Datamodels

Predicting Predictions with Training Data

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Anatomy of an ML prediction

Input x

Output y

"dog" (85%)

Anatomy of an ML prediction

Training set S

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Anatomy of an ML prediction

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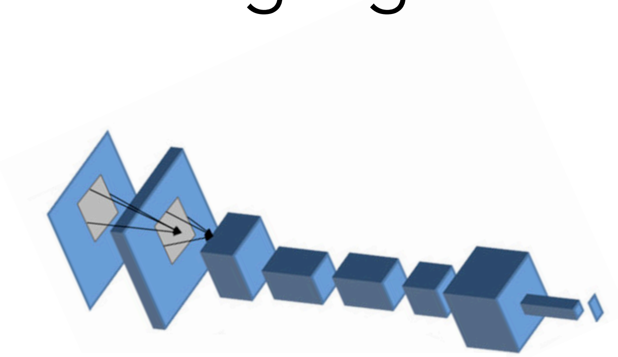
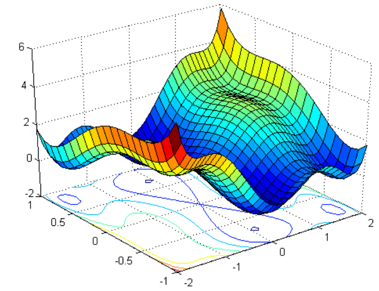
+

Learning algorithm





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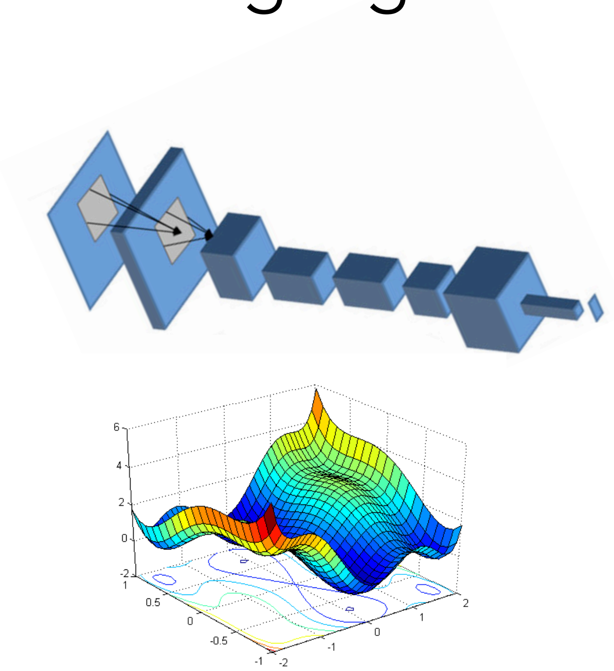

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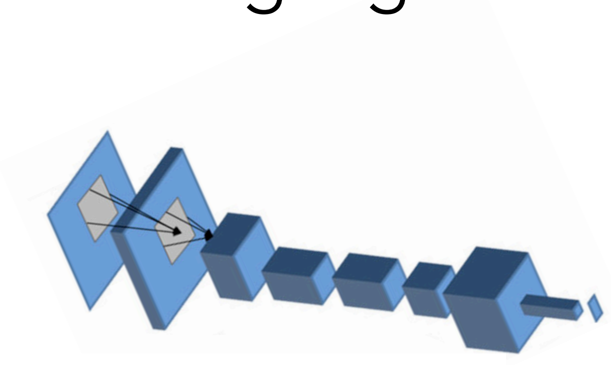

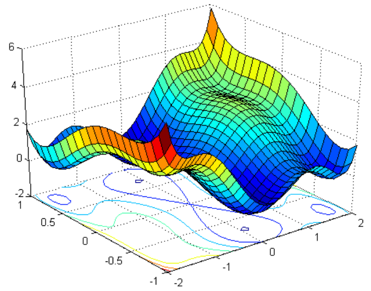

Input x

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Question: How do training data and learning algorithms combine to yield model outputs?

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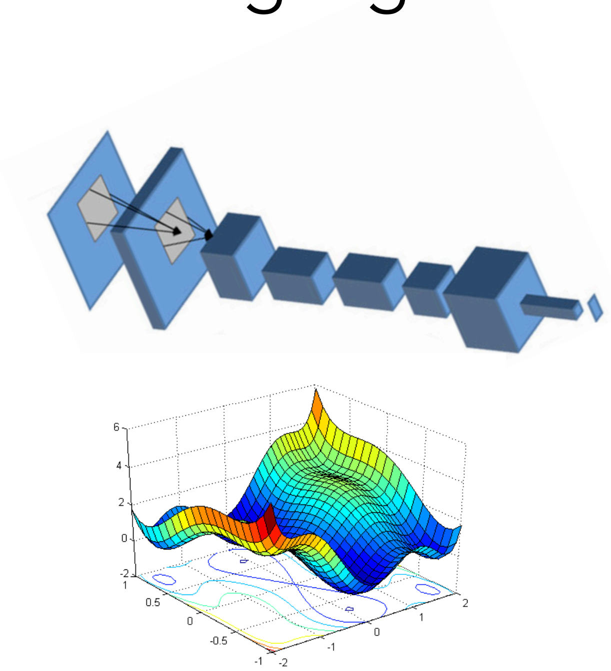

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Question: How do training data and learning algorithms combine to yield model outputs?

We introduce **datamodels** to study this problem

What is a datamodel?

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Model output

$$f(x, S')$$

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Specific example x

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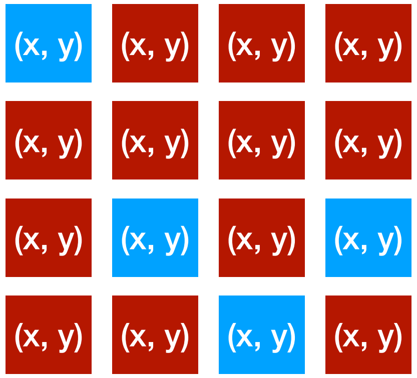

🟦 (x, y)	🟥 (x, y)	🟥 (x, y)	🟥 (x, y)
🟥 (x, y)	🟥 (x, y)	🟥 (x, y)	🟥 (x, y)
🟥 (x, y)	🟦 (x, y)	🟥 (x, y)	🟦 (x, y)
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Subset S' of the training set S

Specific example x

What is a datamodel?

Loss of interest on x
(think: margin of correct class)
after training on S'

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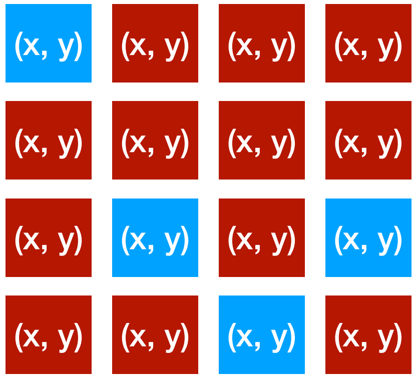
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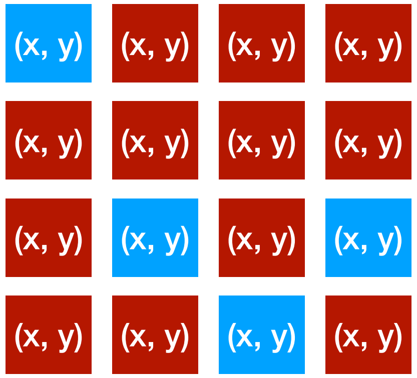

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Problem: Function f is complex and hard to analyze

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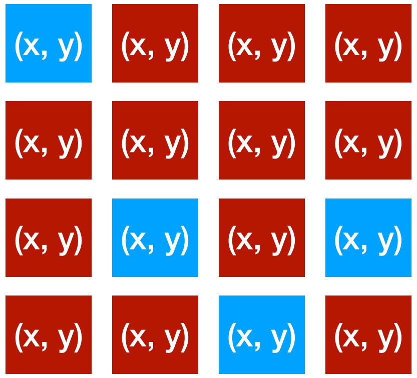
$$f(x, S') \approx \hat{f}(x, S')$$



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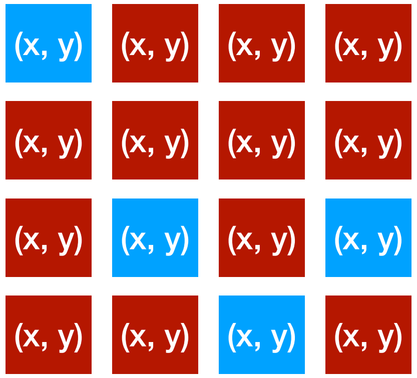

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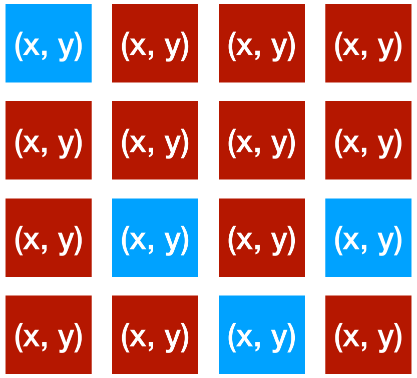

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Indicator vector of S'
[1 0 0 0 0 0 1 0 0 1 0 1 0 0 1 0]

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Learned vector (one weight
per training example in S)

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Datamodels successfully predict the outcome of training on subsets of the training set!

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(Open Q: why?)

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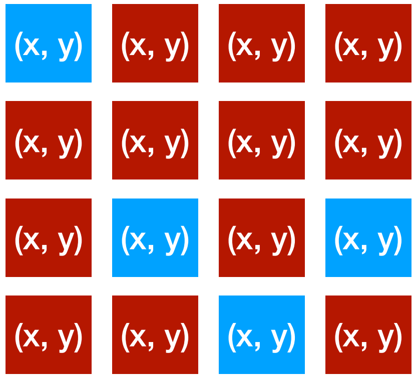

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“boat”

(71% confidence)

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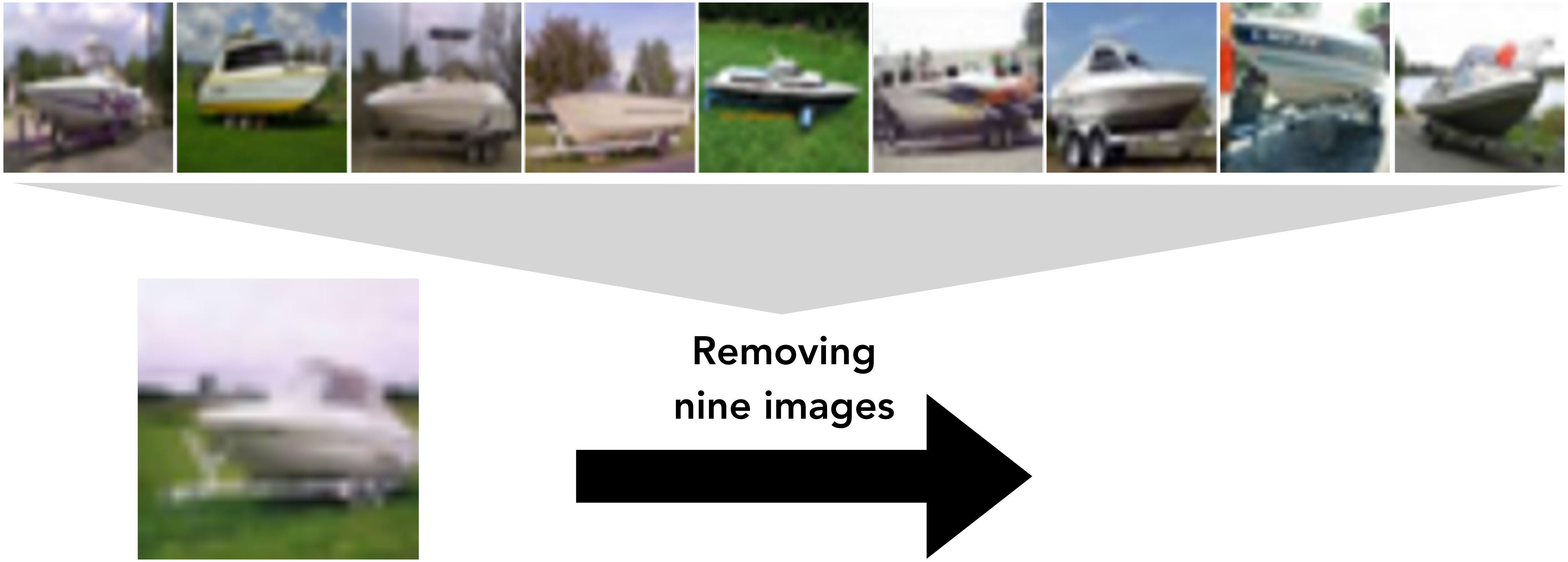

Removing nine images

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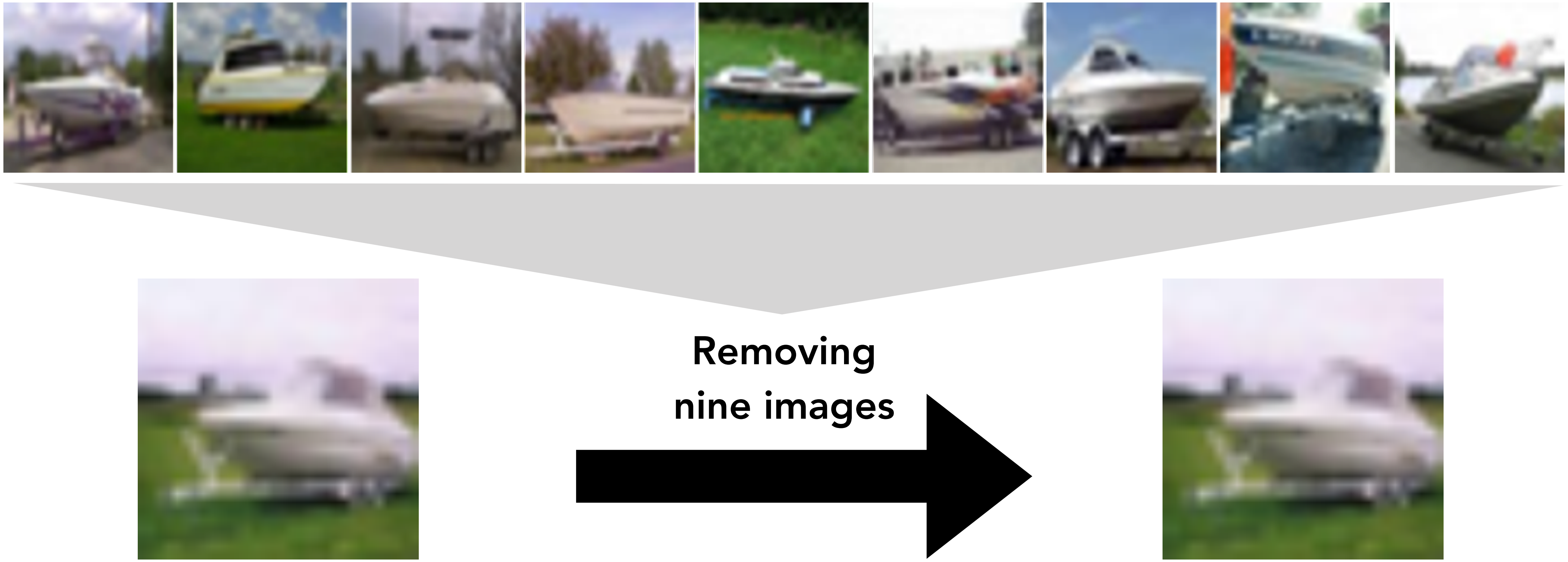

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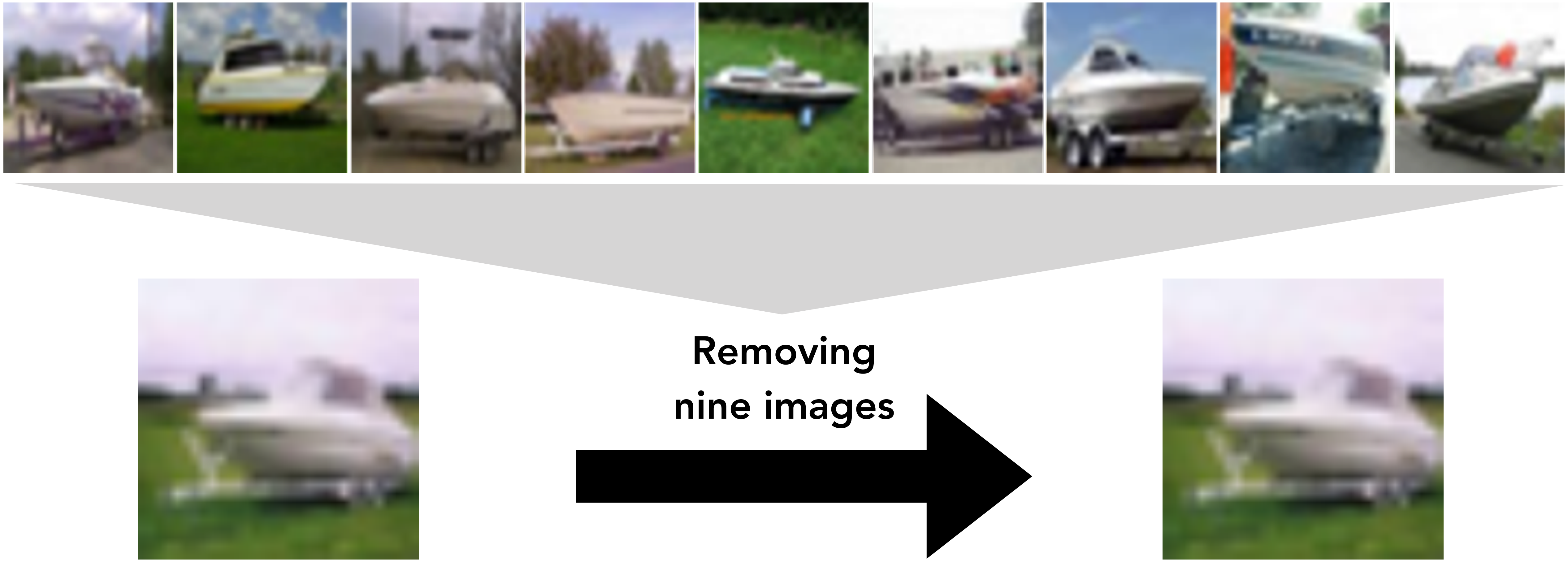

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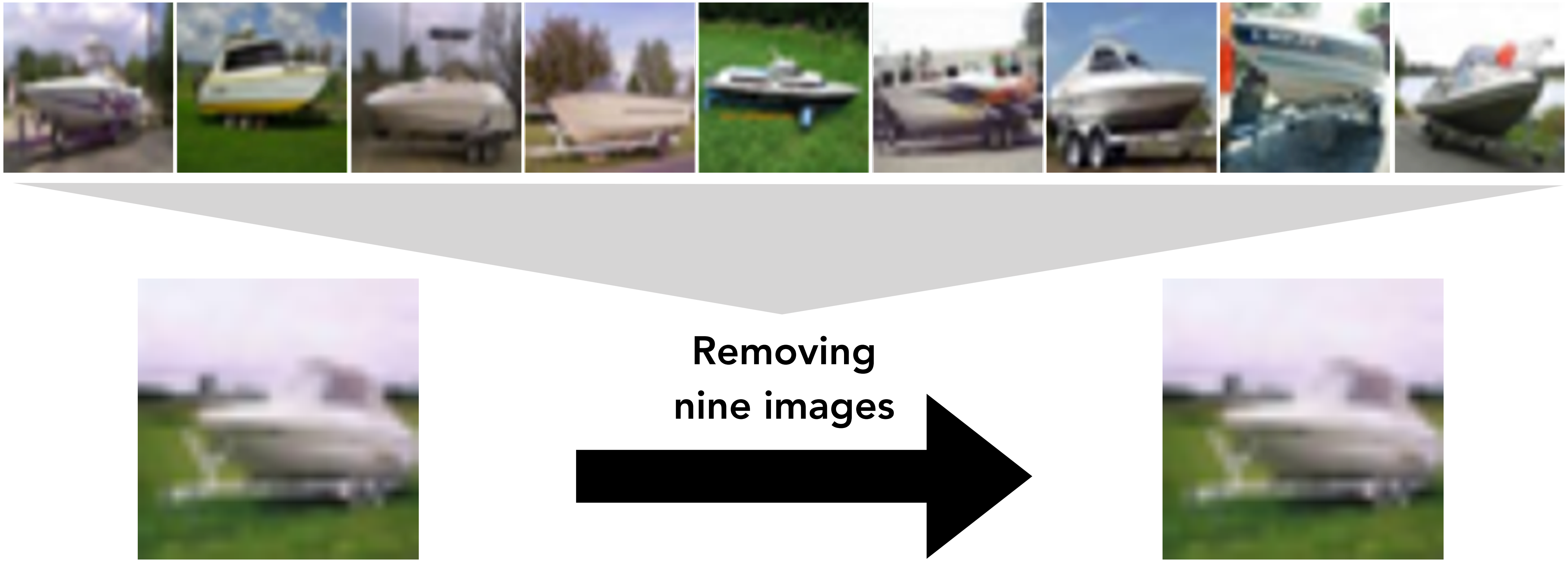

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Can use datamodels to **efficiently** find brittle predictions

Turns out: ~25% of test examples can be misclassified by removing **< 0.2%** of training examples

Takeaways

Datamodels:

A framework for understanding both data and predictions

→ Learn simple data-to-output mapping

→ A versatile tool for model-data understanding

  → Analyzing model brittleness

  → (Many) more applications

See paper for (much) more! https://arxiv.org/abs/2202.00622

Blog posts at:

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