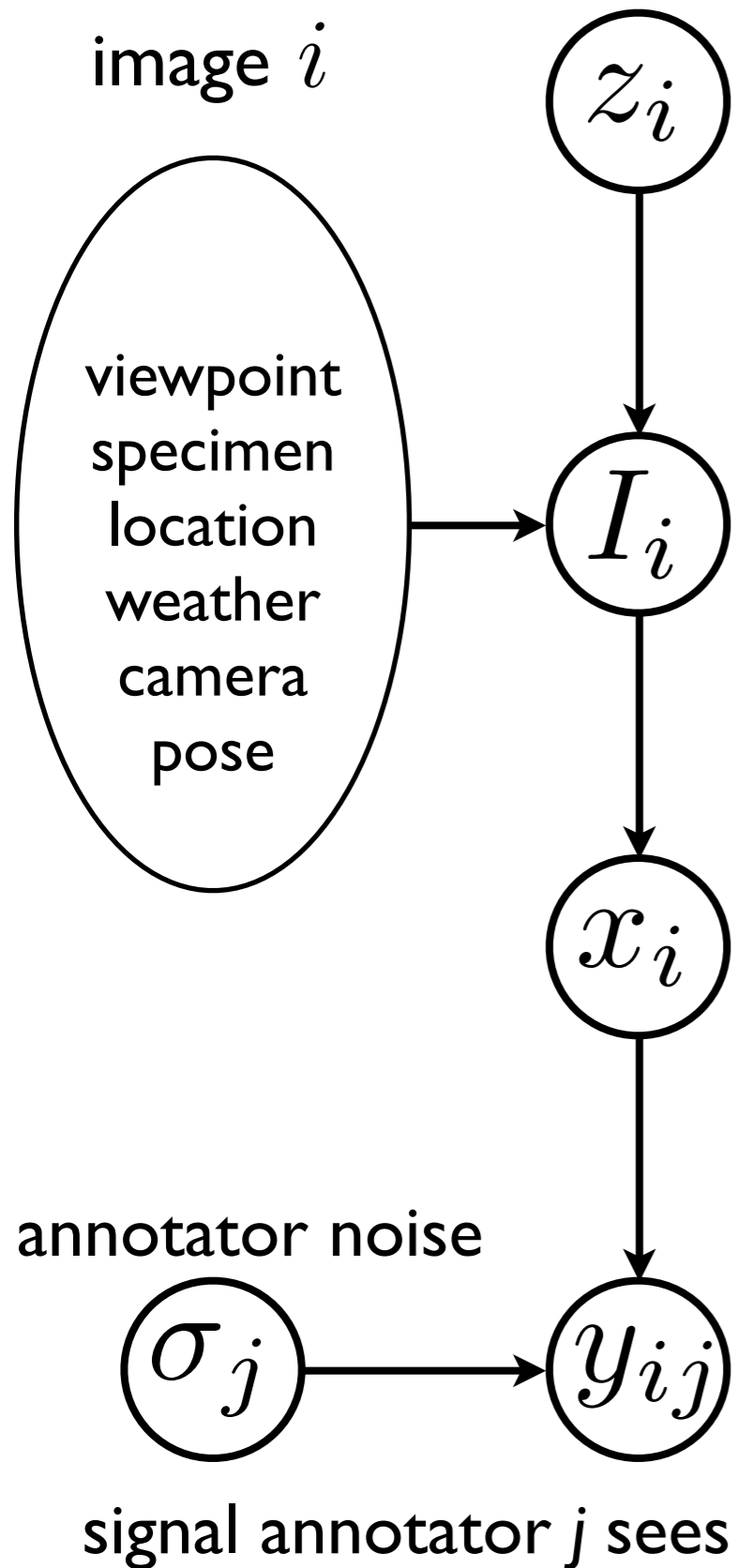
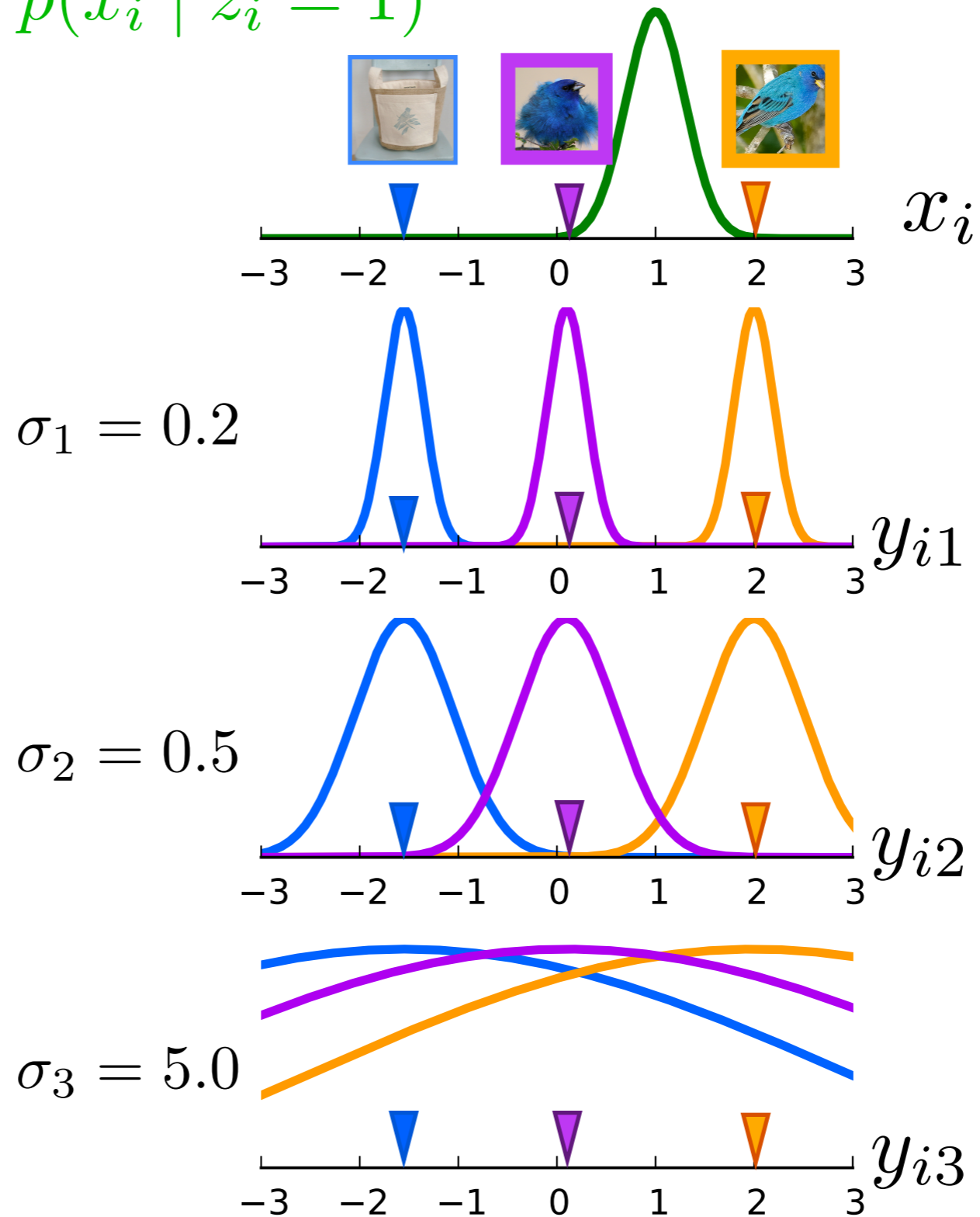


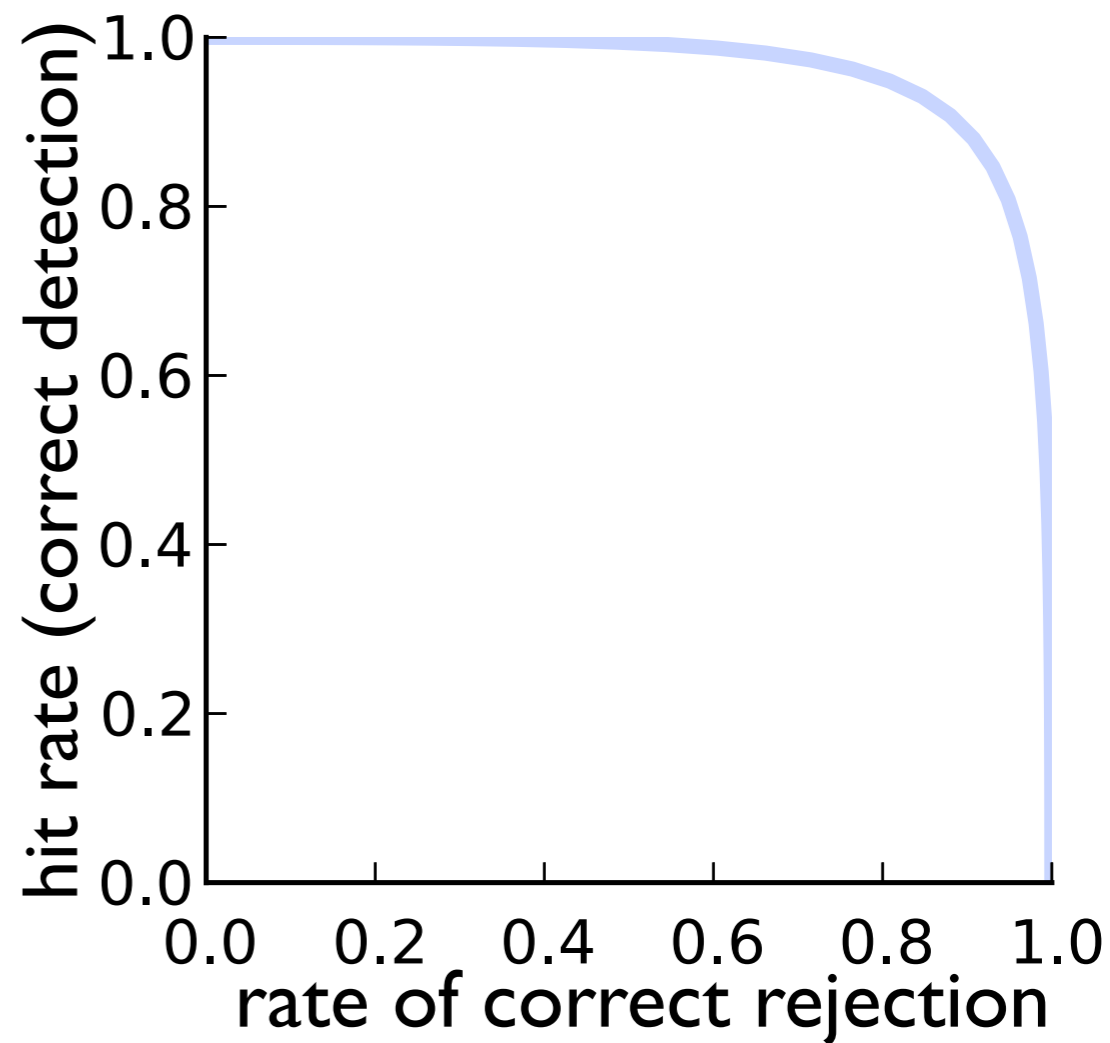
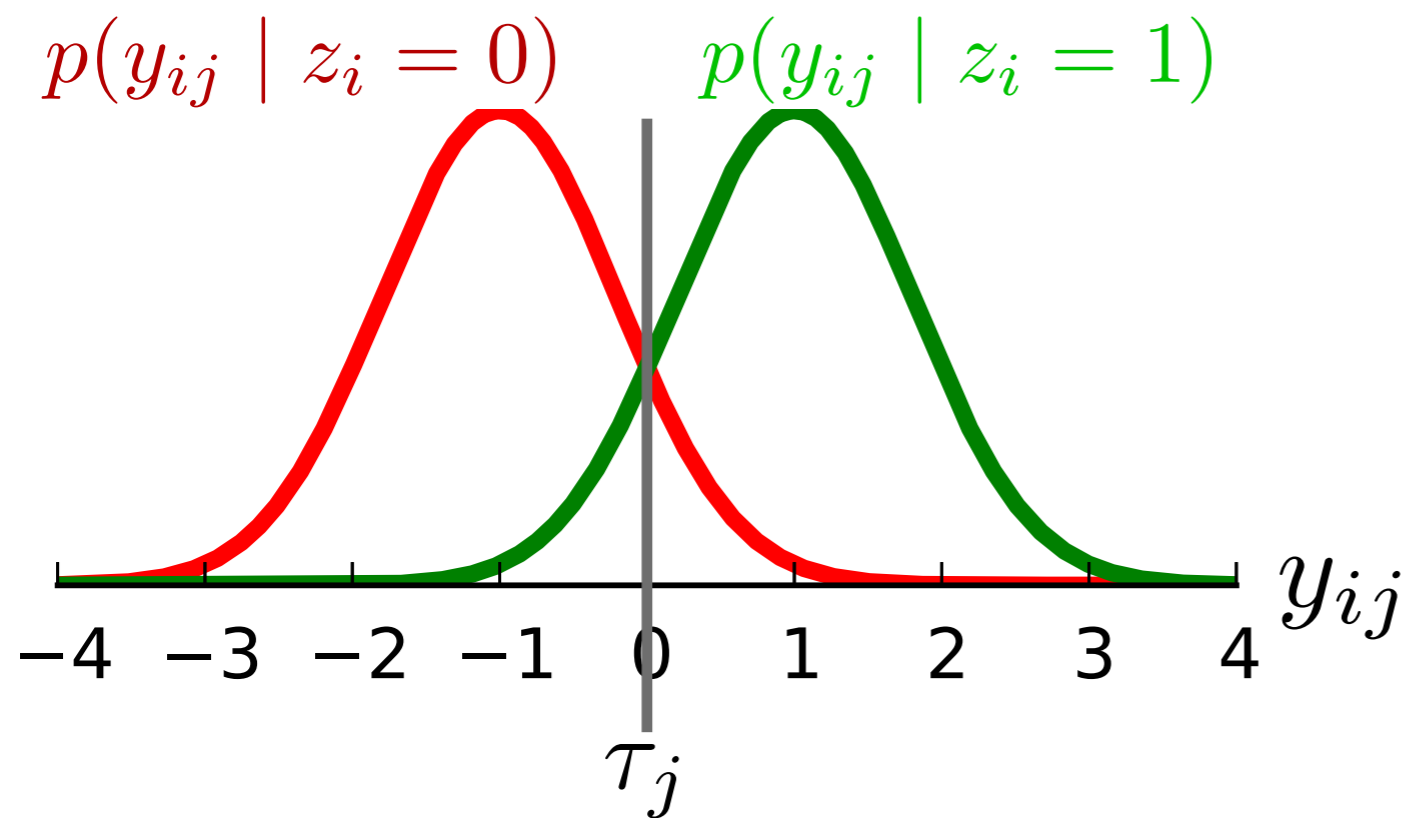
Image difficulty and annotator competence



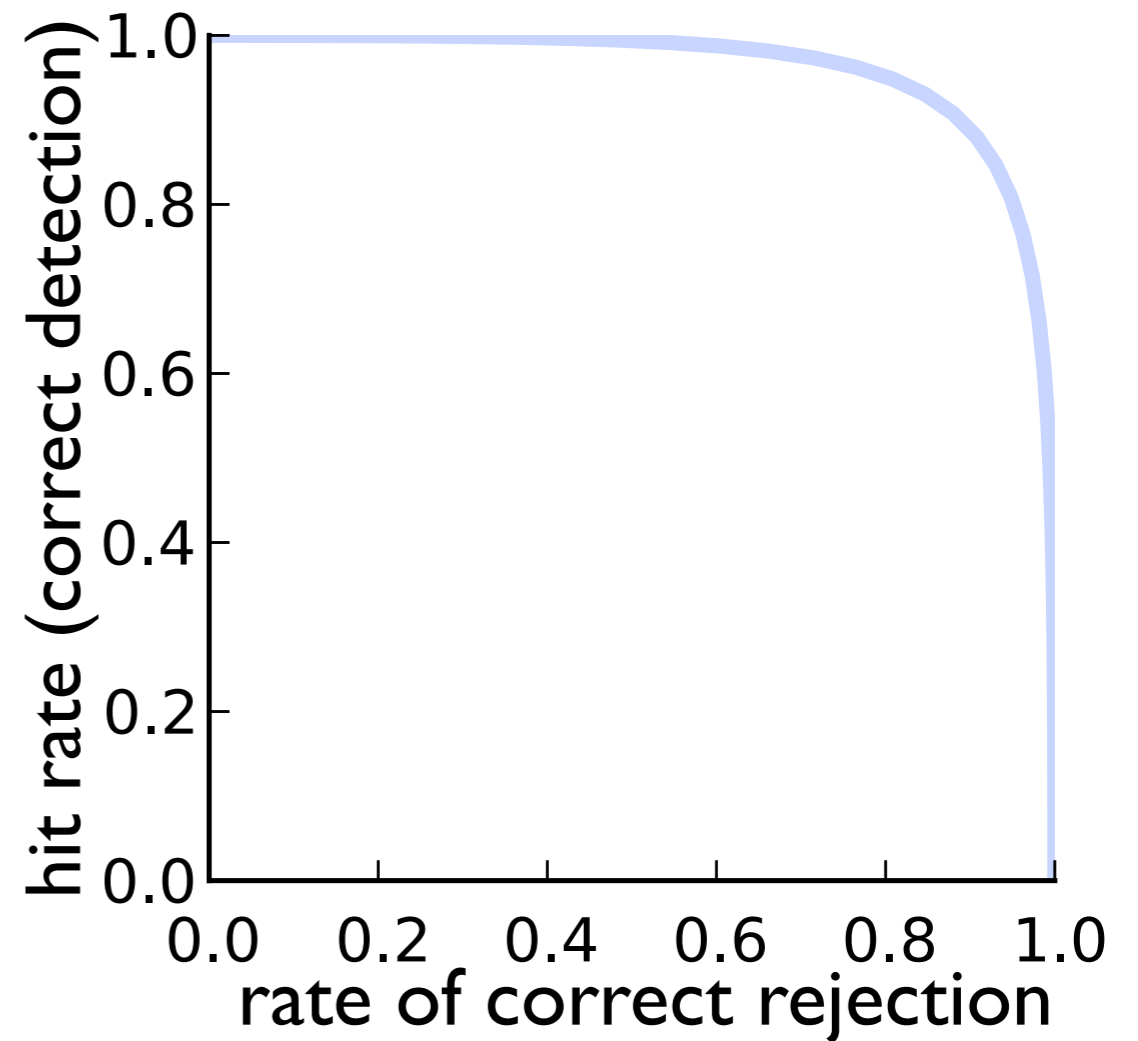
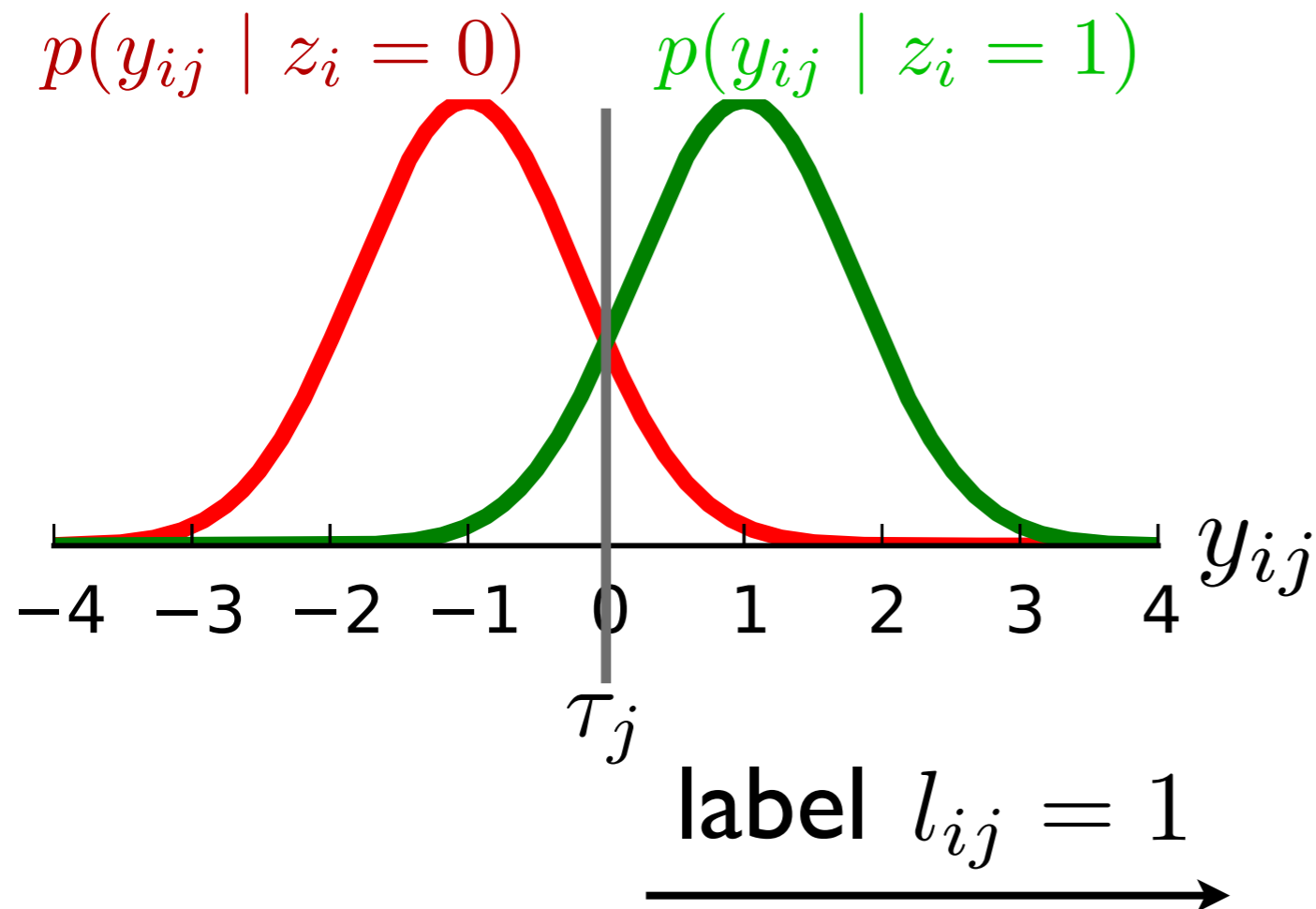
$$p(x_i | z_i = 1)$$



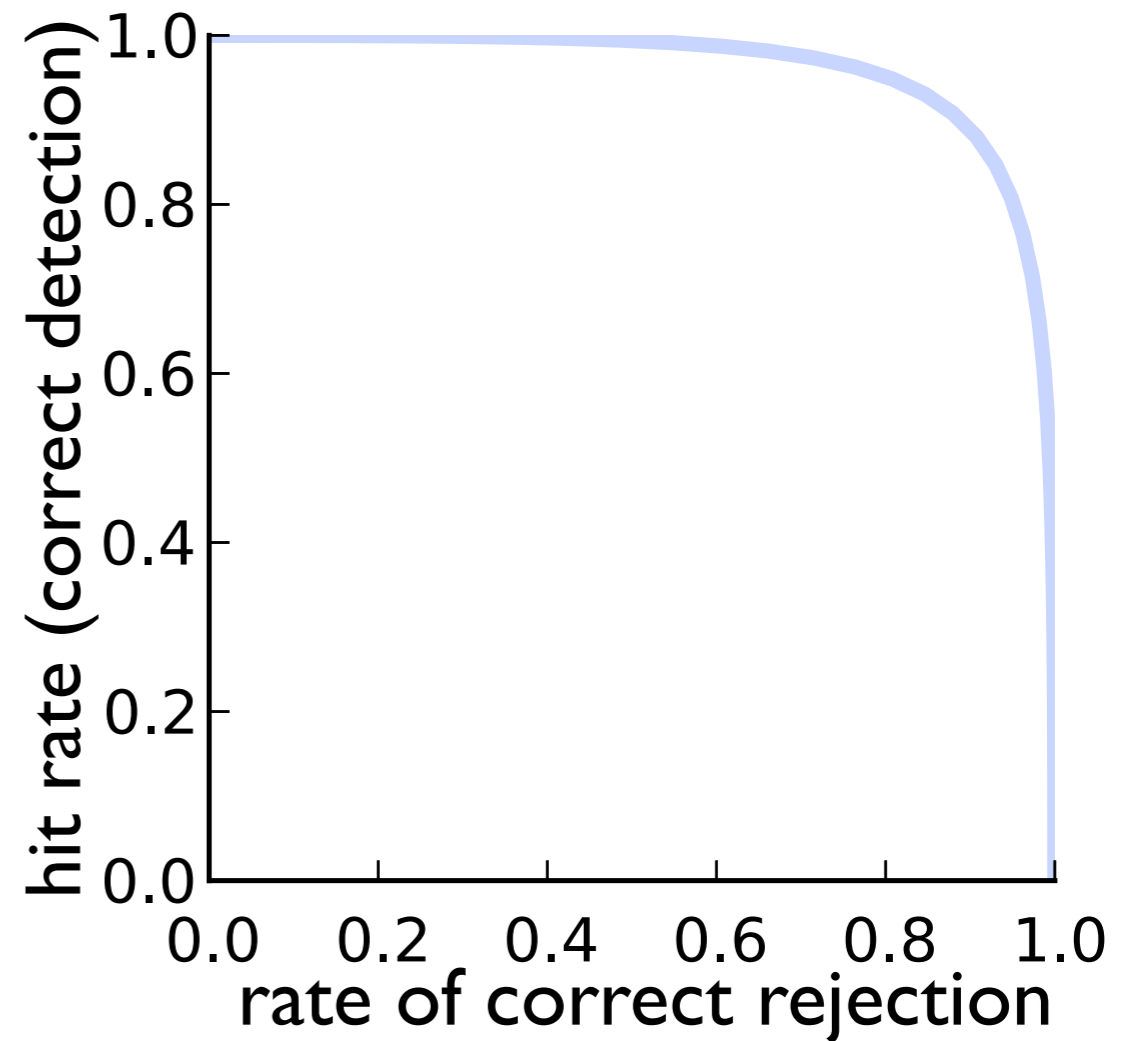
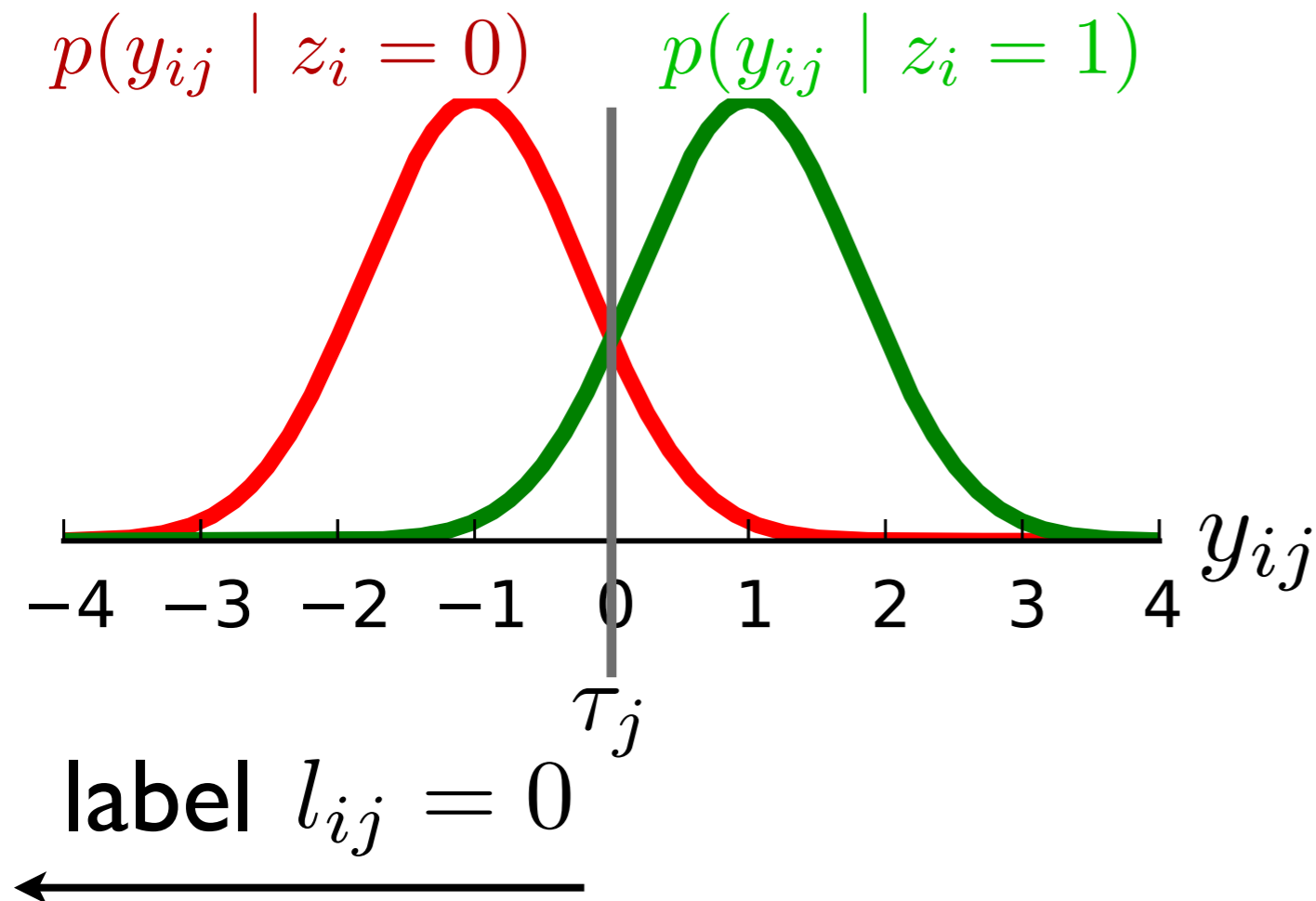
Optimists and pessimists: τ_j



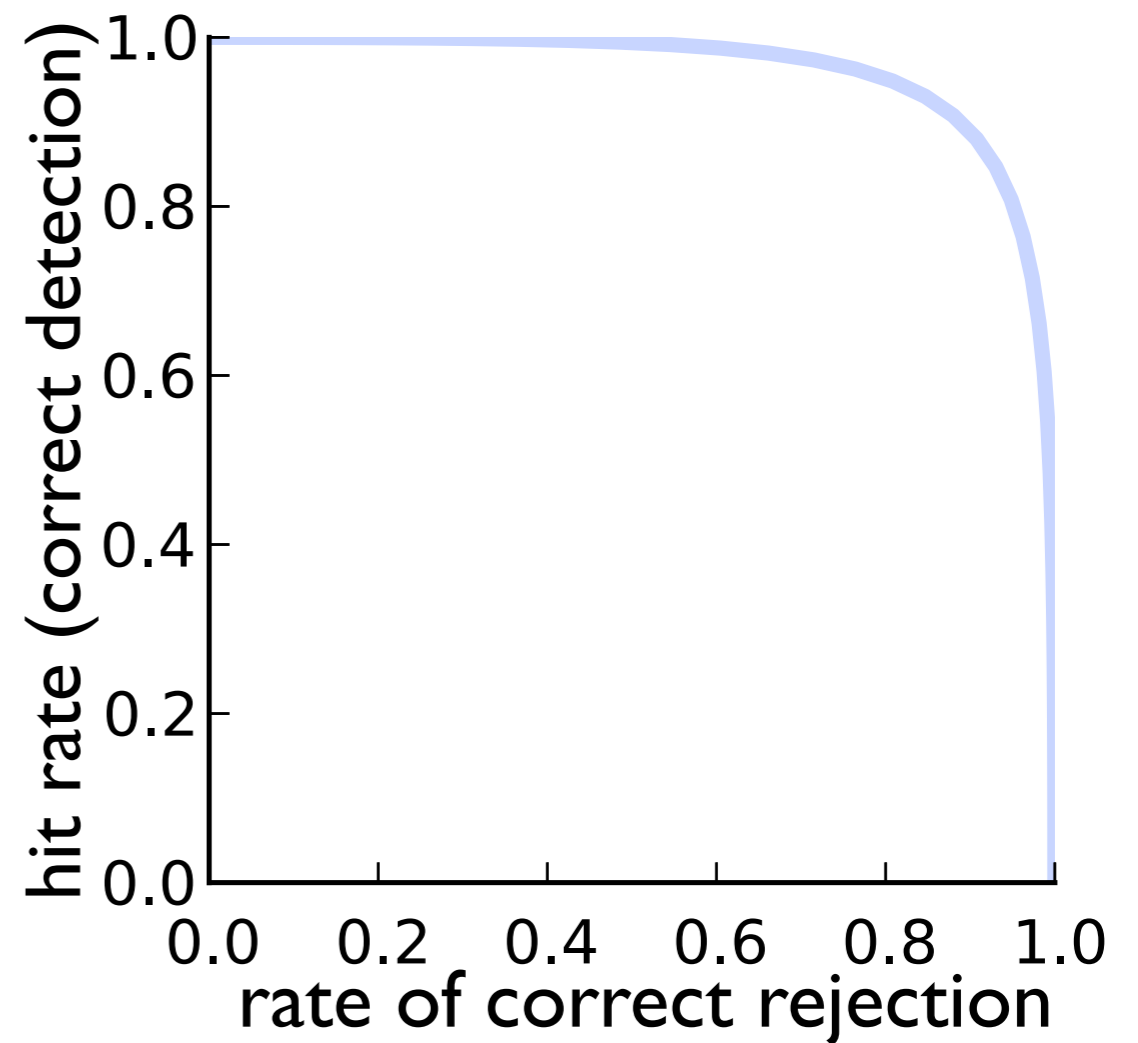
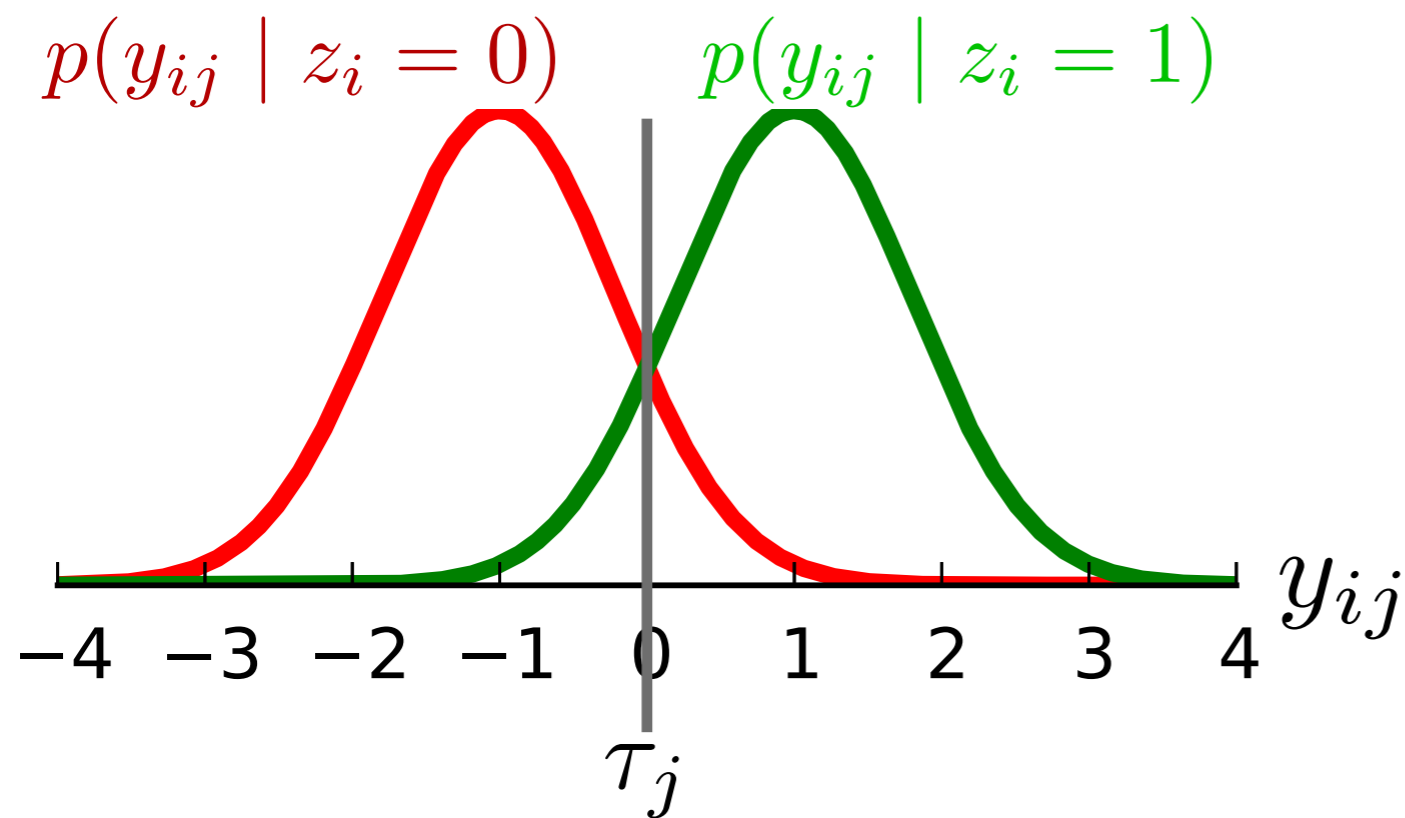
Optimists and pessimists: τ_j



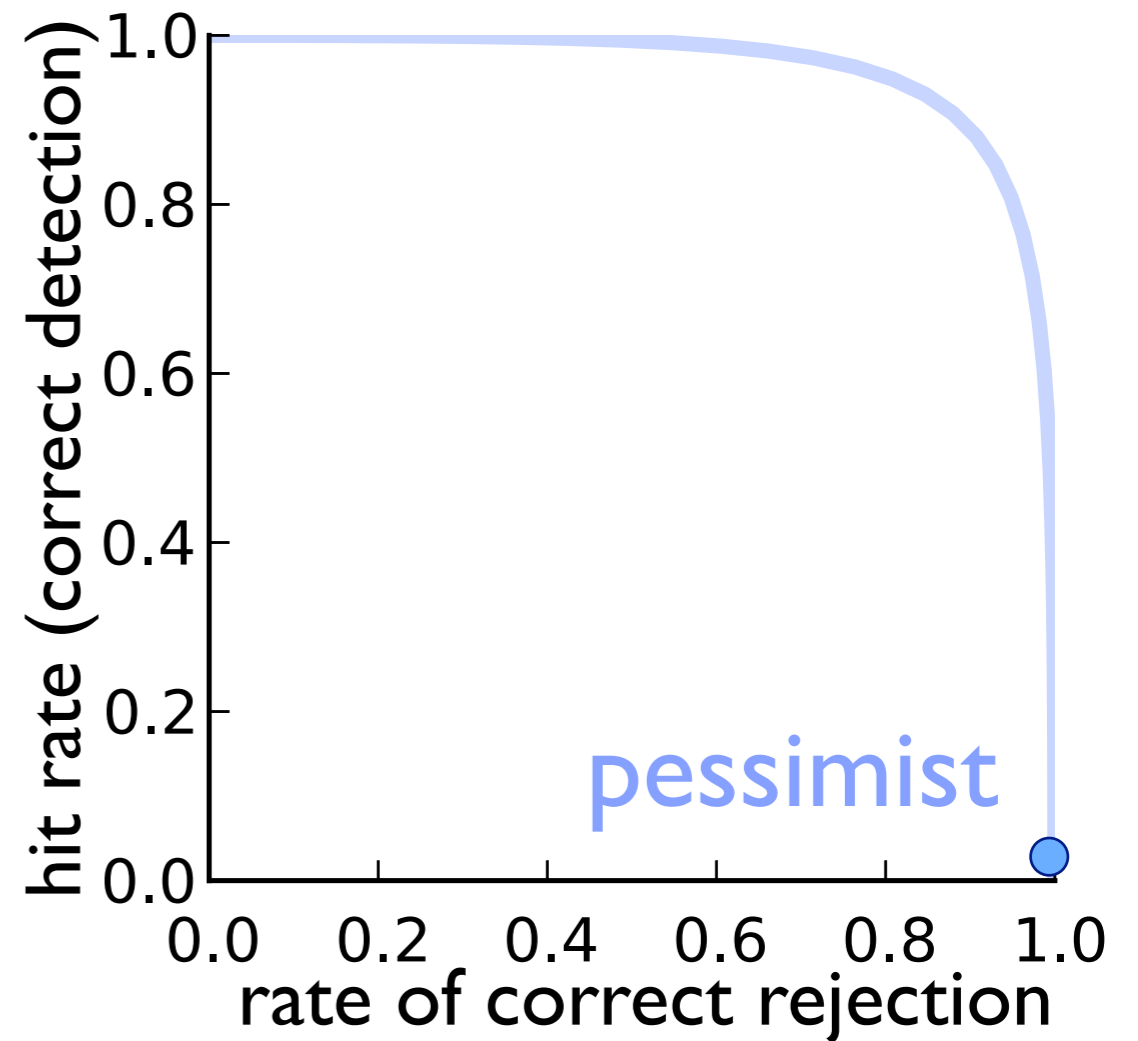
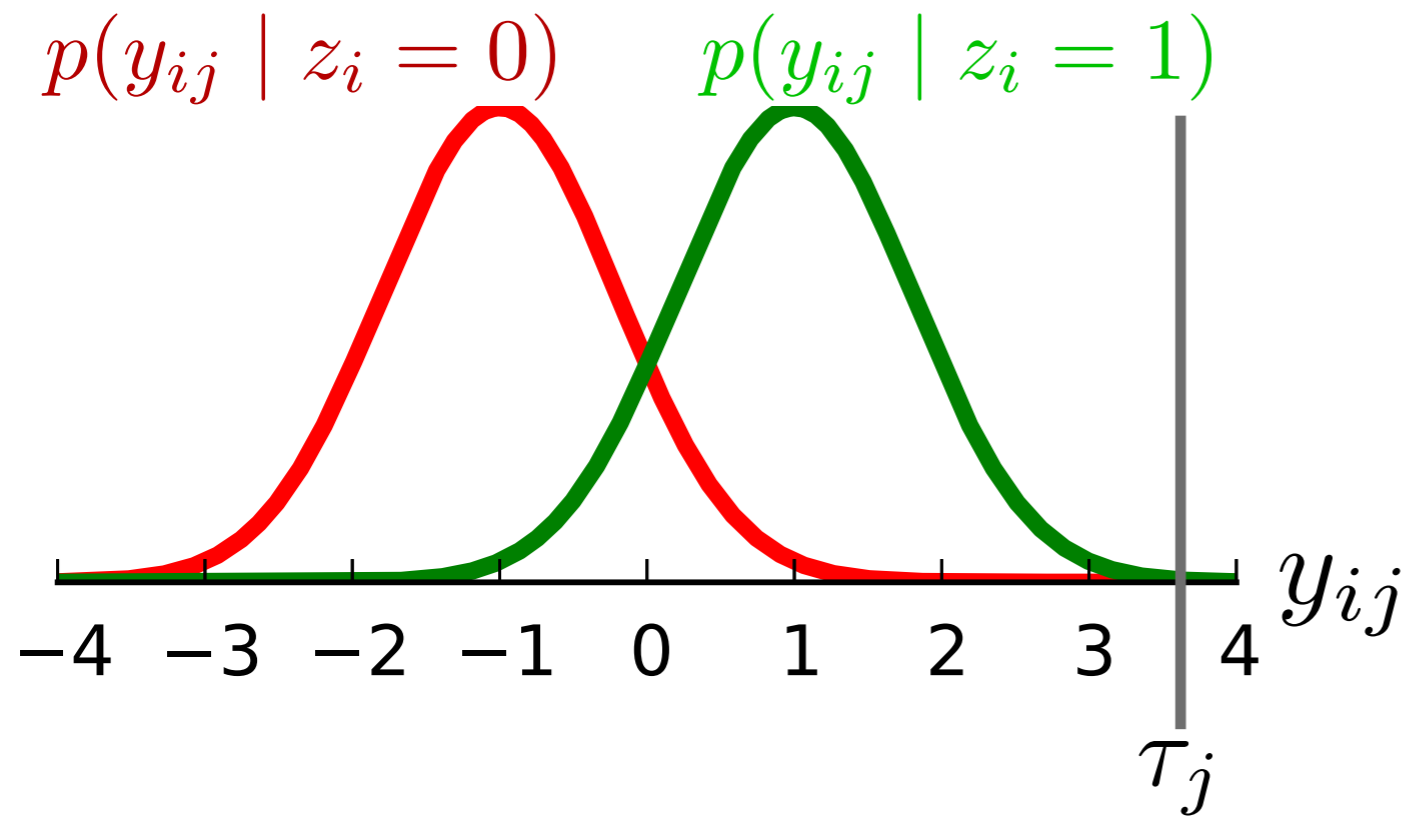
Optimists and pessimists: τ_j



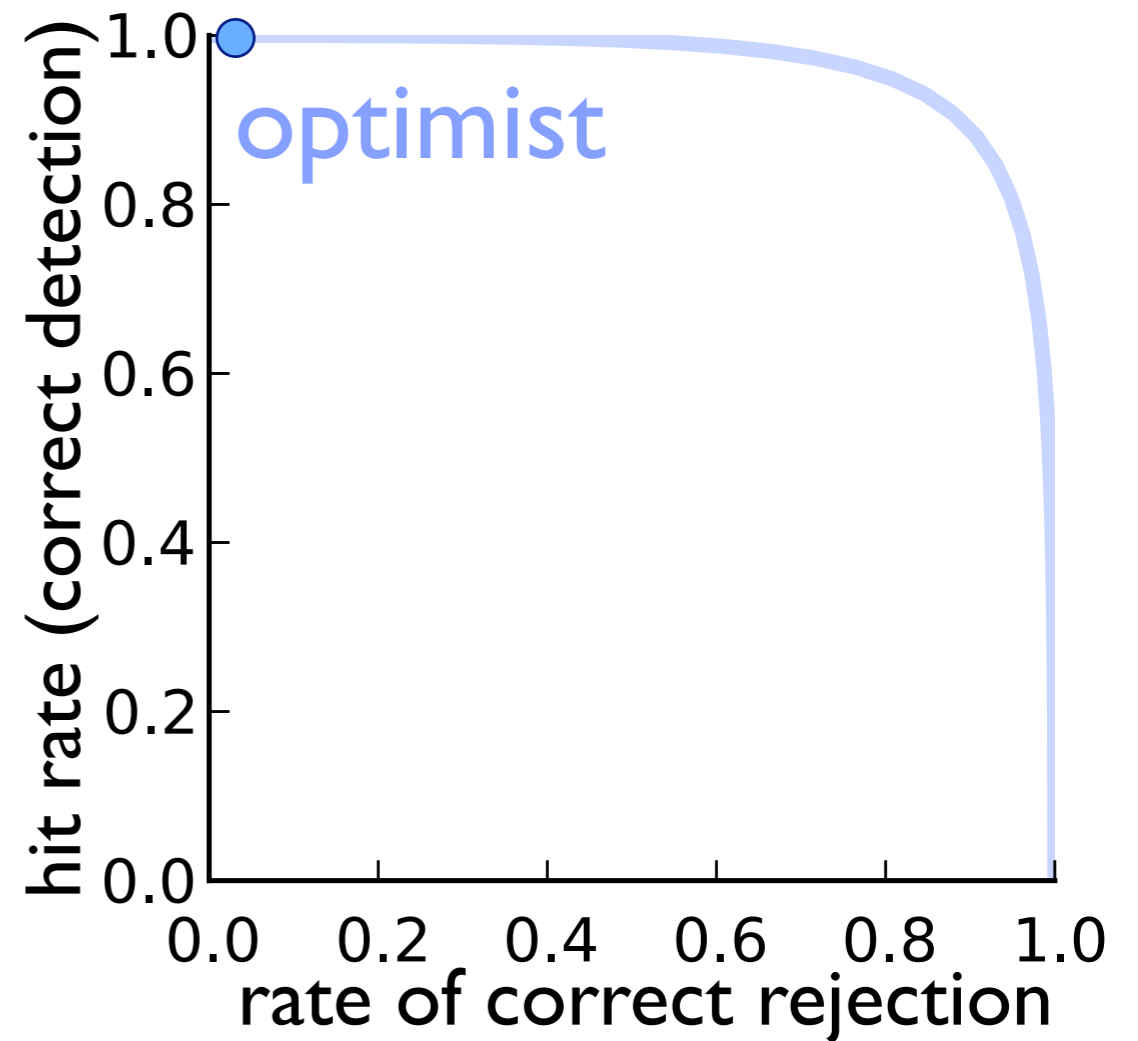
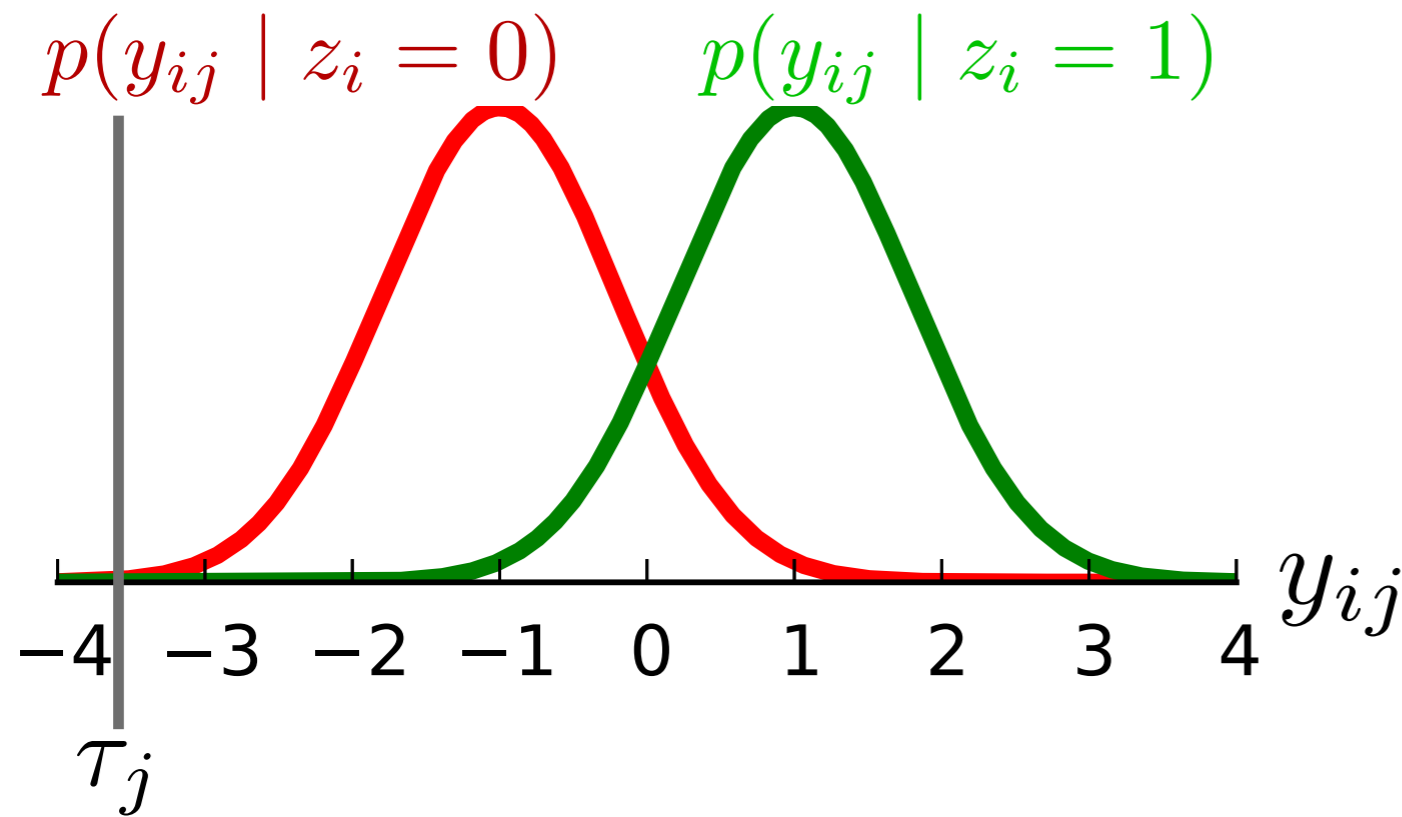
Optimists and pessimists: τ_j



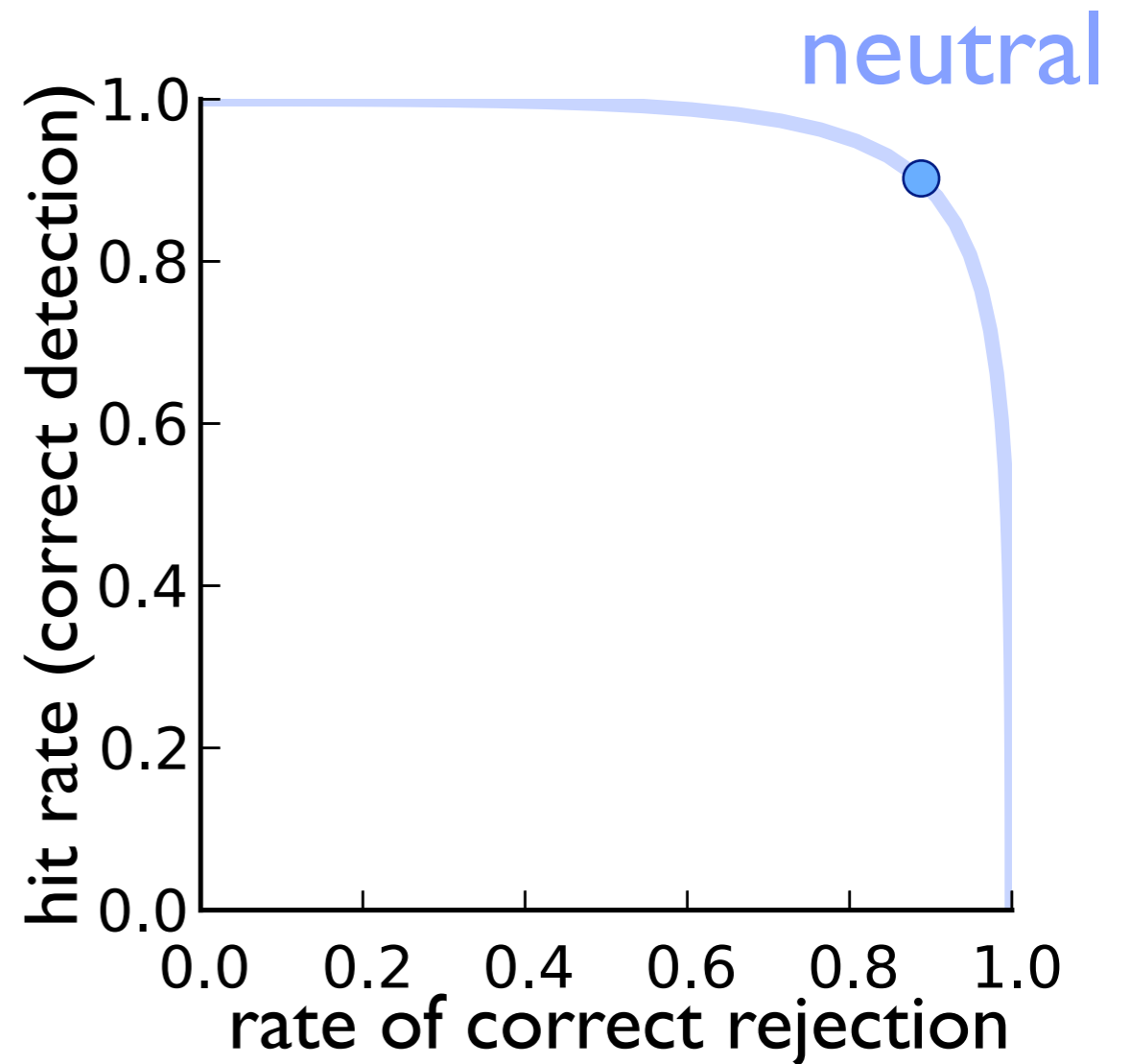
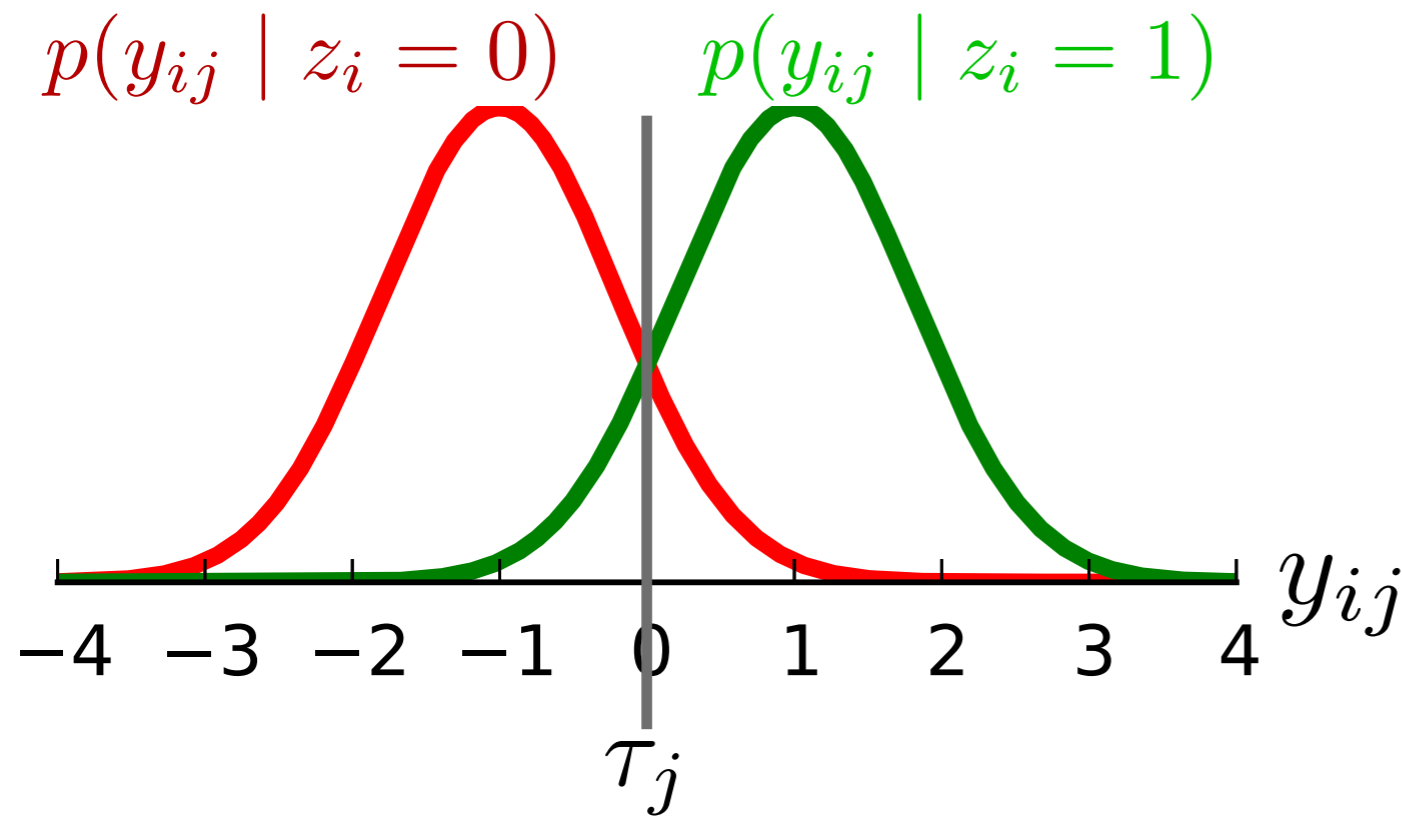
Optimists and pessimists: τ_j



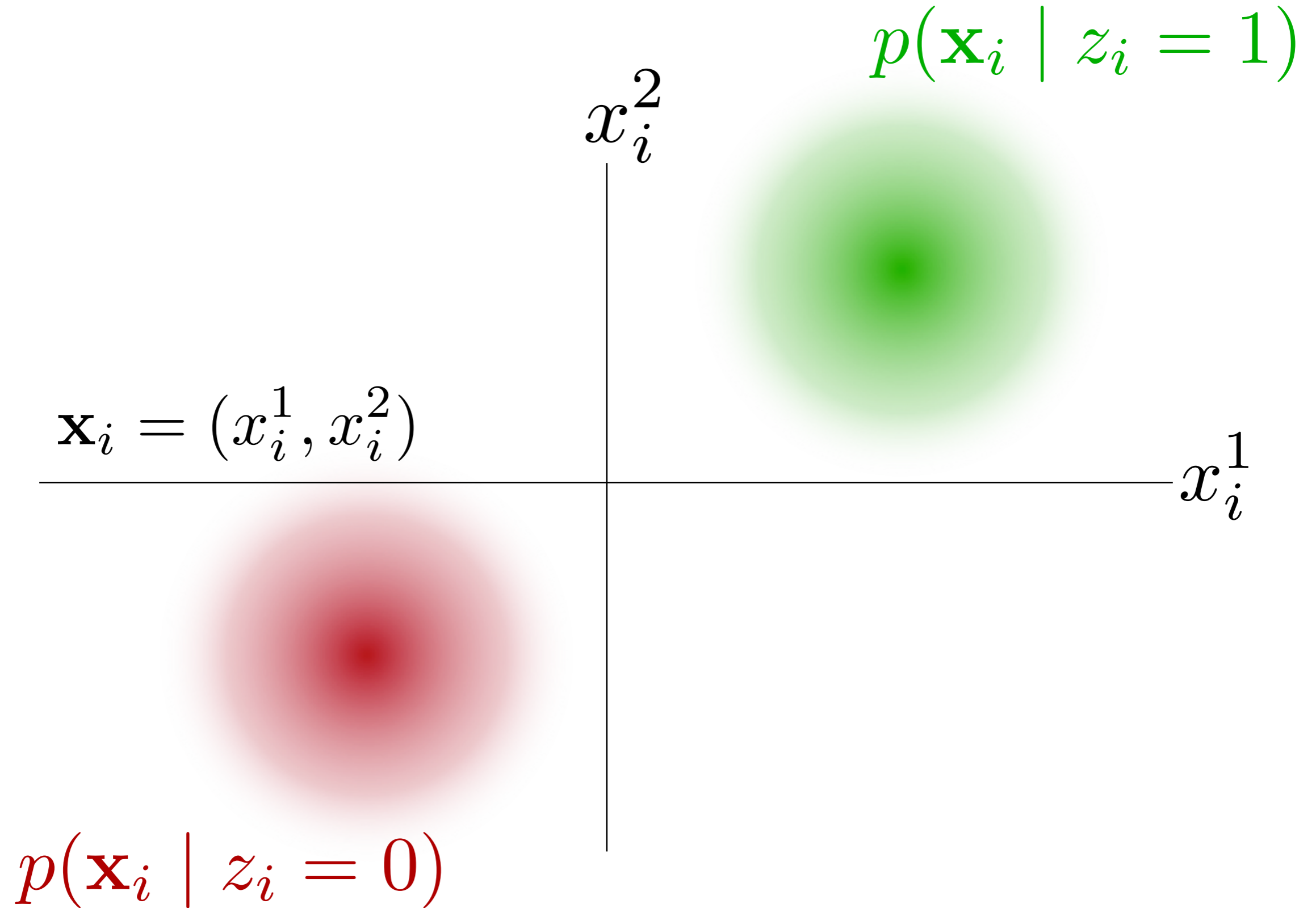
Optimists and pessimists: τ_j



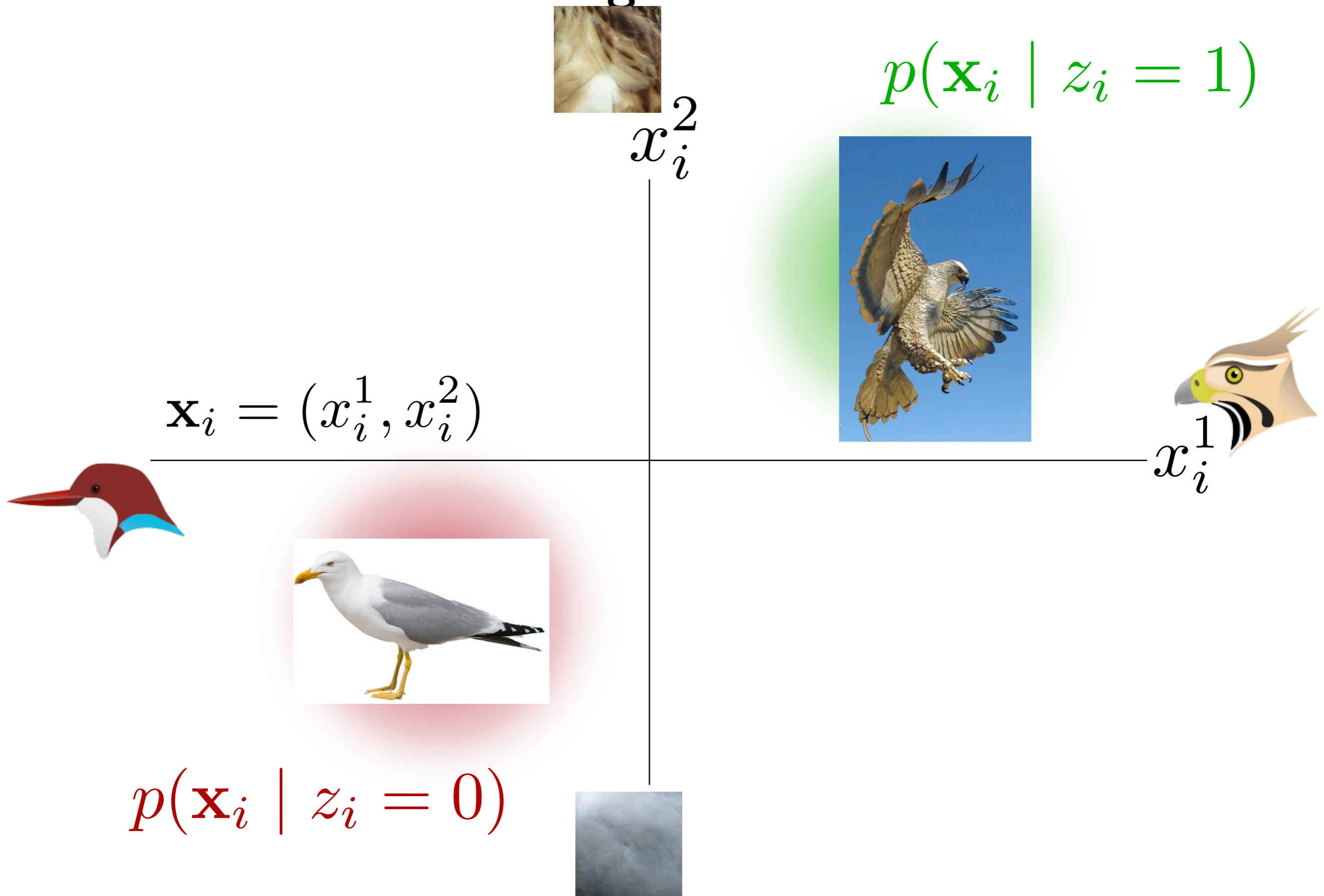
Optimists and pessimists: τ_j



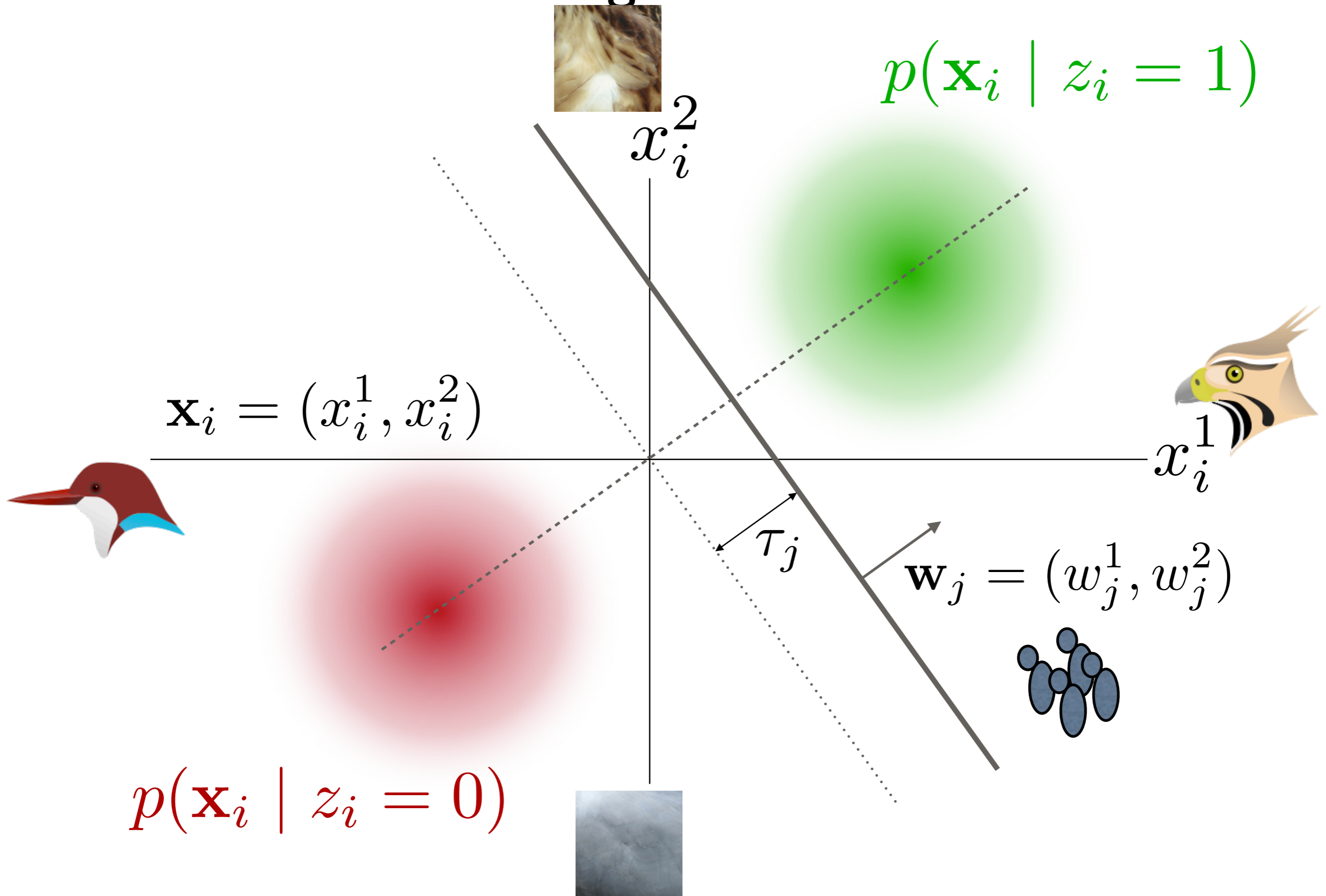
Multidimensional signals and annotators



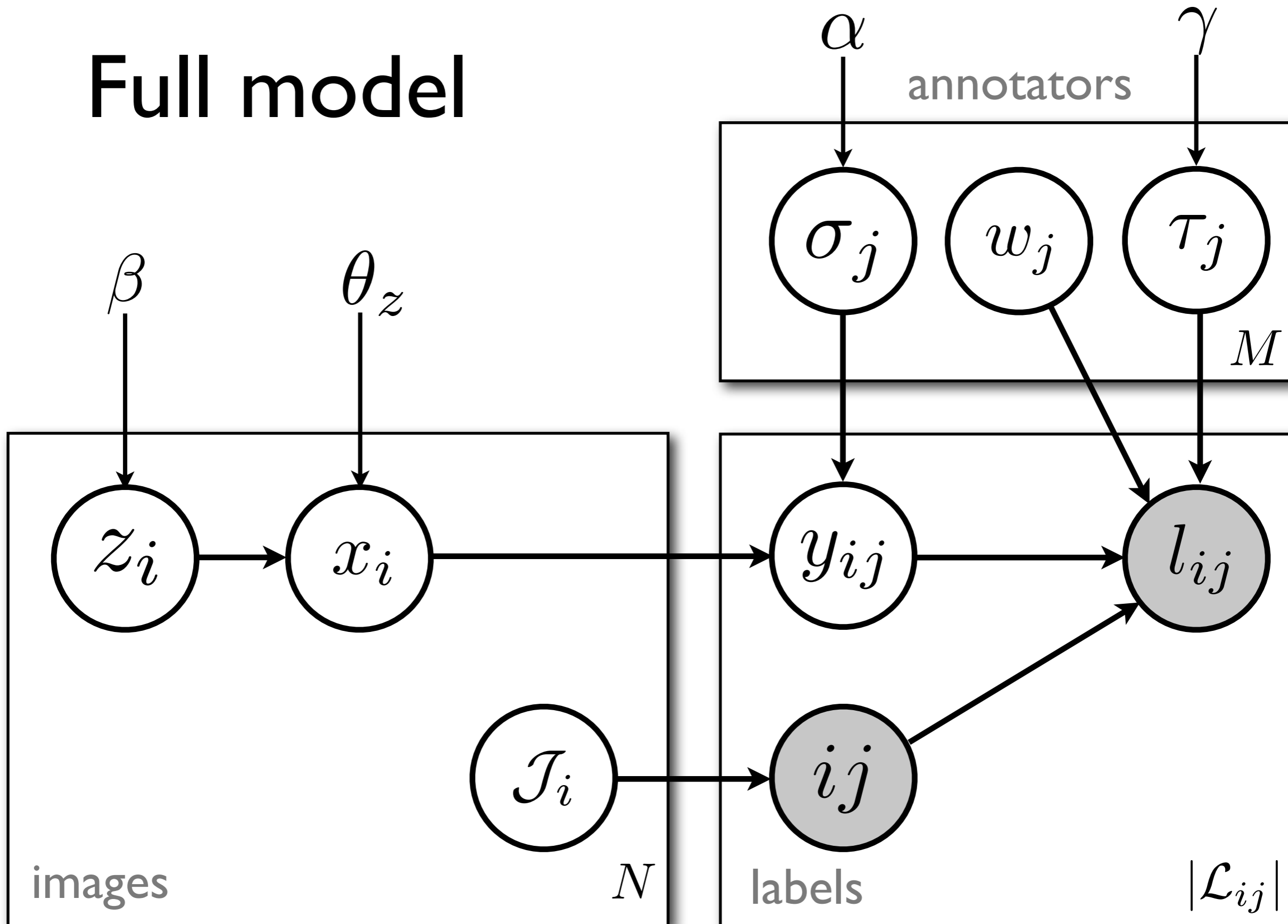
Multidimensional signals and annotators



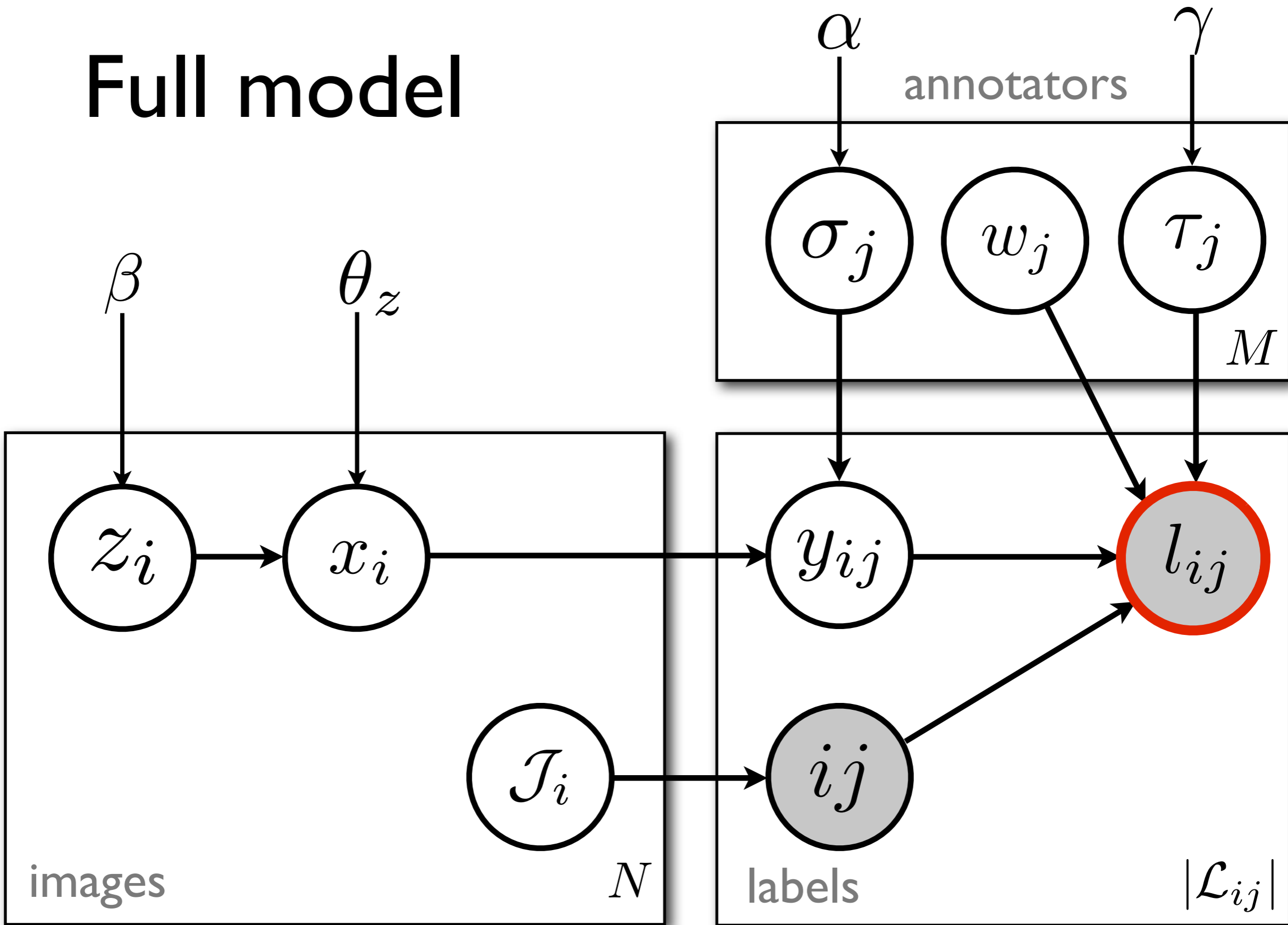
Multidimensional signals and annotators



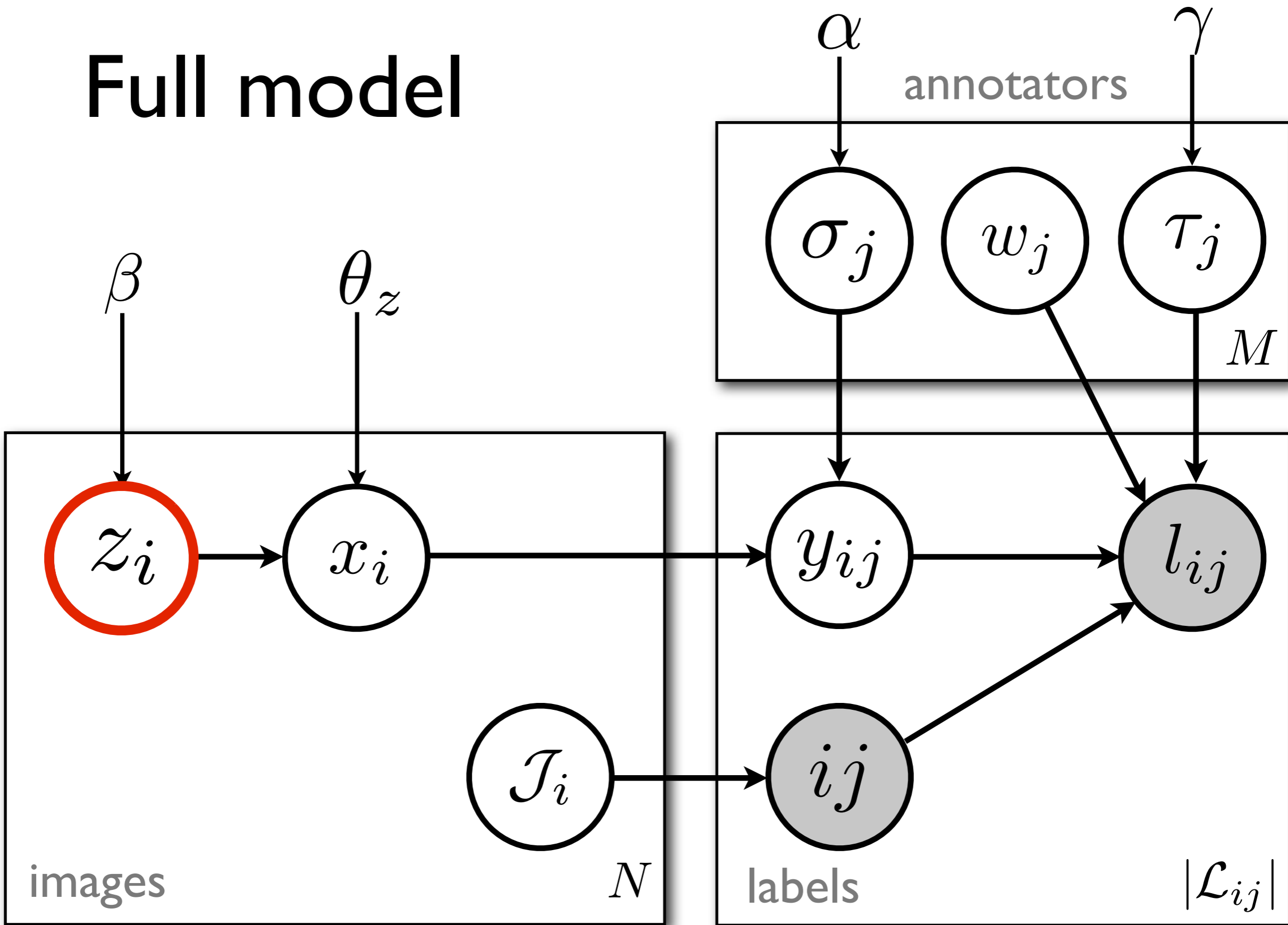
Full model



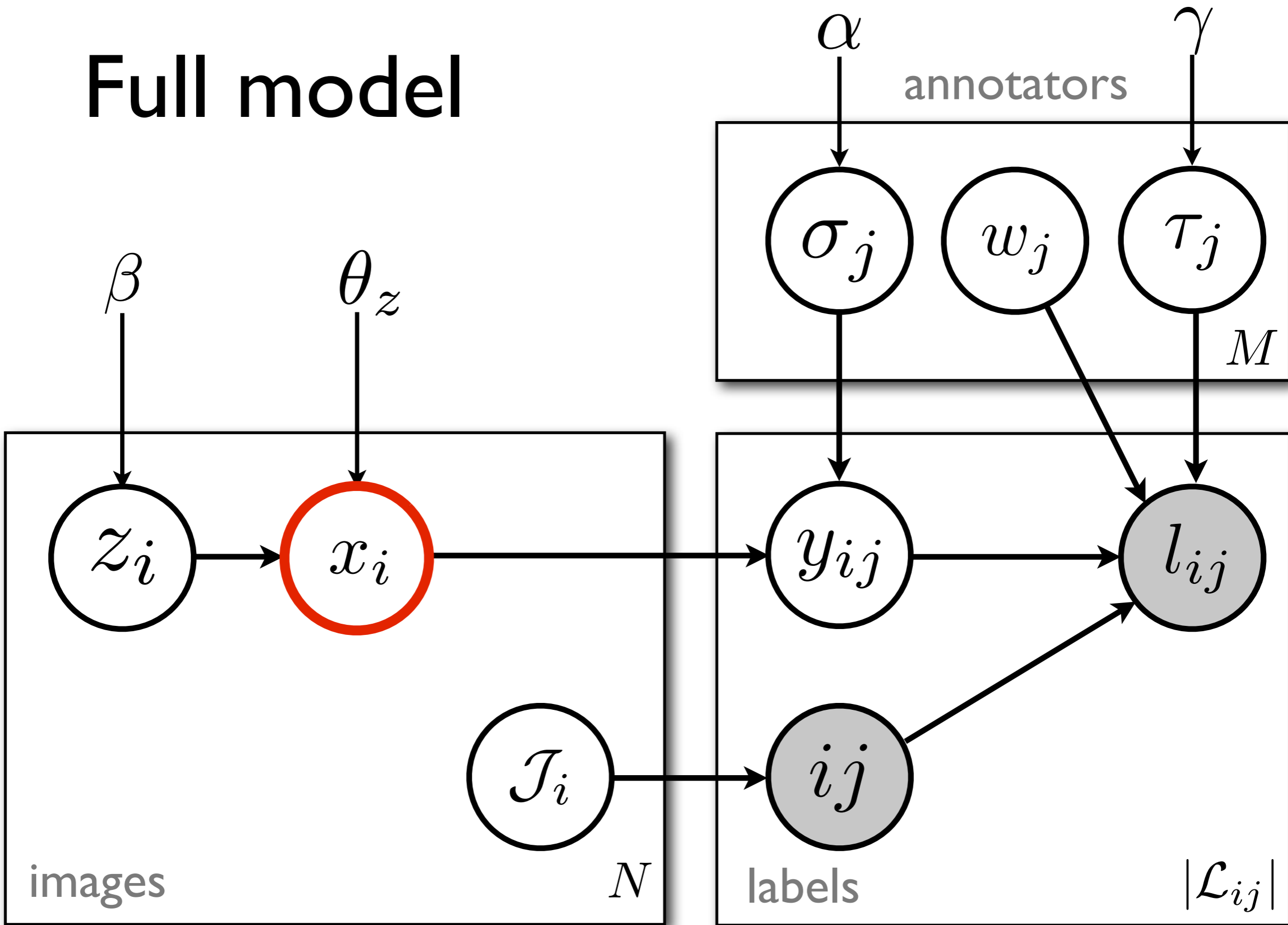
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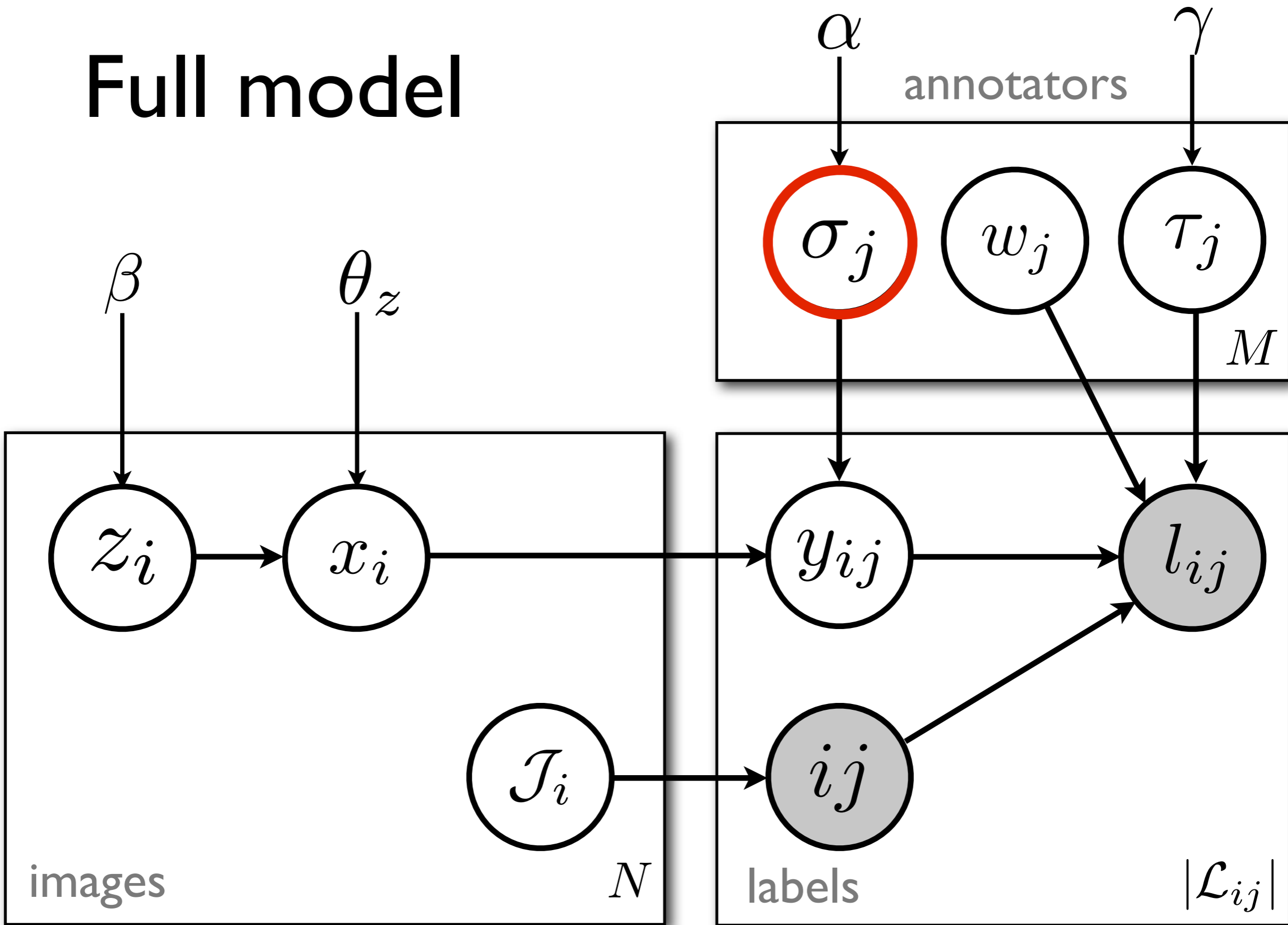
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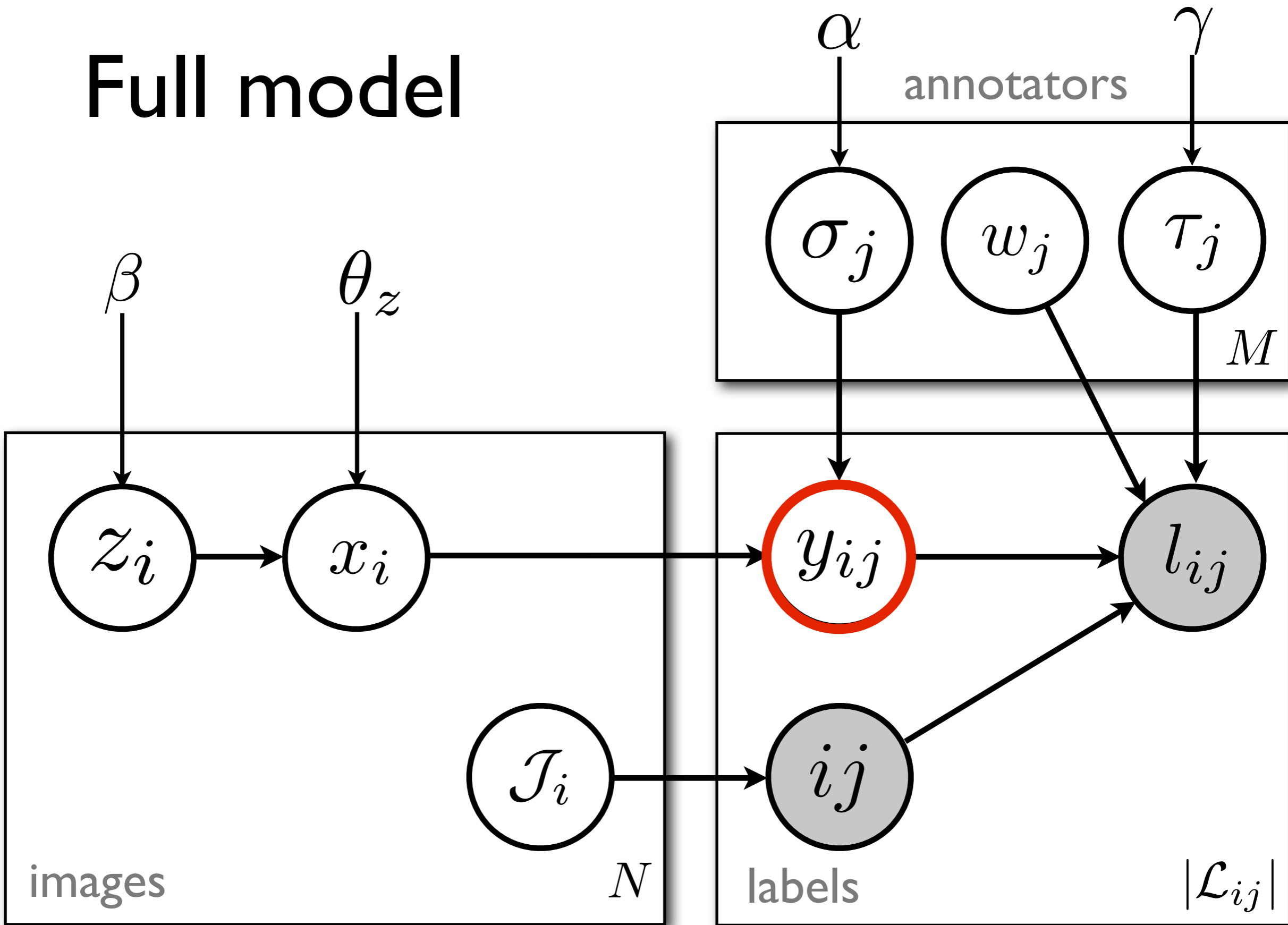
Full model



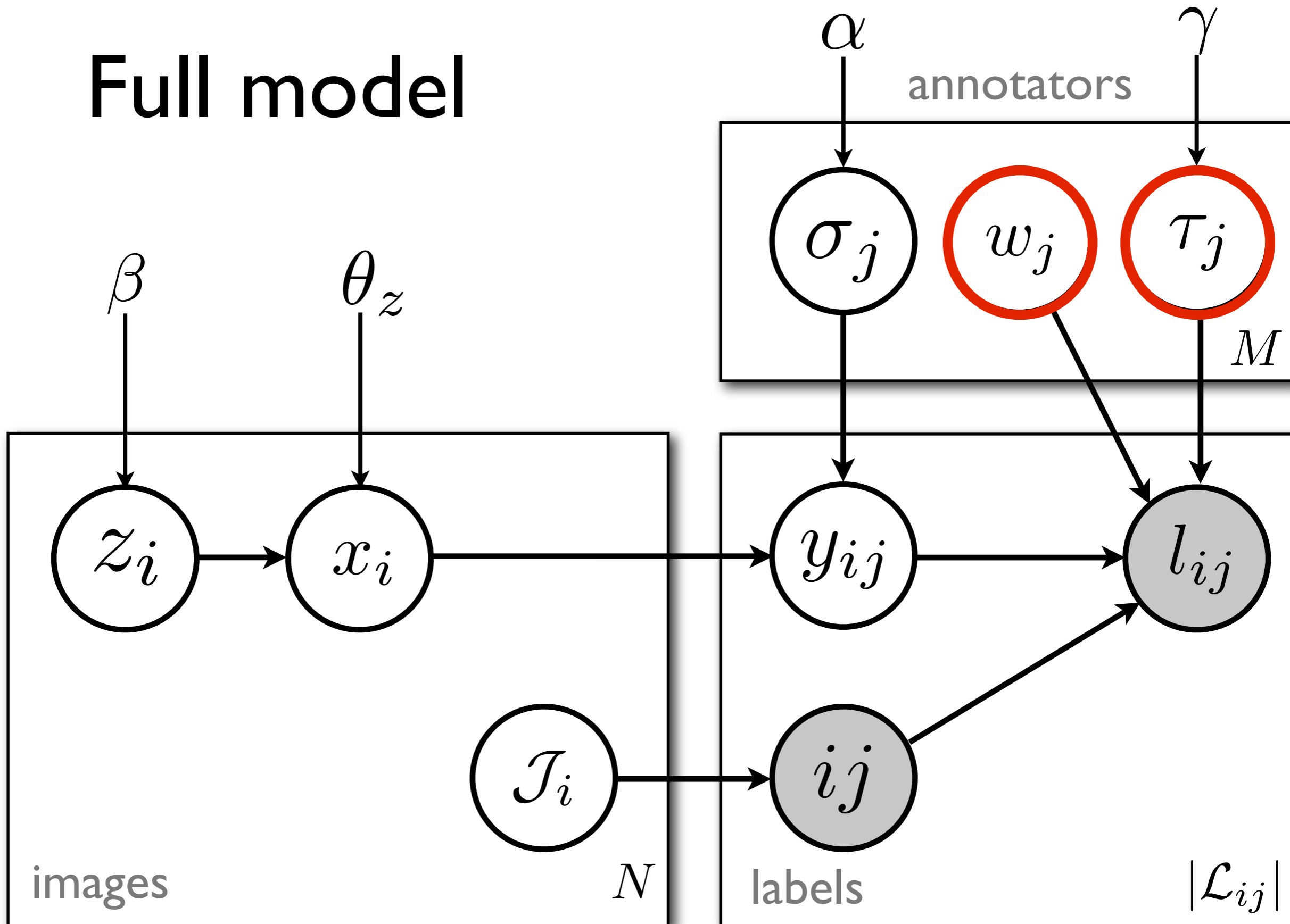
Full model



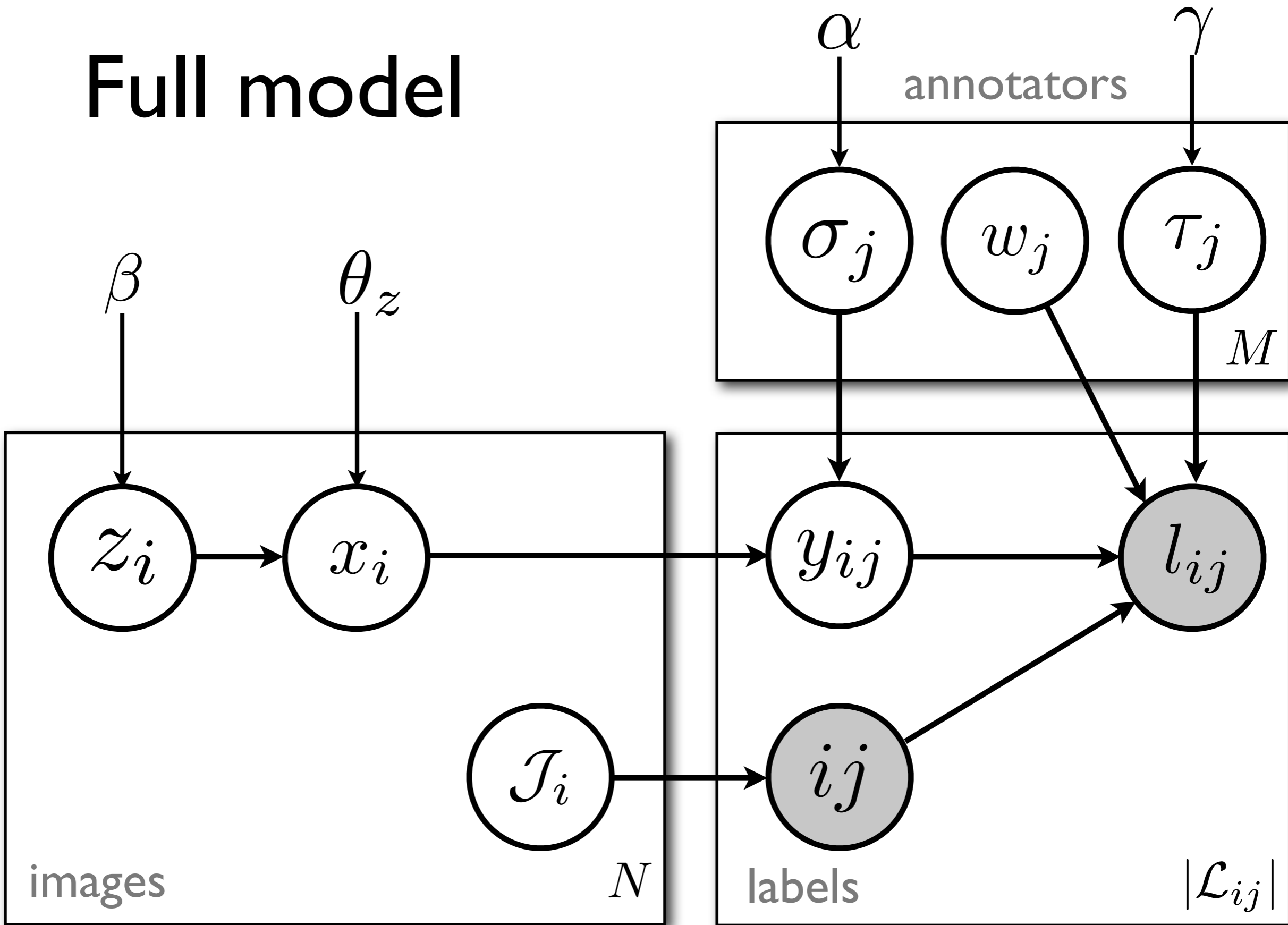
Full model



Full model



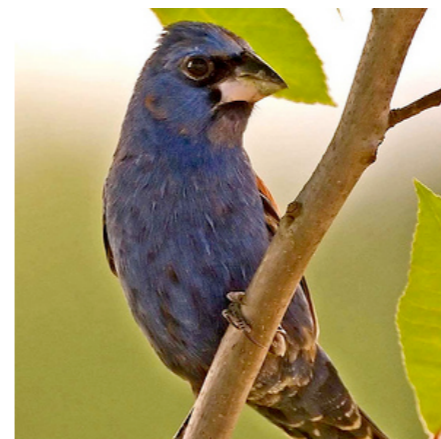
Full model



Experiments: estimating z_i

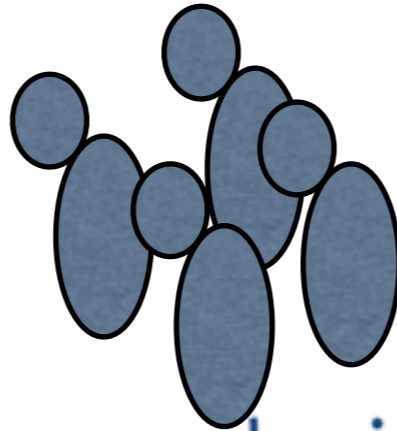
Indigo Bunting

Blue Grosbeak



Experiments: estimating z_i

Annotators



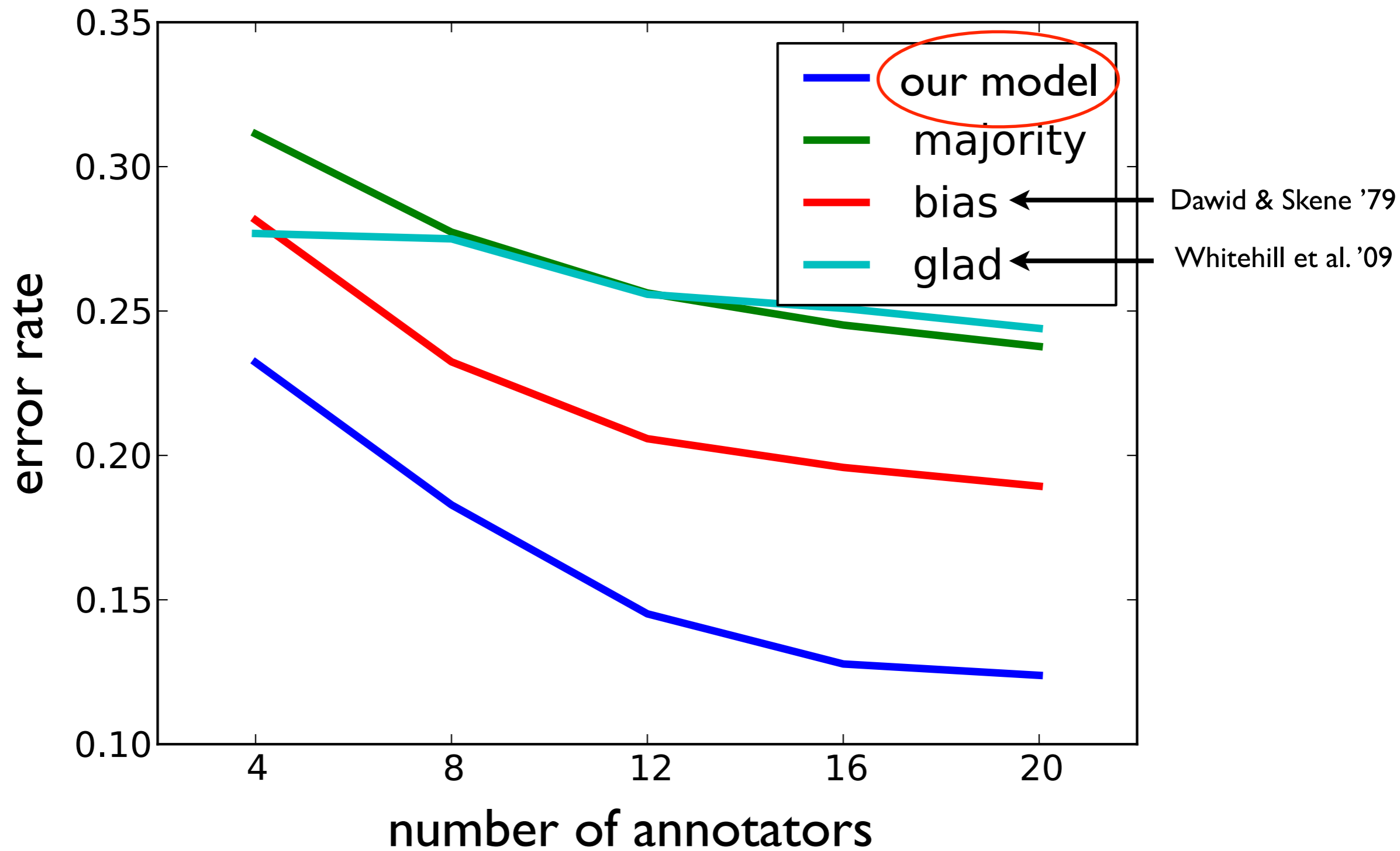
amazonmechanical turk
beta Artificial Intelligence



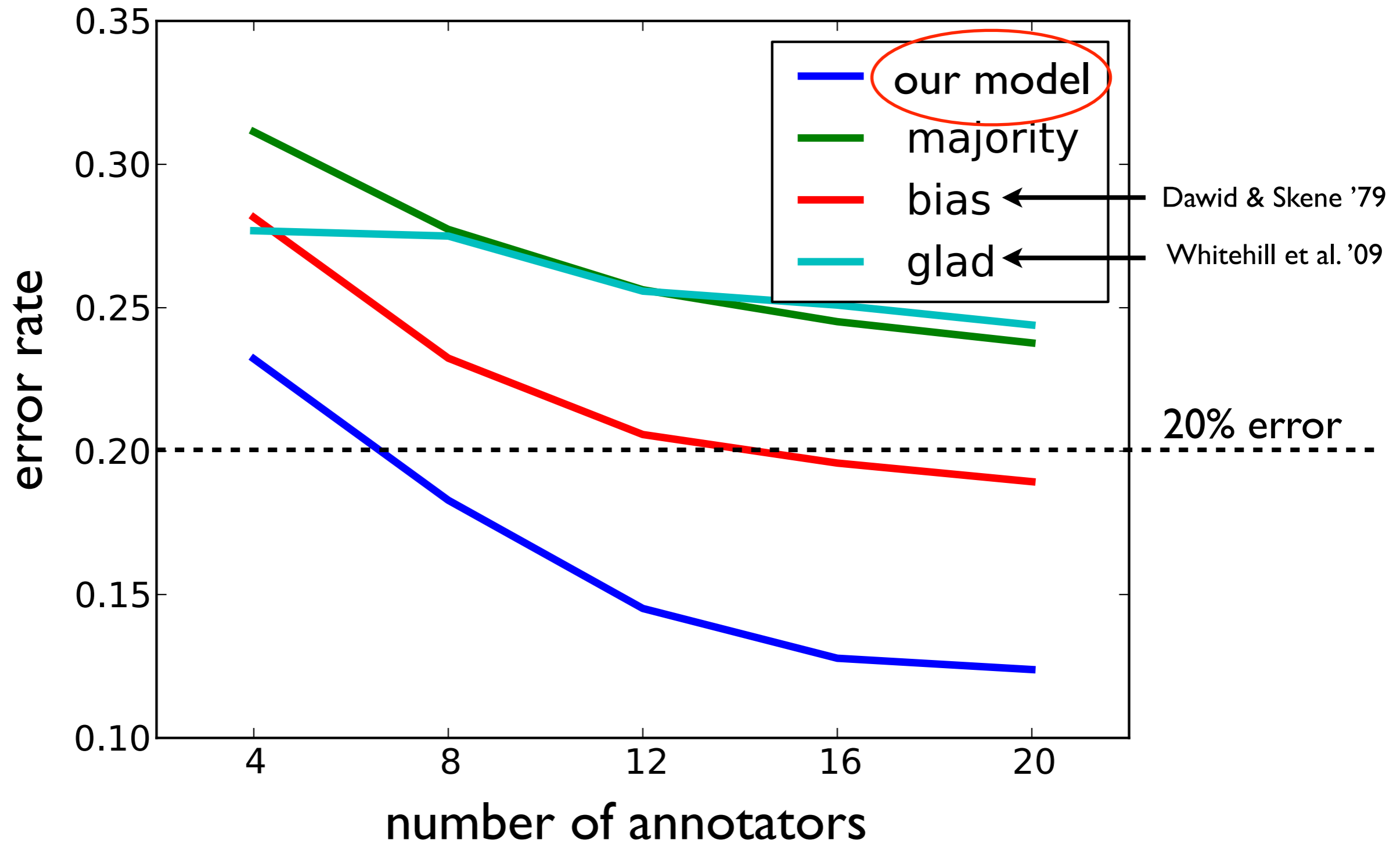
Many binary labels

Model + Inference

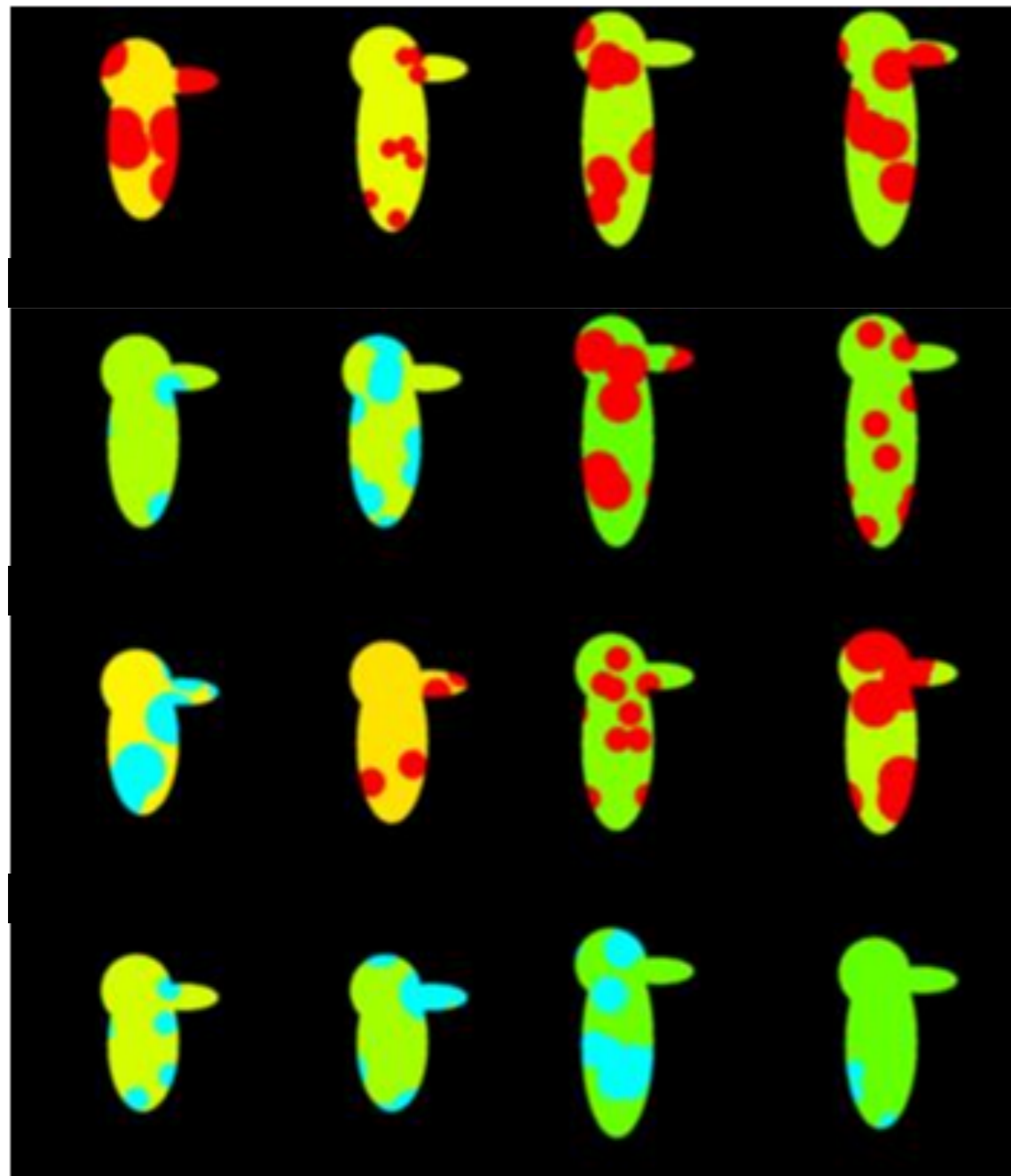
Experiments: estimating z_i



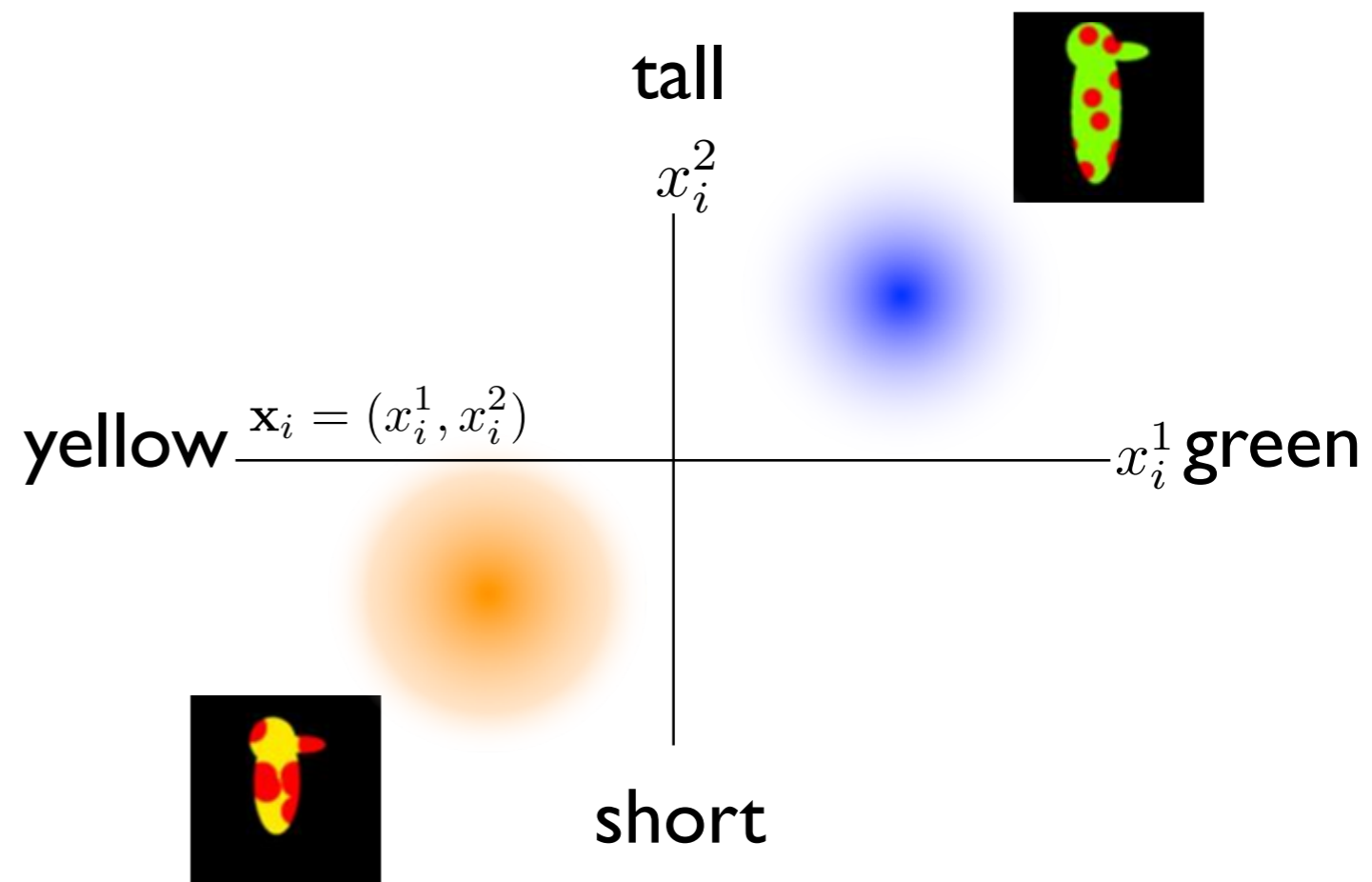
Experiments: estimating z_i



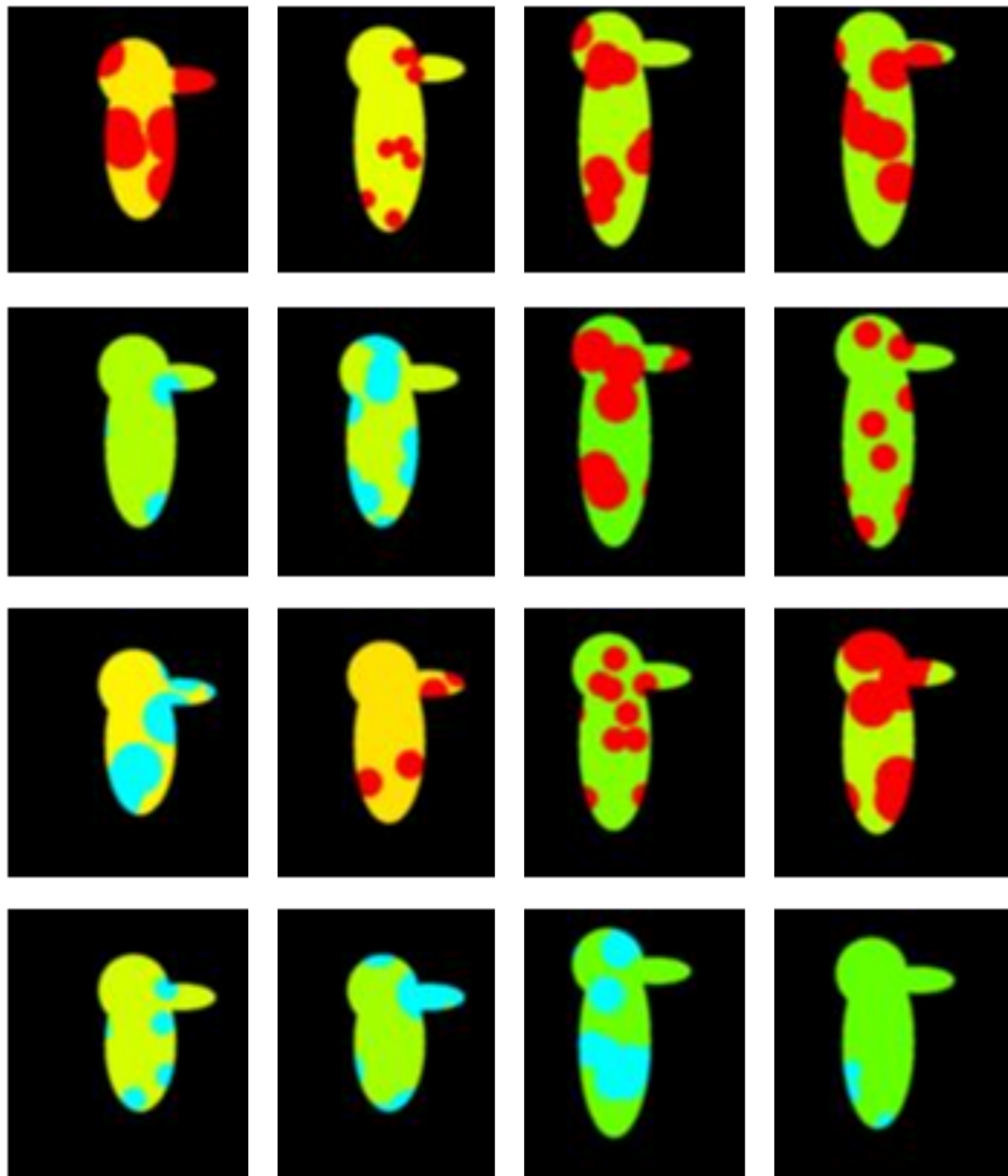
Greebles: estimating multiple attributes



Synthetic figures distinguished by height and color



Greebles: estimating multiple attributes



Send to two groups of annotators

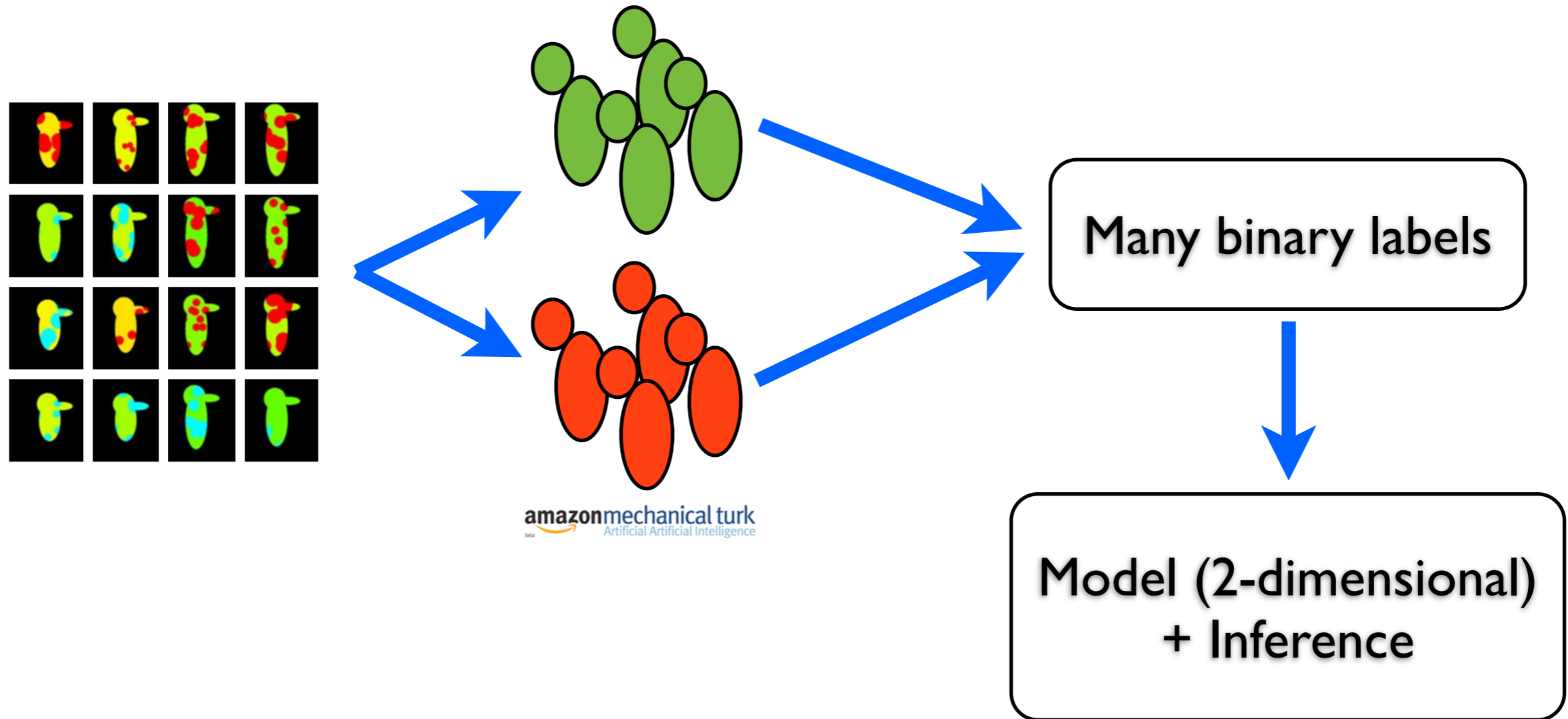


Select green greebles

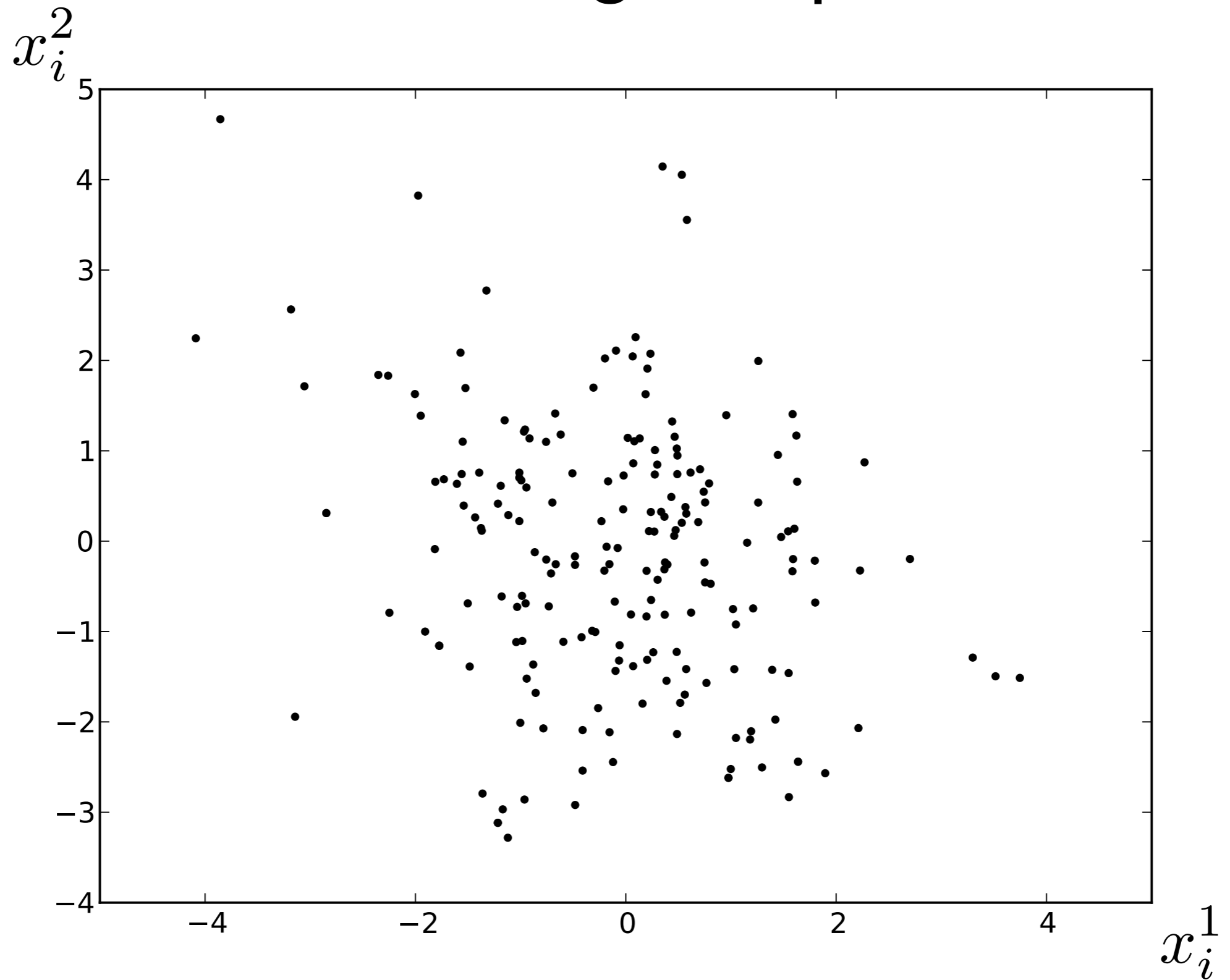


Select tall greebles

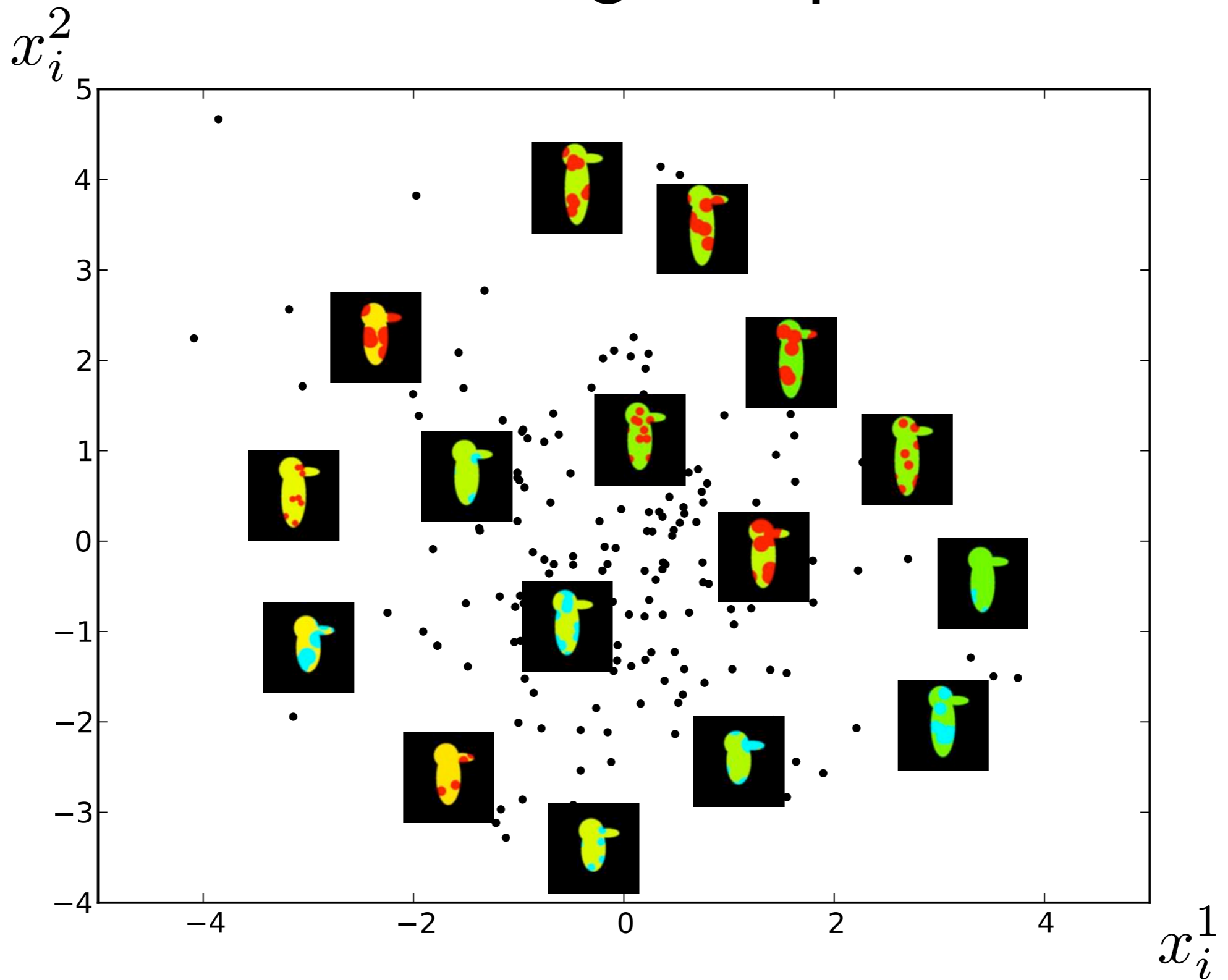
Greebles: estimating multiple attributes



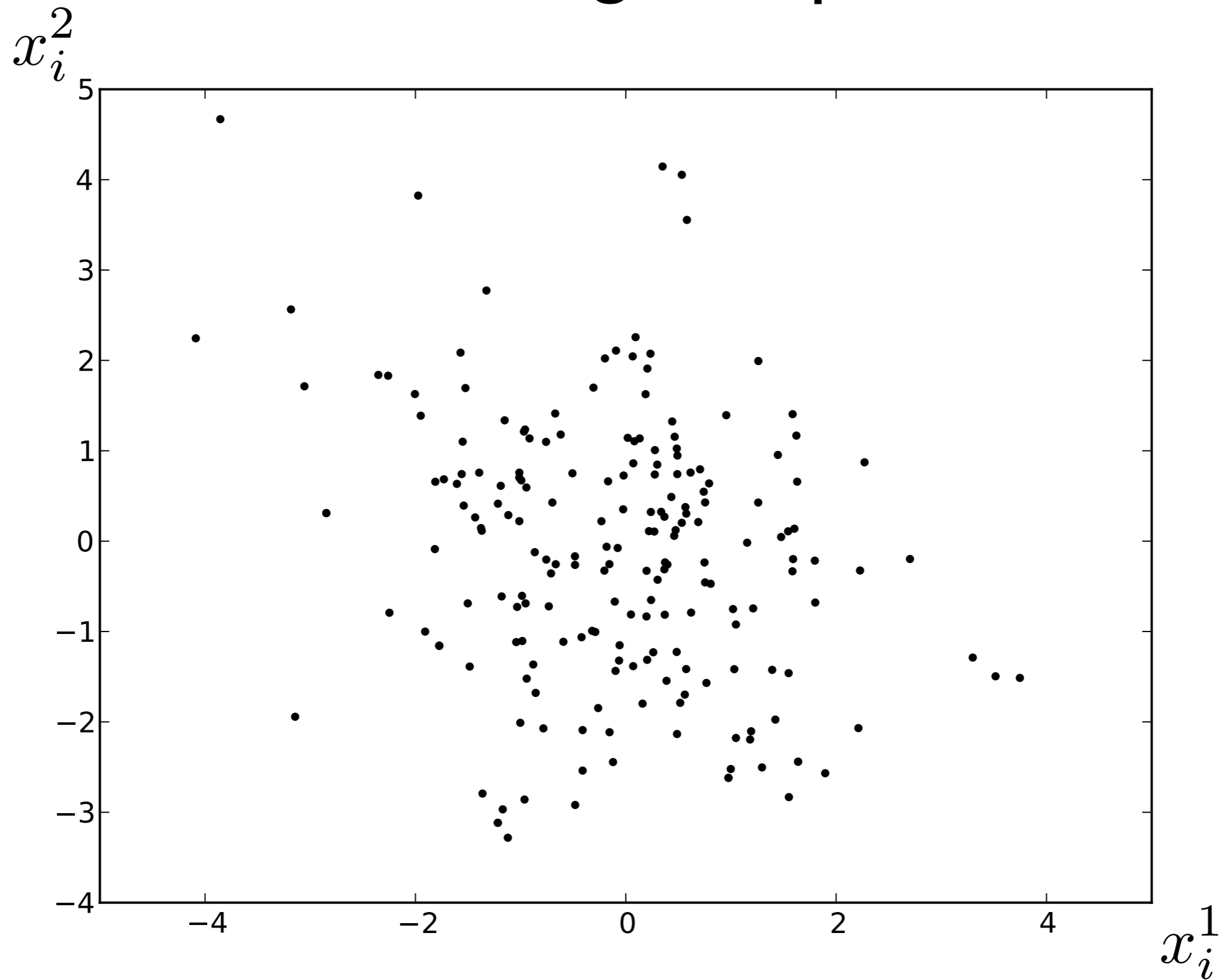
Greebles: estimating multiple attributes



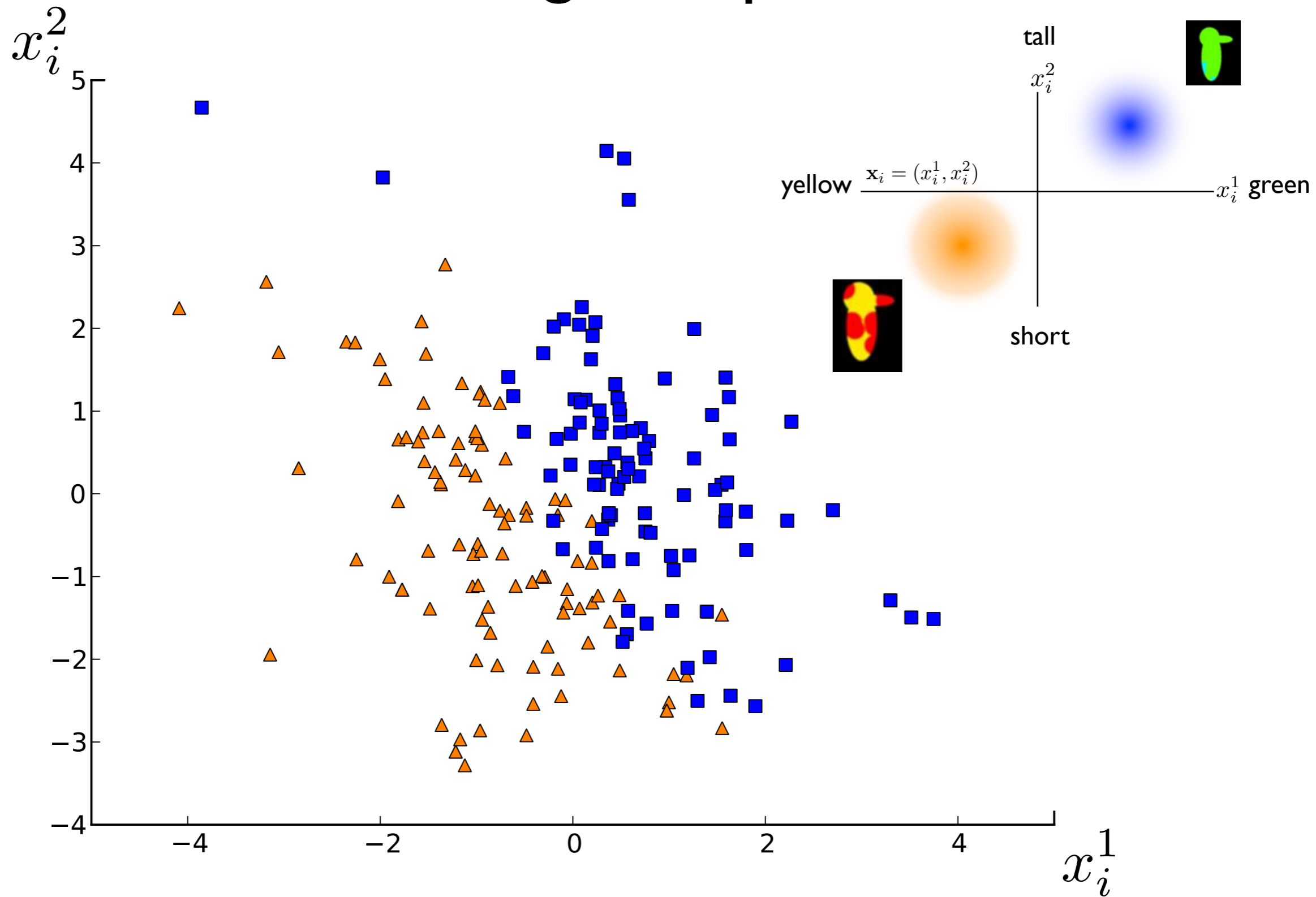
Greebles: estimating multiple attributes



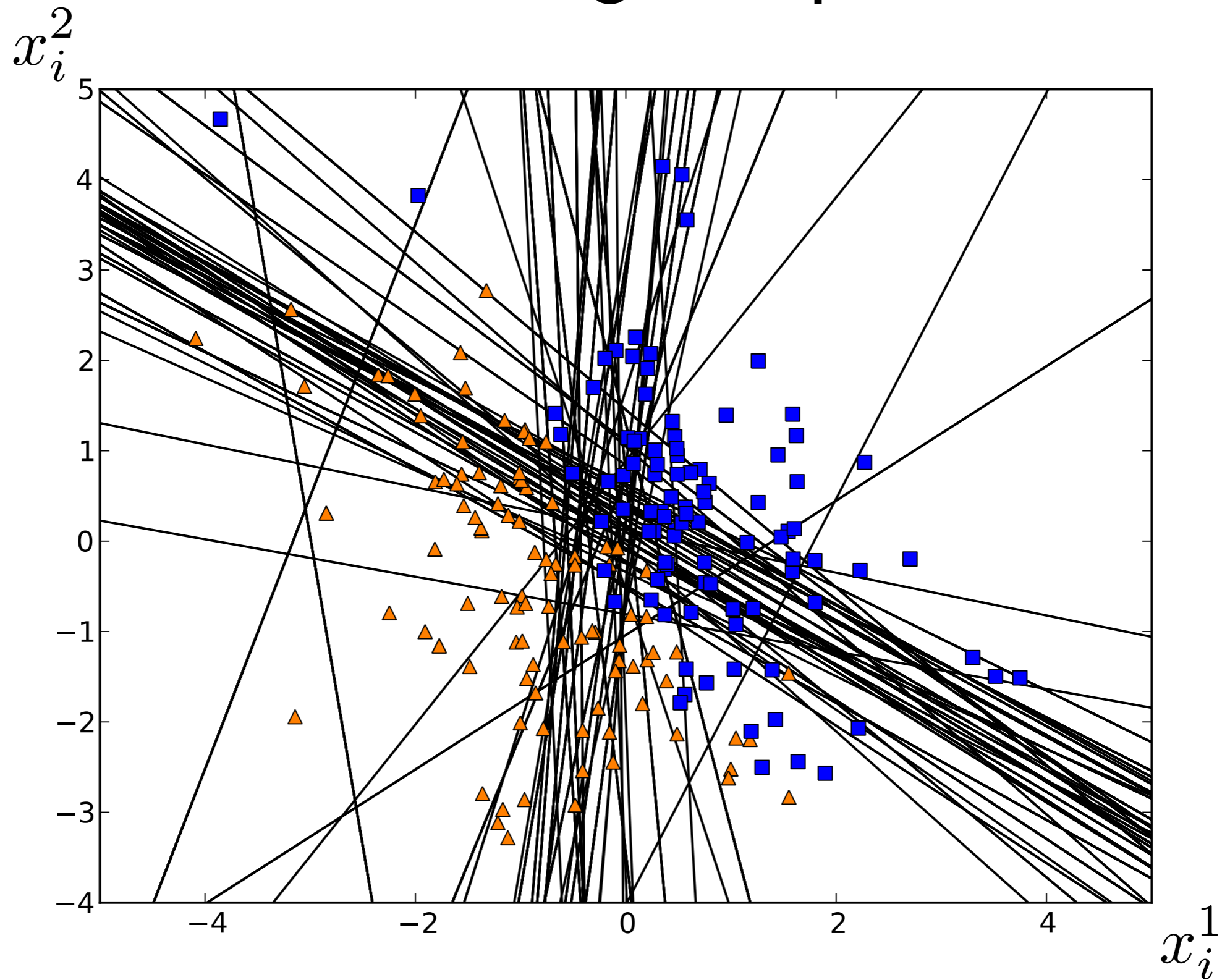
Greebles: estimating multiple attributes



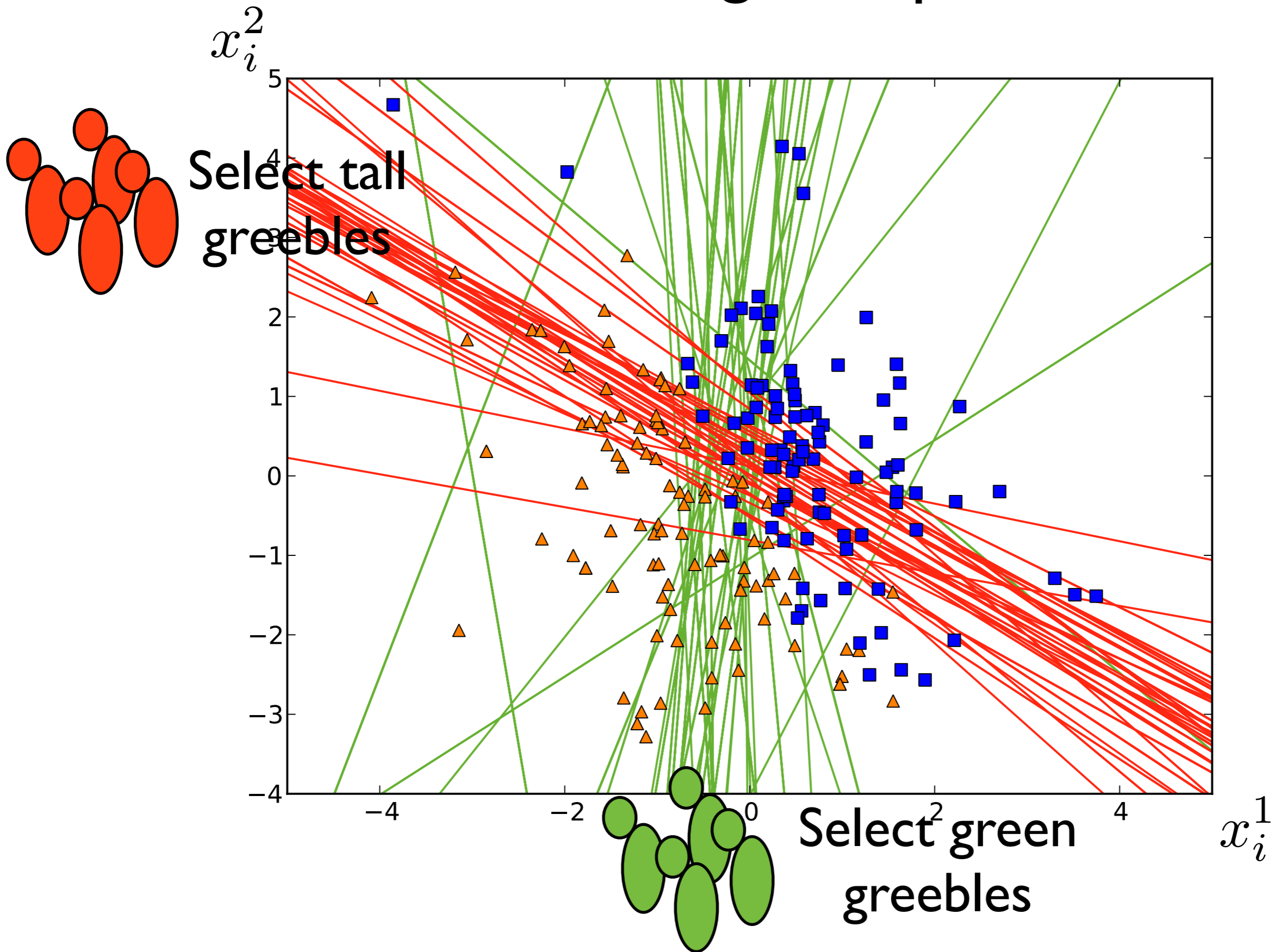
Greebles: estimating multiple attributes



Greebles: estimating multiple attributes



Greebles: estimating multiple attributes



Last Experiment: Waterbirds

Mallard



American Black Duck



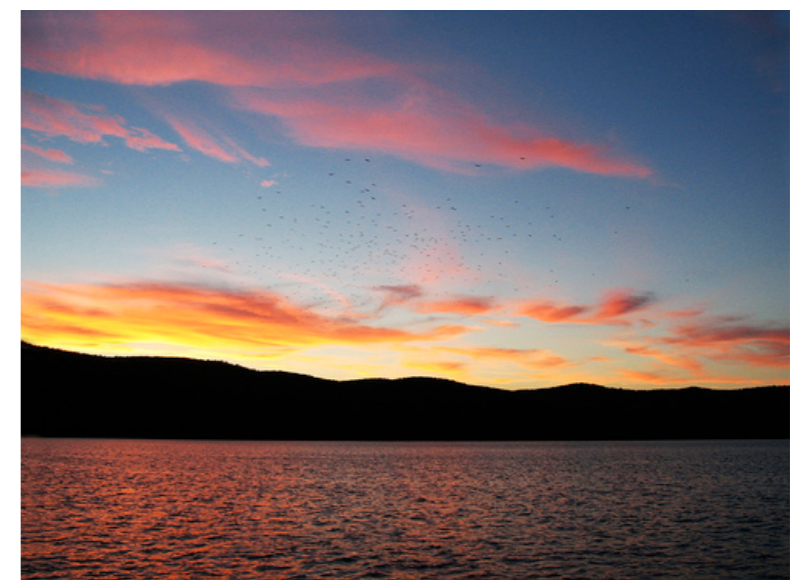
Canada Goose



Red Necked Grebe



Non-bird



DUCKS

Mallard



American Black Duck



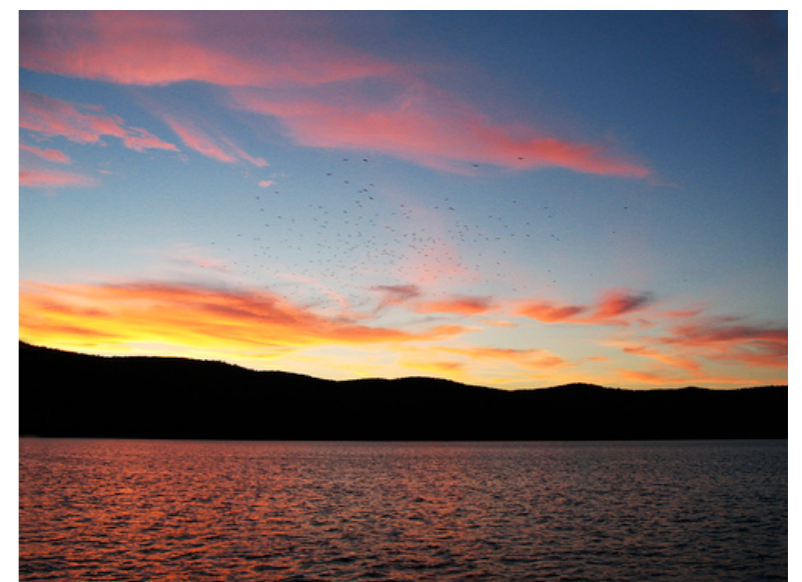
Canada Goose



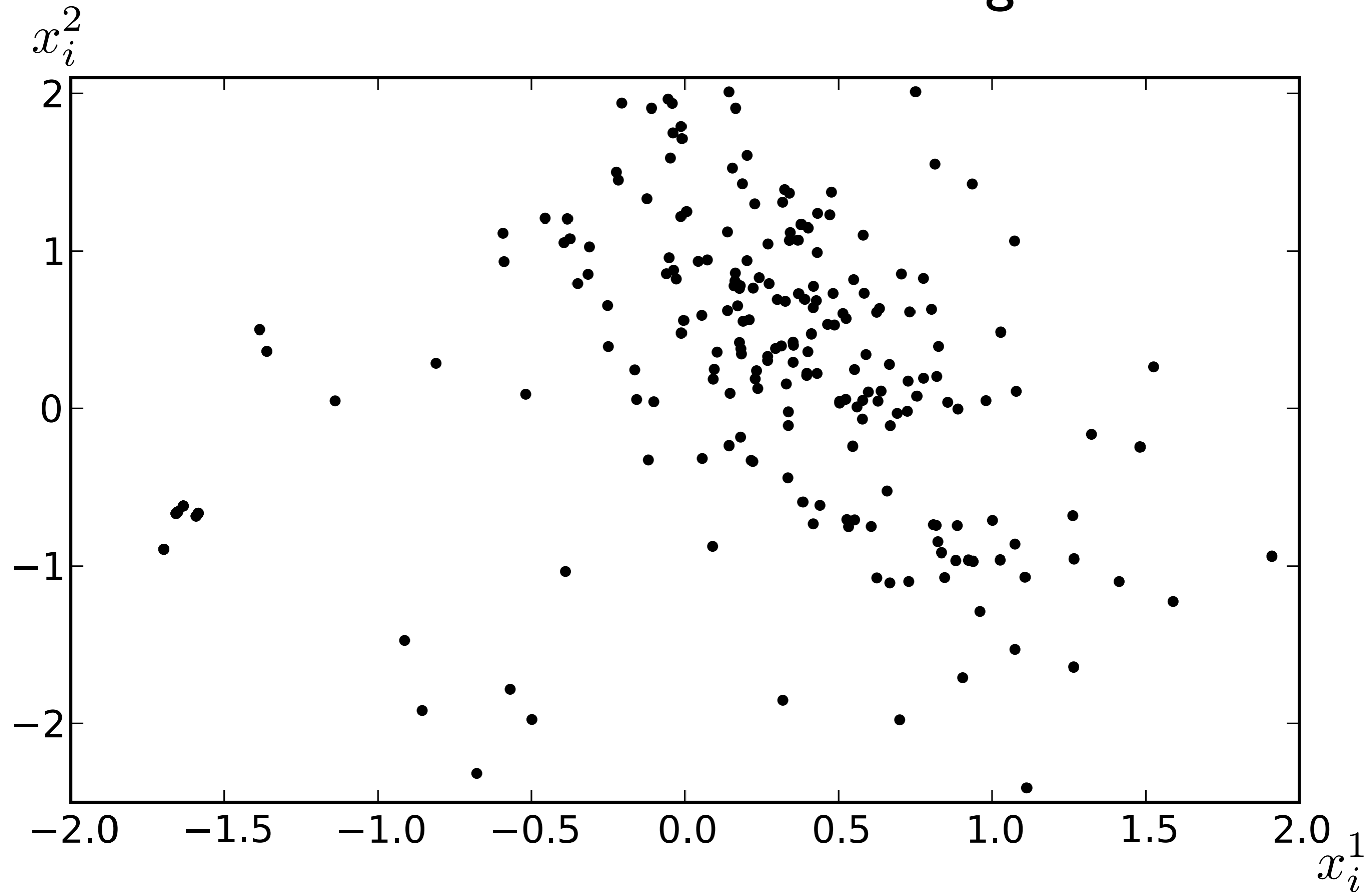
Red Necked Grebe



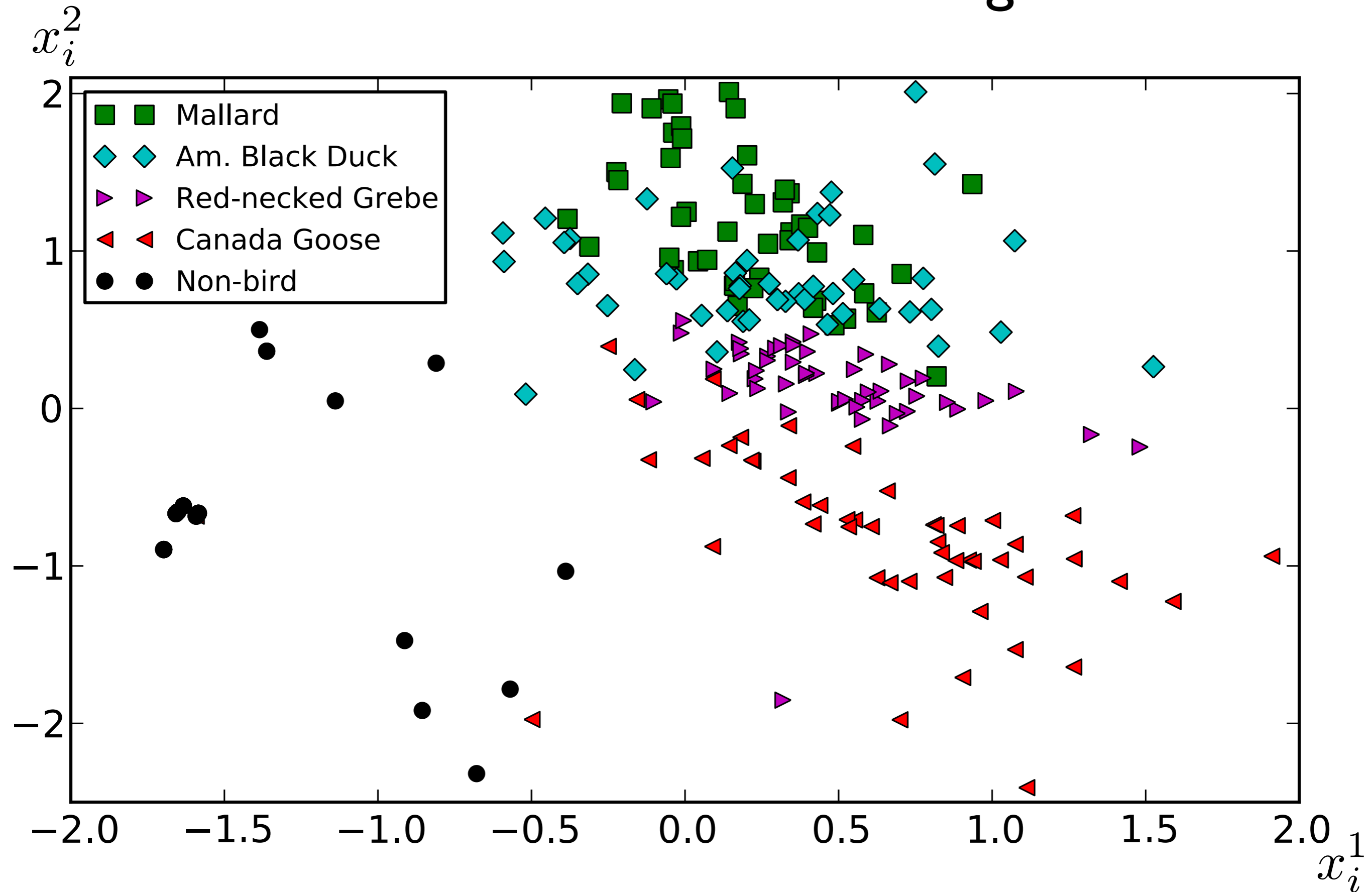
Non-bird



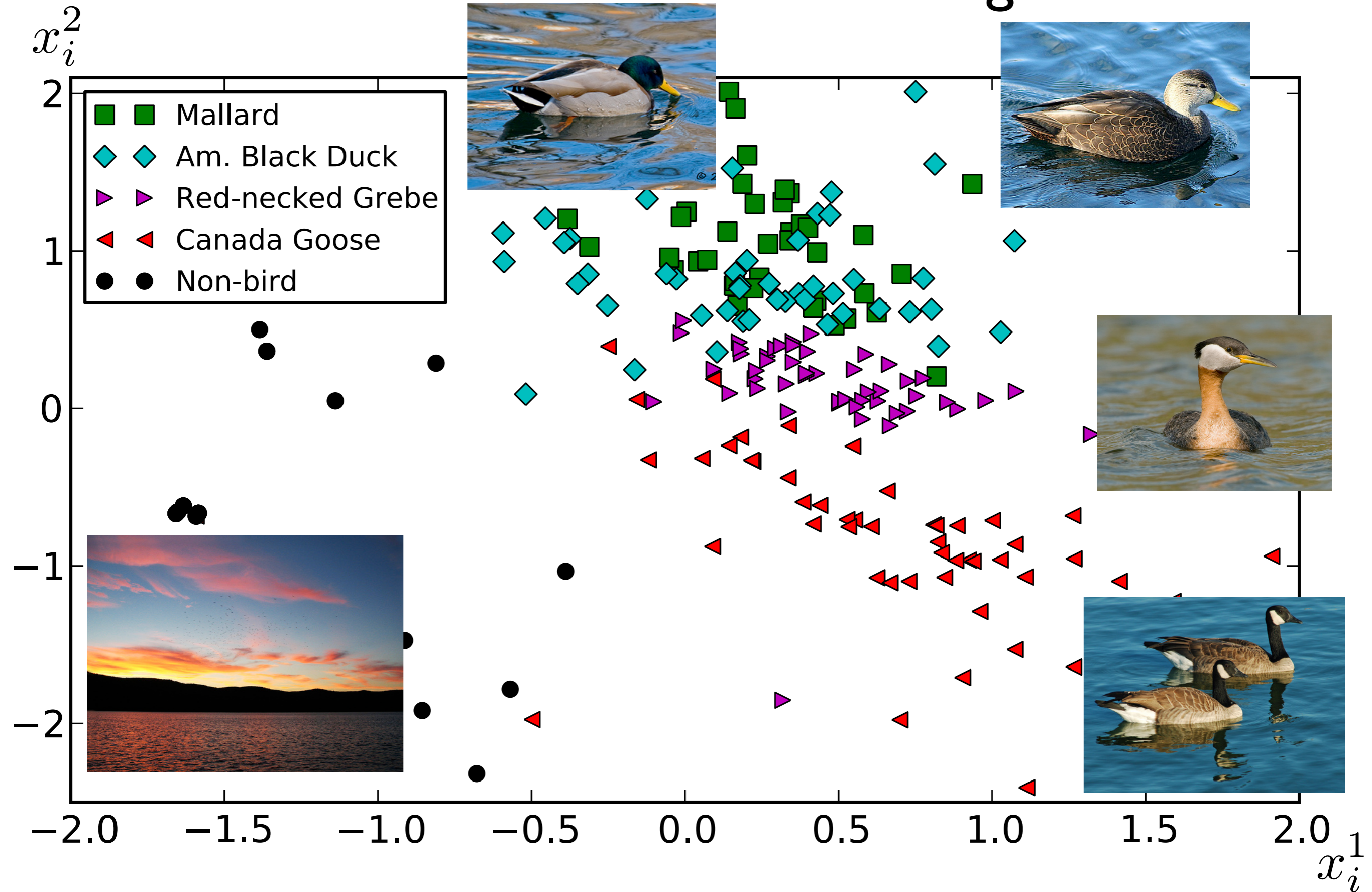
Is there a duck in the image?



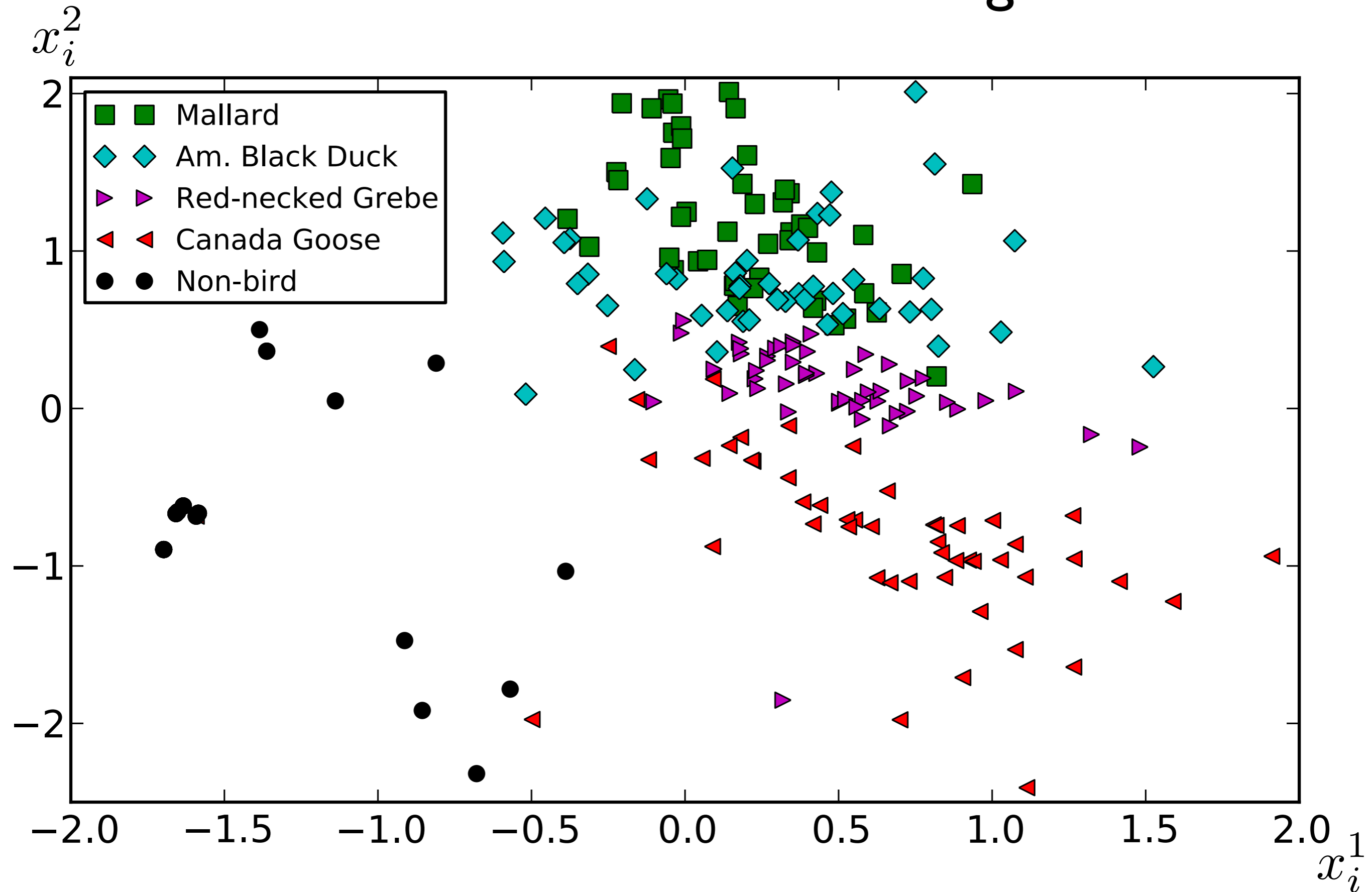
Is there a duck in the image?



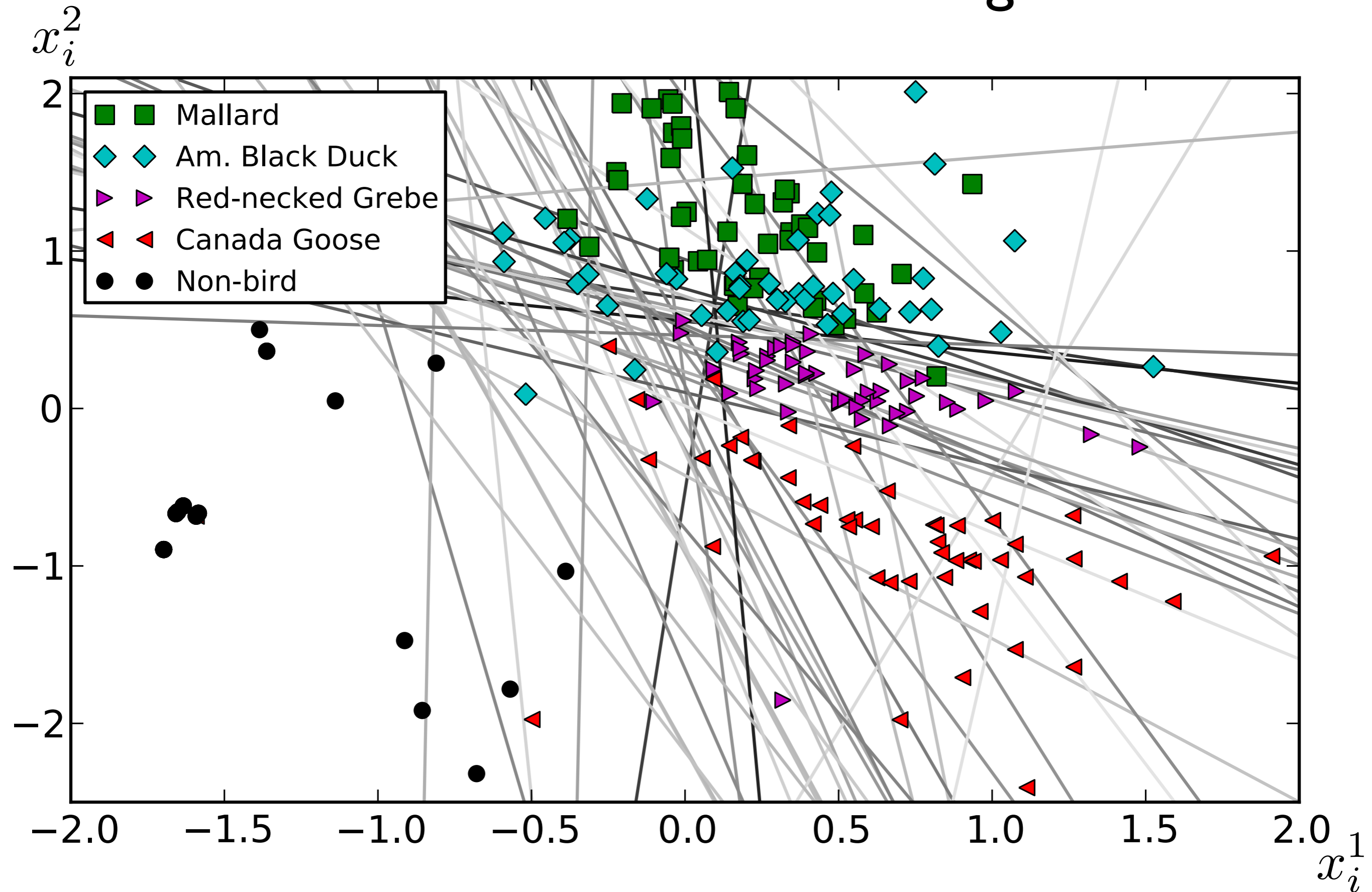
Is there a duck in the image?



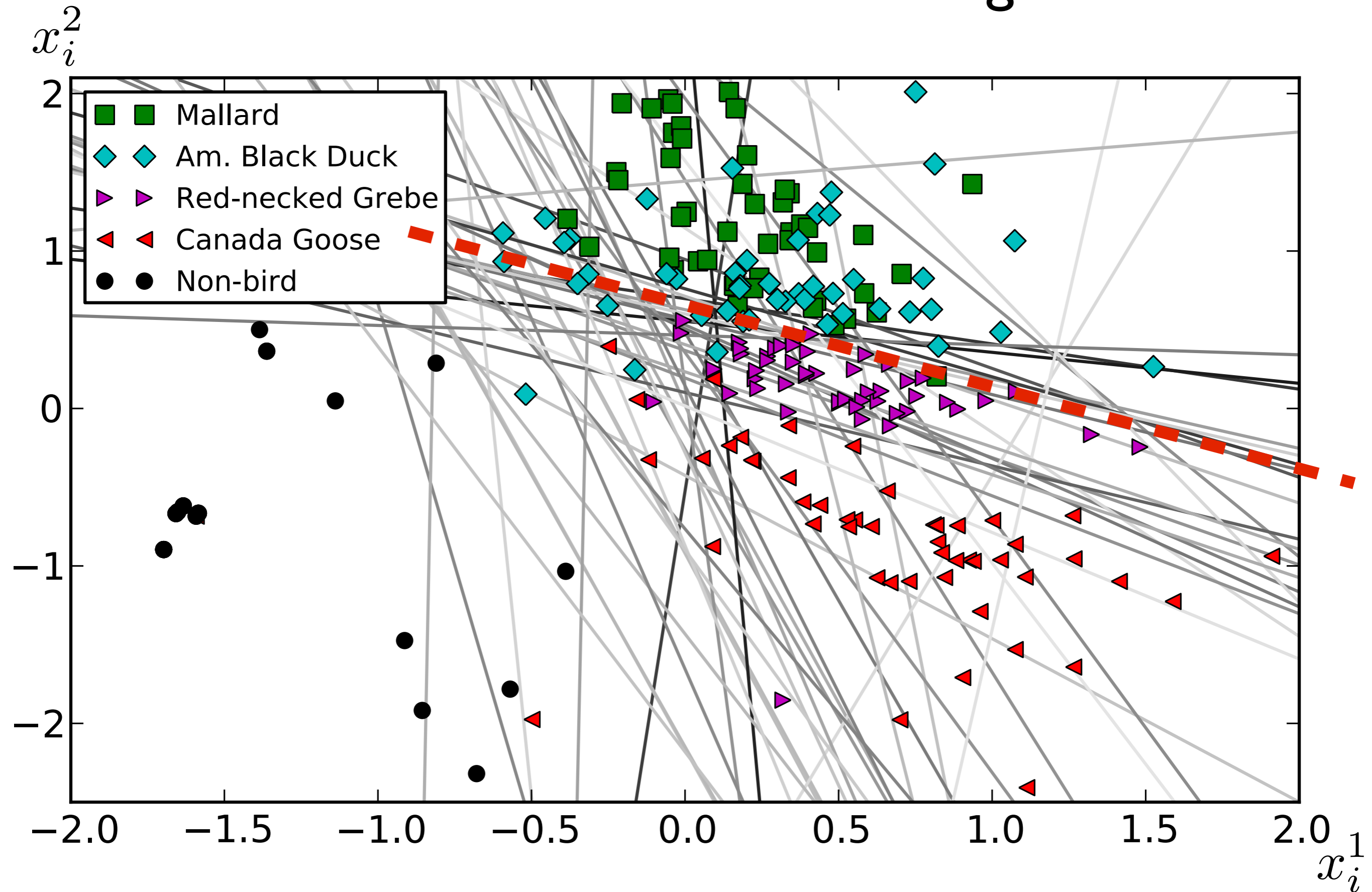
Is there a duck in the image?



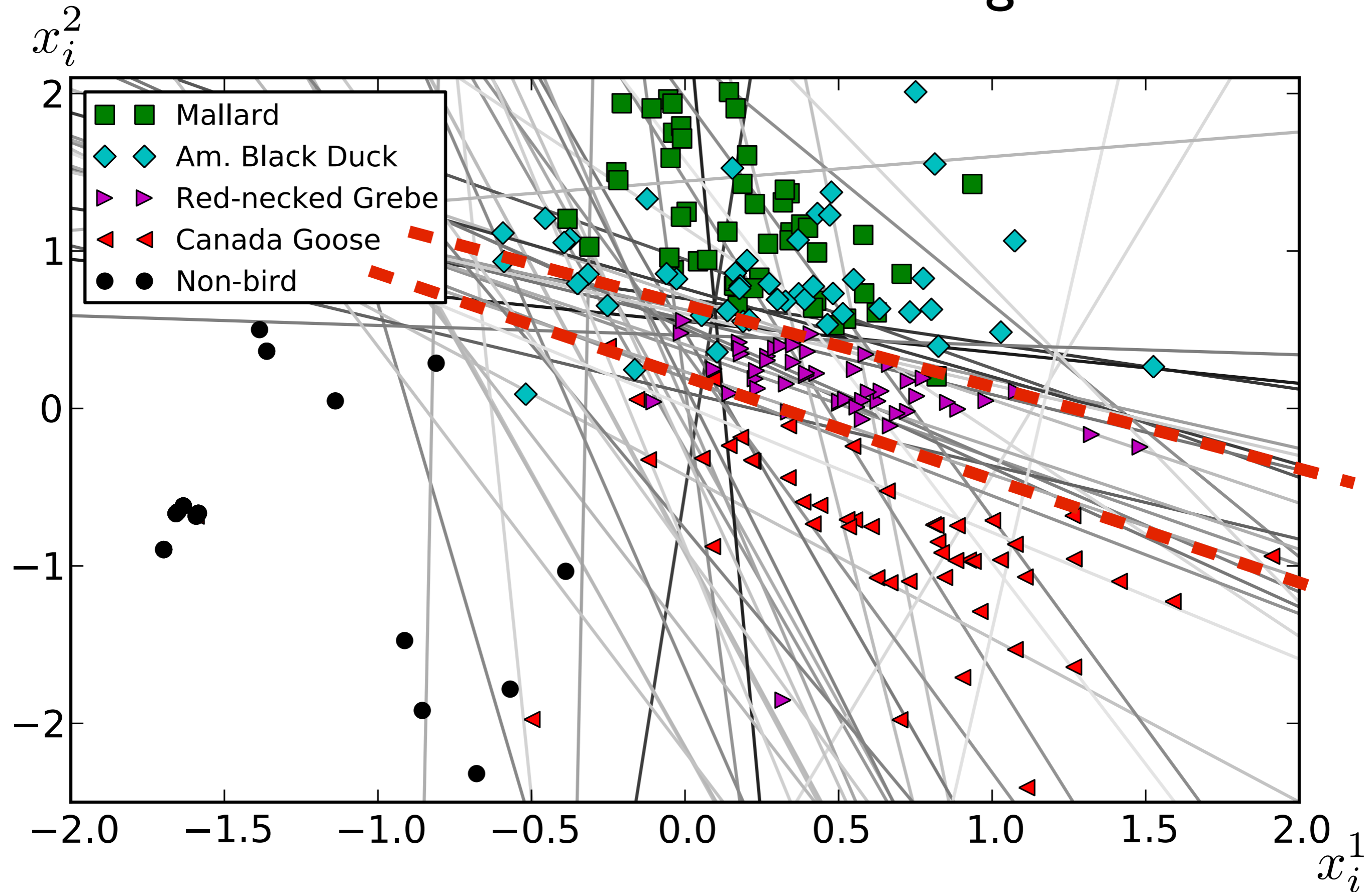
Is there a duck in the image?



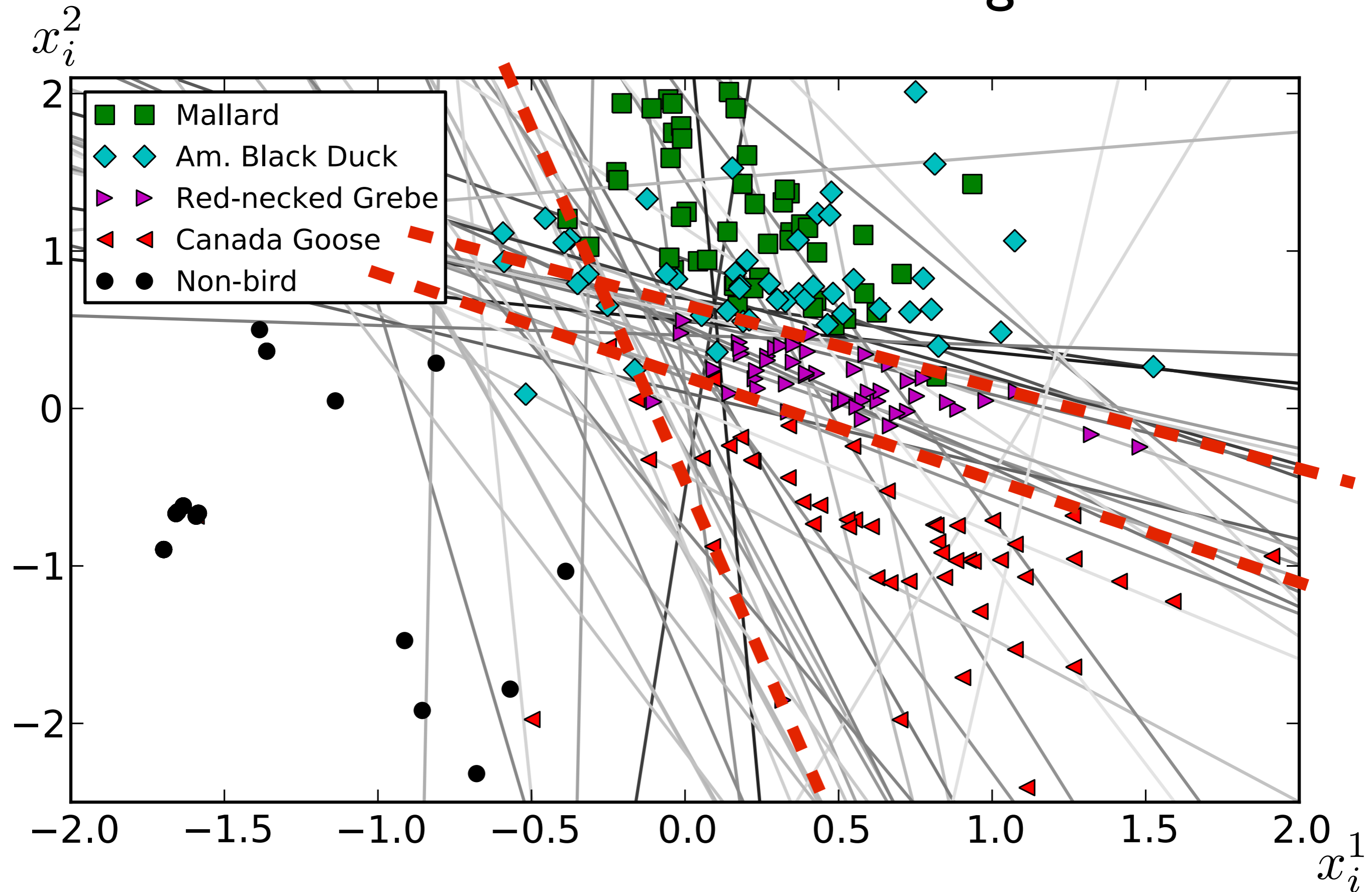
Is there a duck in the image?



Is there a duck in the image?



Is there a duck in the image?



Summary

- Estimate reliable labels
 - Annotator competence and optimism
 - Annotator expertise
 - Image ambiguity/difficulty
-
- Image grouping
 - Schools of thought

thank you

learn more at poster W33