The blue and green colors are actually the same

http://blogs.discovermagazine.com/badastronomy/2009/06/24/the-blue-and-the-green/

Machine Learning: Overview

Computer Vision

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Photo: CMU Machine Learning
Department protests G20

Slides: Isabelle Guyon,
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Mark Johnson,
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Machine learning: Overview

- Core of ML: Making predictions or decisions from Data.

- This overview will not go in to depth about the statistical underpinnings of learning methods. We're looking at ML as a tool. Take *CSCI 1950-F: Introduction to Machine Learning* to learn more about ML.

Impact of Machine Learning

- Machine Learning is arguably the greatest export from computing to other scientific fields.
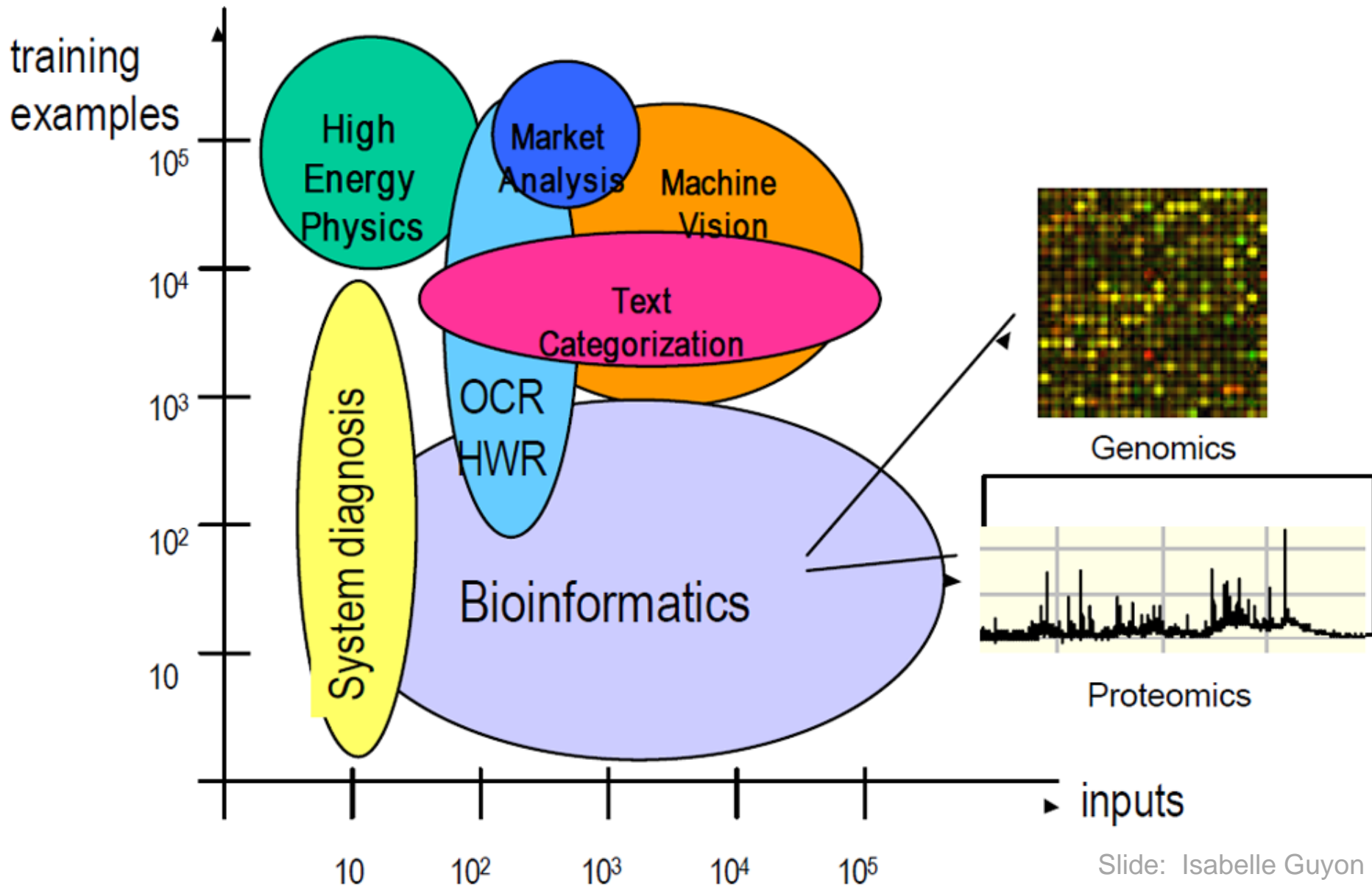
Machine Learning Applications
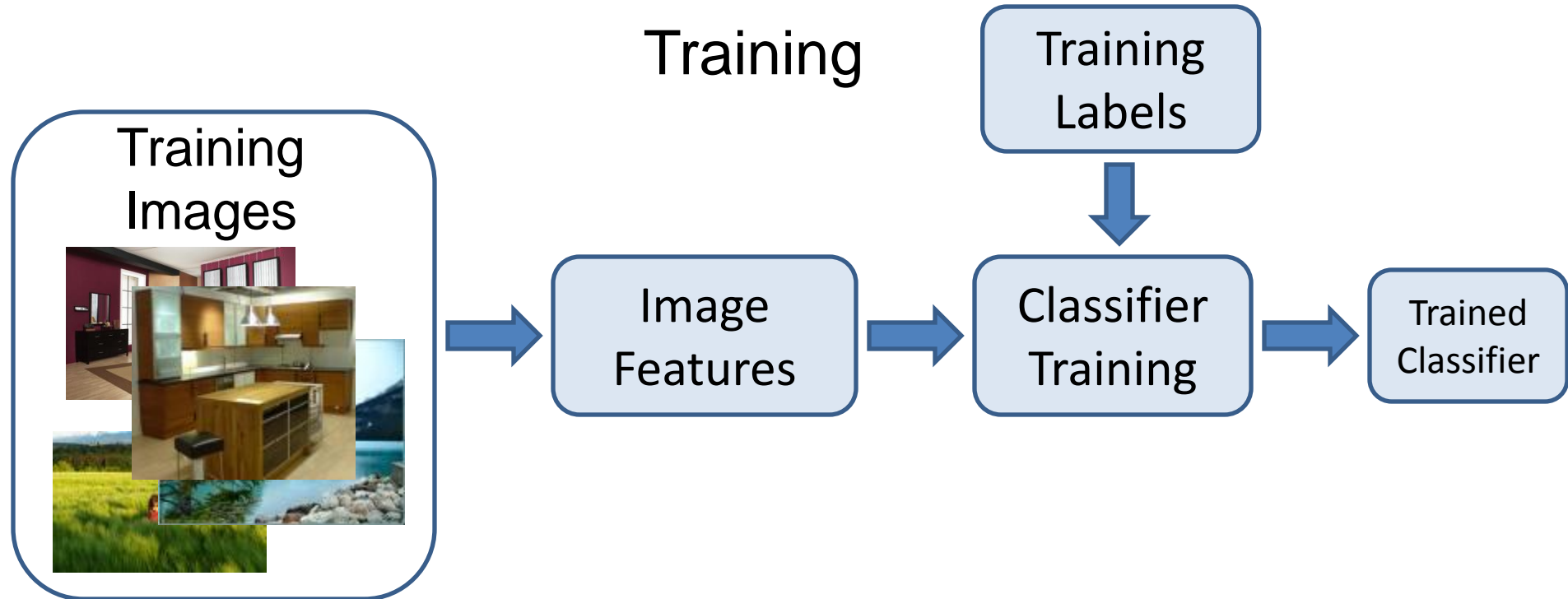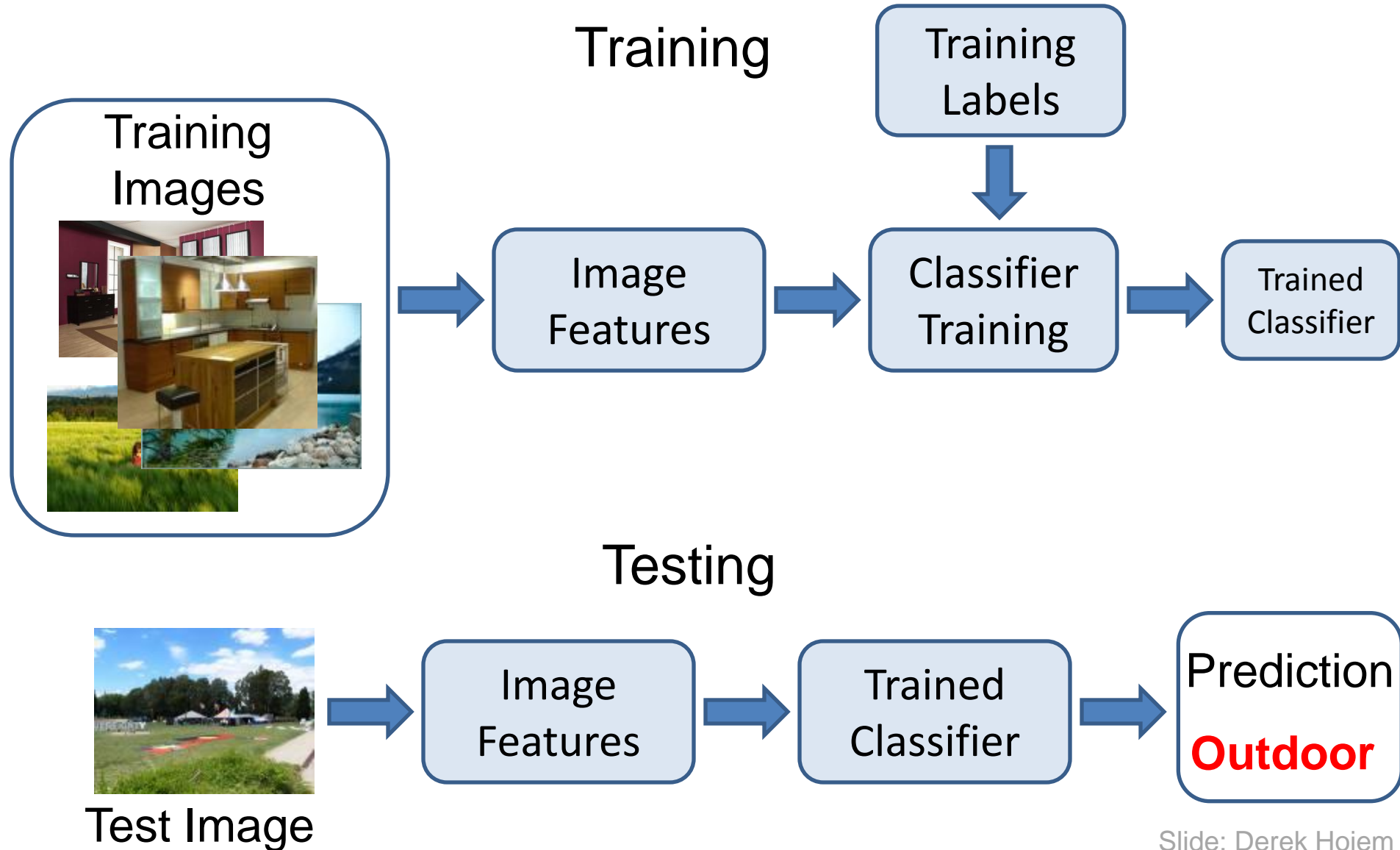
Image Categorization

Training

Image Categorization

Training

Training Images → Image Features → Classifier Training → Trained Classifier

Training Labels → Classifier Training

Testing

Test Image → Image Features → Trained Classifier → Prediction **Outdoor**

Slide: Derek Hoiem

Claim:

The decision to *use* machine learning is more important than the choice of a *particular* learning method.

If you hear somebody talking of a specific learning mechanism, be wary (e.g. YouTube comment "Oooh, we could plug this in to a Neural network and blah blah blah")

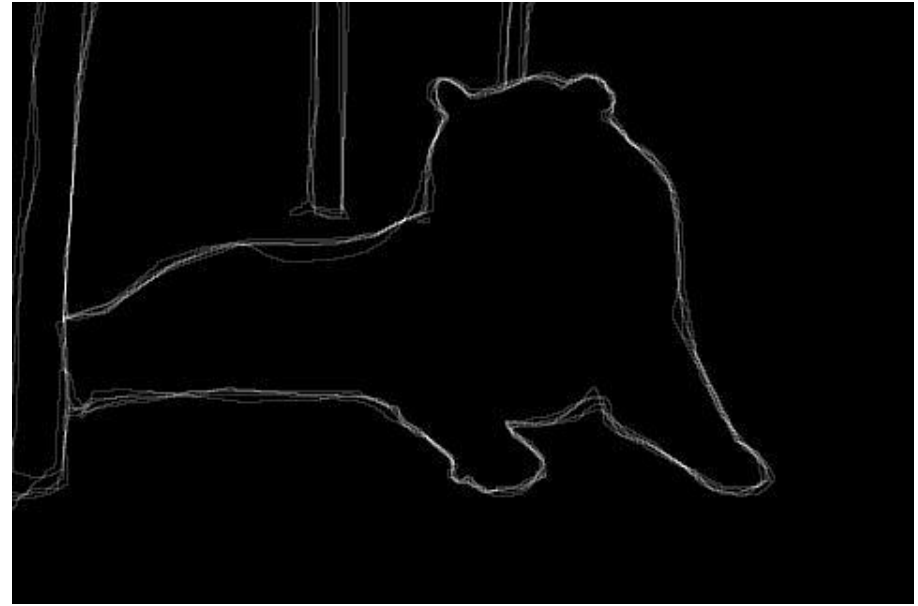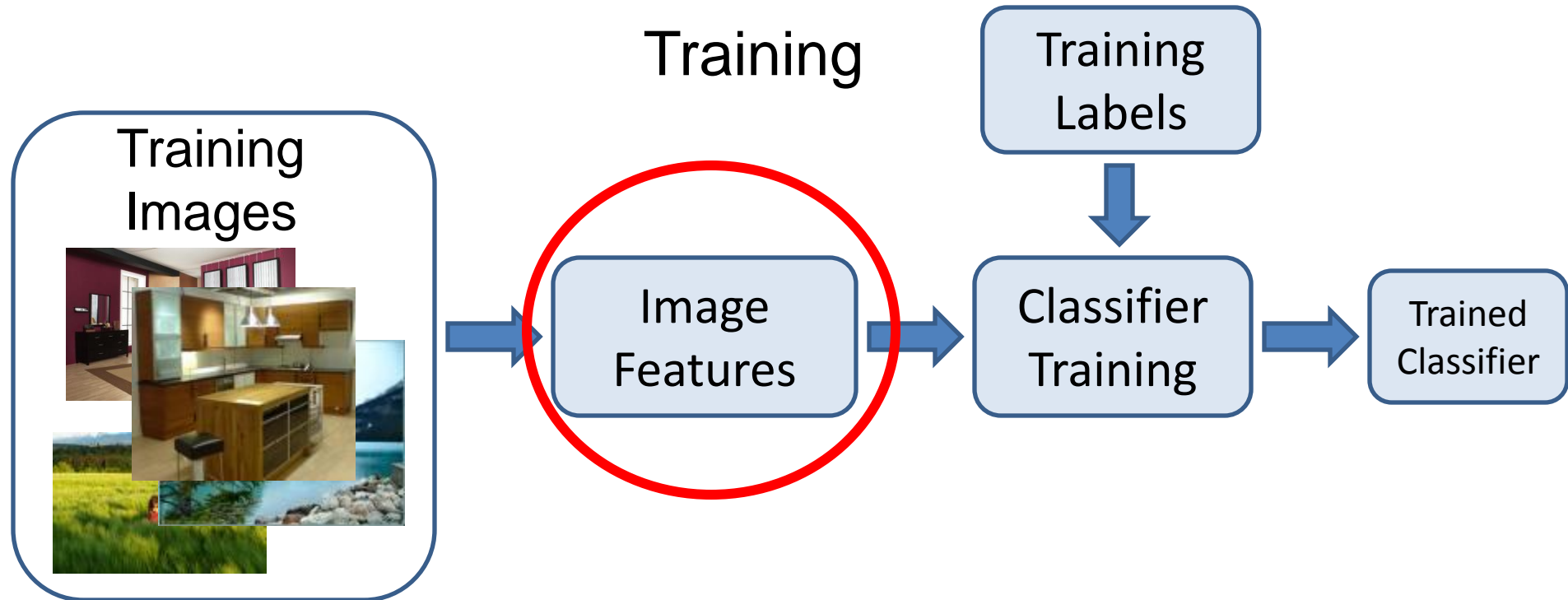# Example: Boundary Detection

- Is this a boundary?

Image features

Training

Slide: Derek Hoiem

General Principles of Representation

- Coverage
  - Ensure that all relevant info is captured

Image Intensity

- Concision
  - Minimize number of features without sacrificing coverage

- Directness
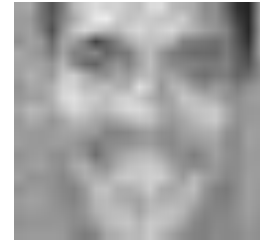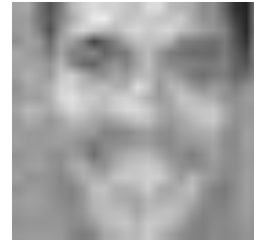 - Ideal features are independently useful for prediction
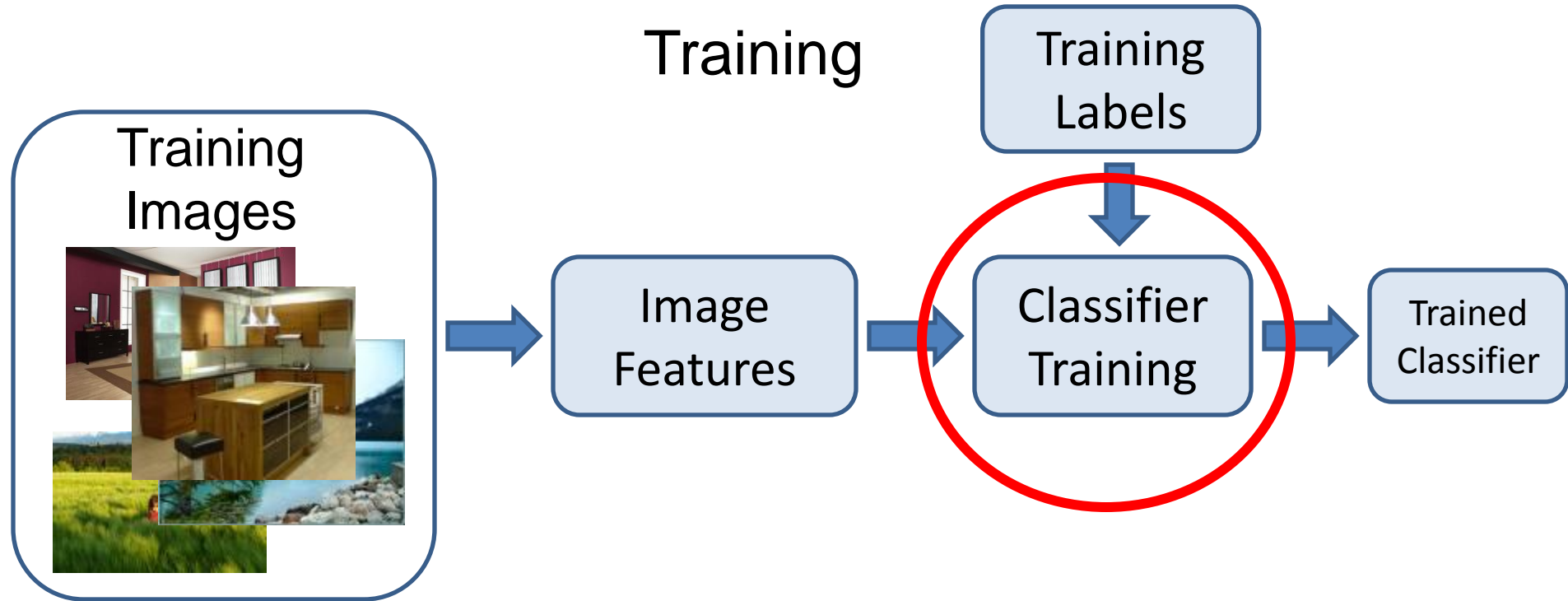
Image representations

- Templates
  - Intensity, gradients, etc.

- Histograms
  - Color, texture, SIFT descriptors, etc.

Classifiers

Training

Training Images → Image Features → Classifier Training → Trained Classifier

Training Labels → Classifier Training

Slide: Derek Hoiem

Learning a classifier

Given some set of features with corresponding labels, learn a function to predict the labels from the features
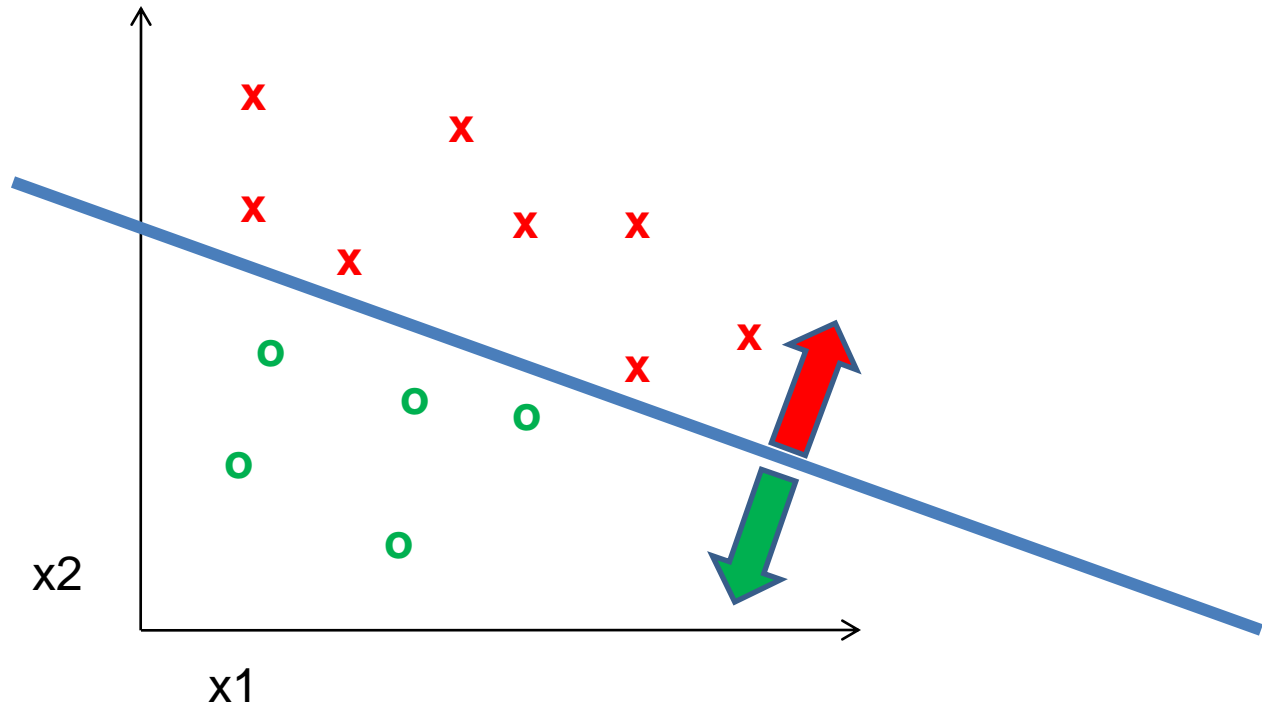
One way to think about it…

- Training labels dictate that two examples are the same or different, in some sense

- Features and distance measures define visual similarity

- Classifiers try to learn weights or parameters for features and distance measures so that visual similarity predicts label similarity

Machine Learning Problems

|	Supervised Learning	Unsupervised Learning
Discrete	classification or categorization	clustering
Continuous	regression	dimensionality reduction

Dimensionality Reduction

- **PCA**, ICA, LLE, Isomap

- PCA is the most important technique to know. It takes advantage of correlations in data dimensions to produce the best possible lower dimensional representation, according to reconstruction error.

- PCA should be used for dimensionality reduction, not for discovering patterns or making predictions. Don't try to assign semantic meaning to the bases.
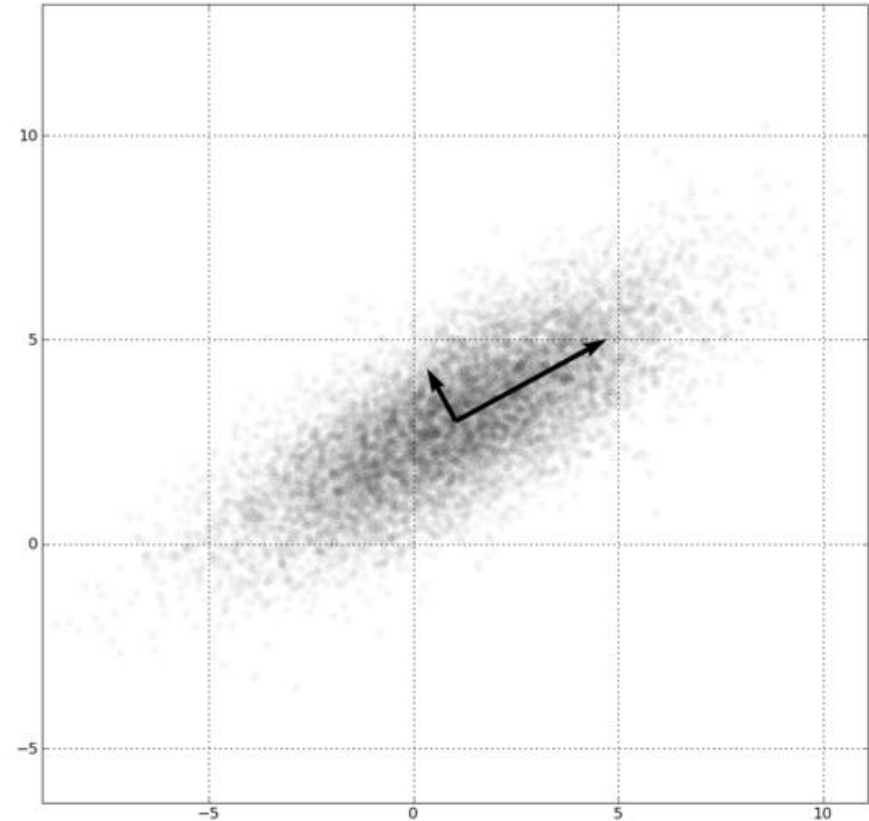
Many classifiers to choose from

- SVM
- Neural networks
- Naïve Bayes
- Bayesian network
- Logistic regression
- Randomized Forests
- Boosted Decision Trees
- K-nearest neighbor
- RBMs
- Etc.

Which is the best one?

Next Two Lectures:

- Friday we'll talk about clustering methods (k-means, mean shift) and their common usage in computer vision -- building "bag of words" representations inspired by the NLP community. We'll be using these models for projects 2 and 3.

- Monday we'll focus specifically on classification methods, e.g. nearest neighbor, naïve-Bayes, decision trees, linear SVM, Kernel methods. We'll be using these for projects 3 and 4 (and optionally 2).