Model Basics

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Spring 2021

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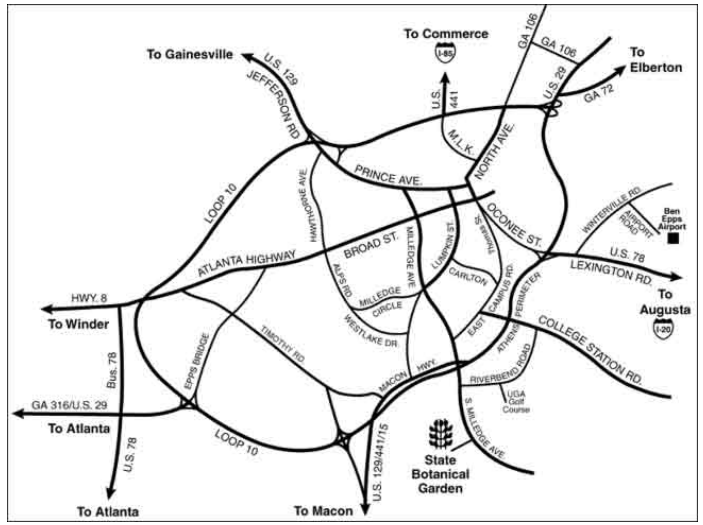
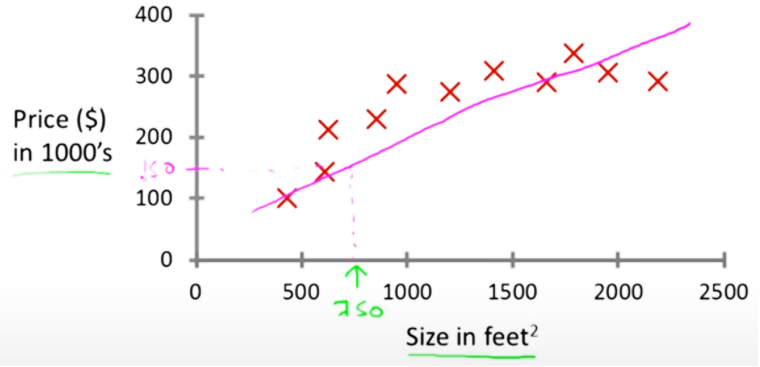
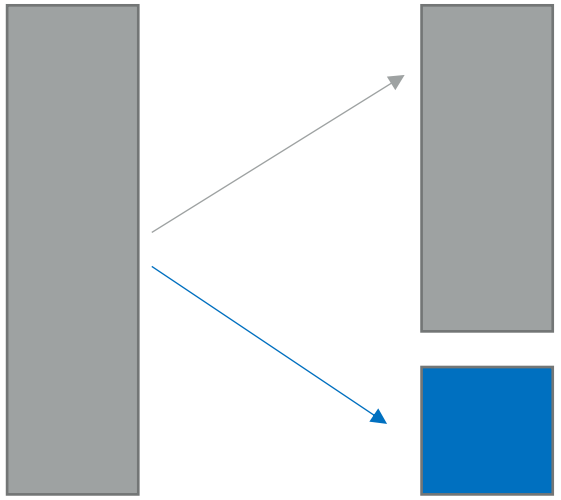






Data

Training Data

Testing Data

Attributes

Target attribute

Name	Balance	Age	Employed	Write-off
Mike	$200,000	42	no	yes
Mary	$35,000	33	yes	no
Claudio	$115,000	40	no	no
Robert	$29,000	23	yes	yes
Dora	$72,000	31	no	no

This is one row (example).
Feature vector is: **<Claudio,115000,40,no>**
Class label (value of Target attribute) is **no**

Model Defined

A **simplified* representation** of reality created for a **specific purpose**

- *based on some assumptions about what is and is not important, or sometimes based on constraints on information or tractability

Model Goal

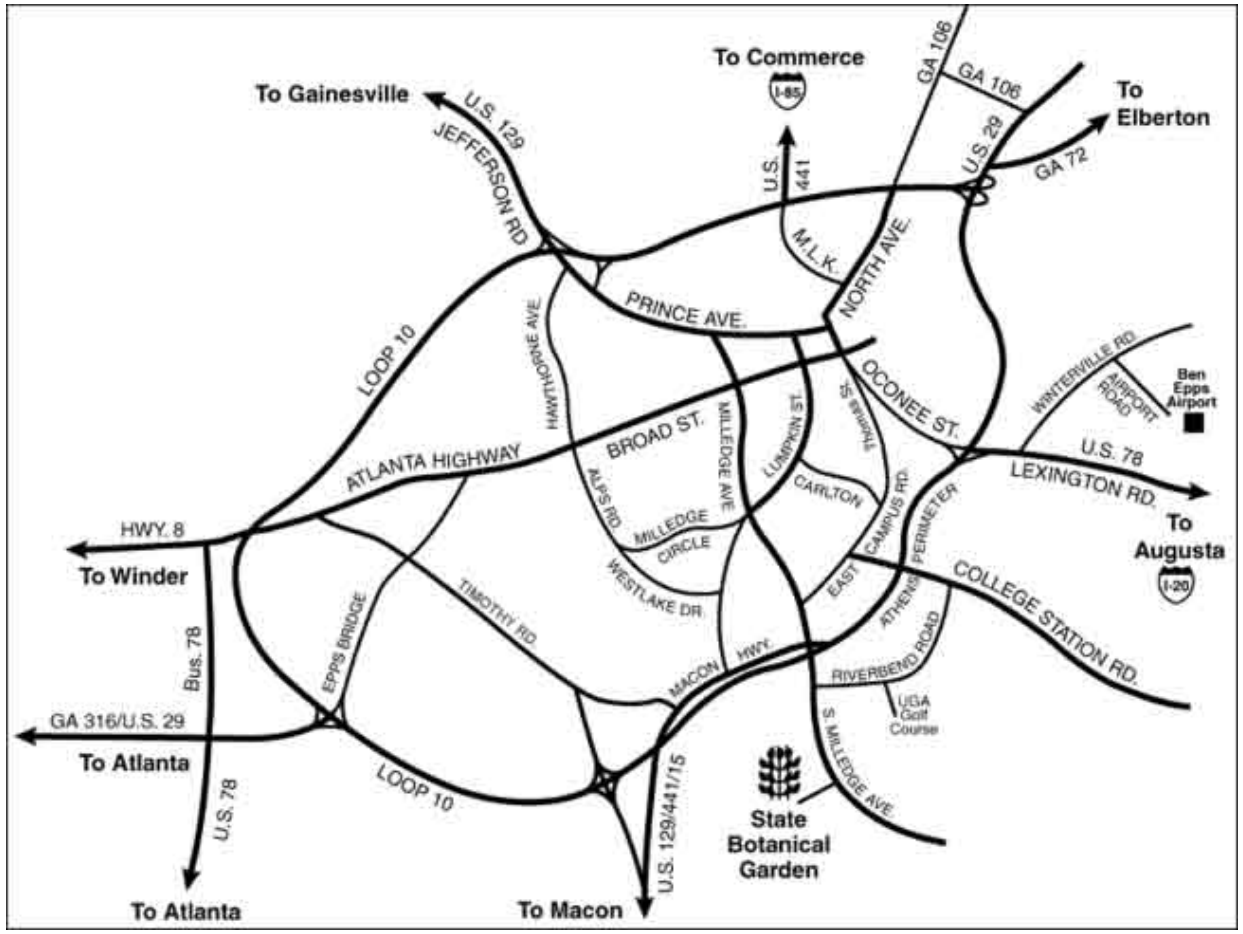
Not to uncover truth, but to discover a simple approximation that is still useful

- i.e., capture **true "signals"** (or patterns generated by the phenomenon of interest) and **ignore "noise"** (or random variation that you're not interested in)

“All models are wrong, but some are useful”

George Box

Model Example



Predictive (or Supervised Learning) Model

A formula for estimating the unknown value of interest:

- **The target!**
  - The formula could be mathematical or a logical statement, such as a rule. Often, it is a hybrid

More Terminology

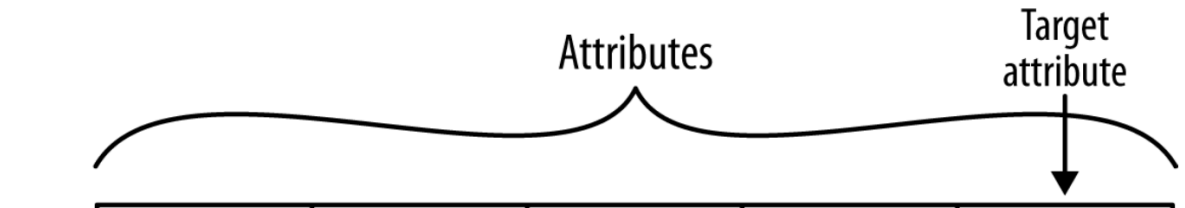
Instance / example = a fact or data point described by a set of attributes (also known as variables, columns, or features)

Model induction = the creation of models from data

Training data = the input data used for model induction

Testing data = the input data used for model testing

More Terminology



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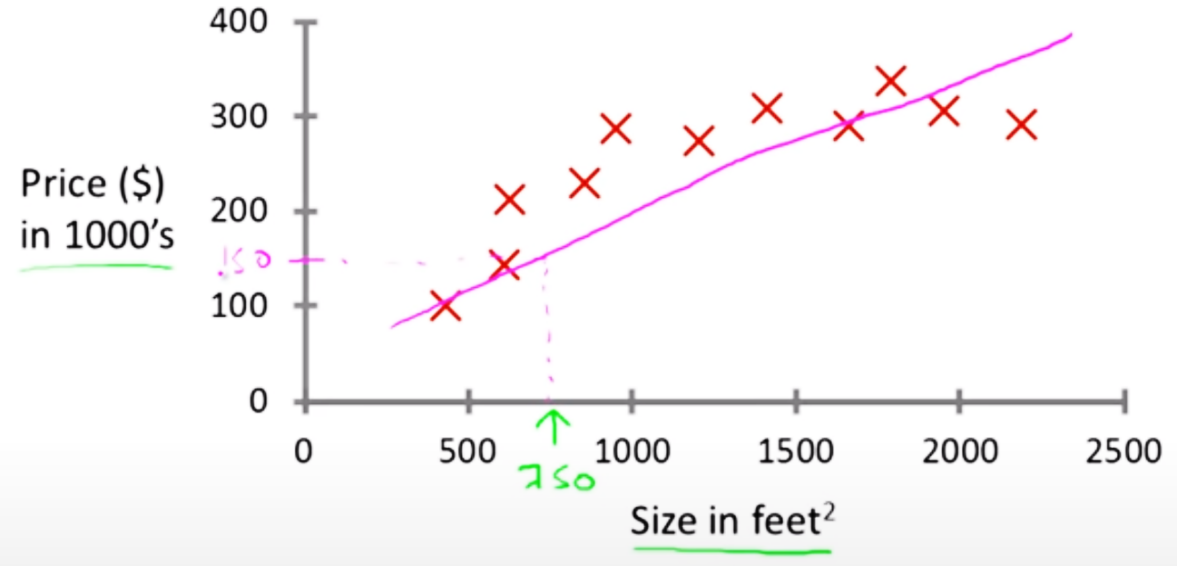
Dora	$72,000	31	no	no

This is one row (example).
Feature vector is: **<Claudio,115000,40,no>** <class, number, number, class>
Class label (value of Target attribute) is **no**

Predictive Model: Regression

Suppose you want to predict house prices, and you have some data about the price of a house (in thousands of $) over size (sqft)

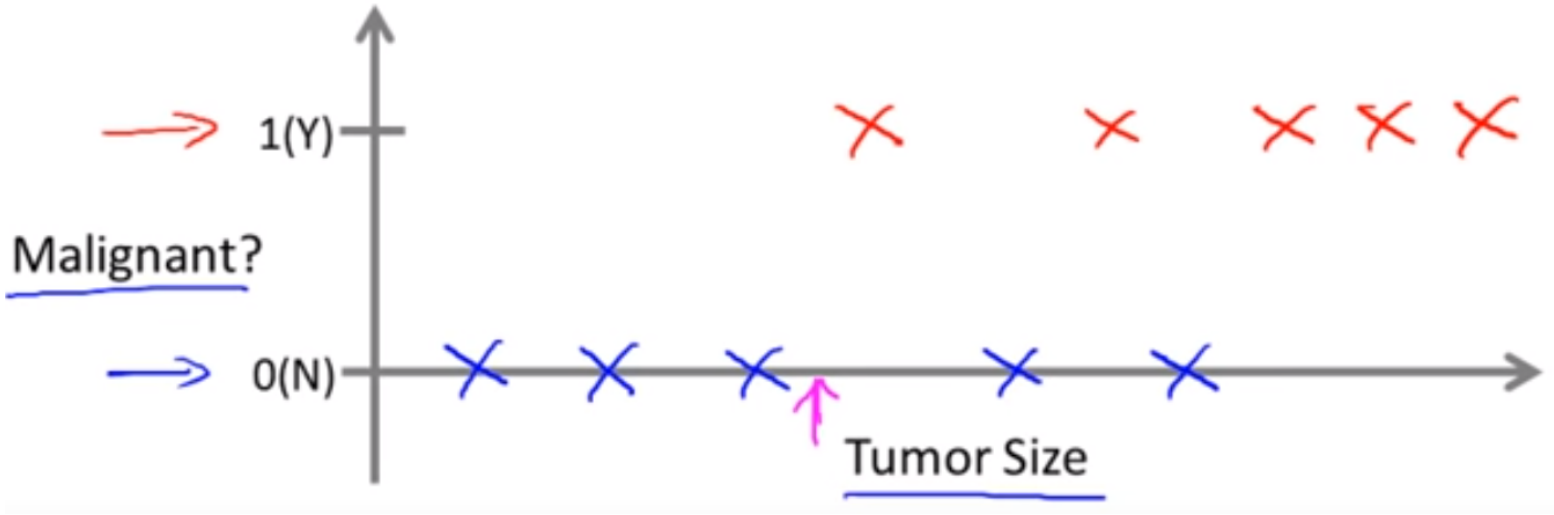
Estimate numeric value (e.g., with a linear regression)



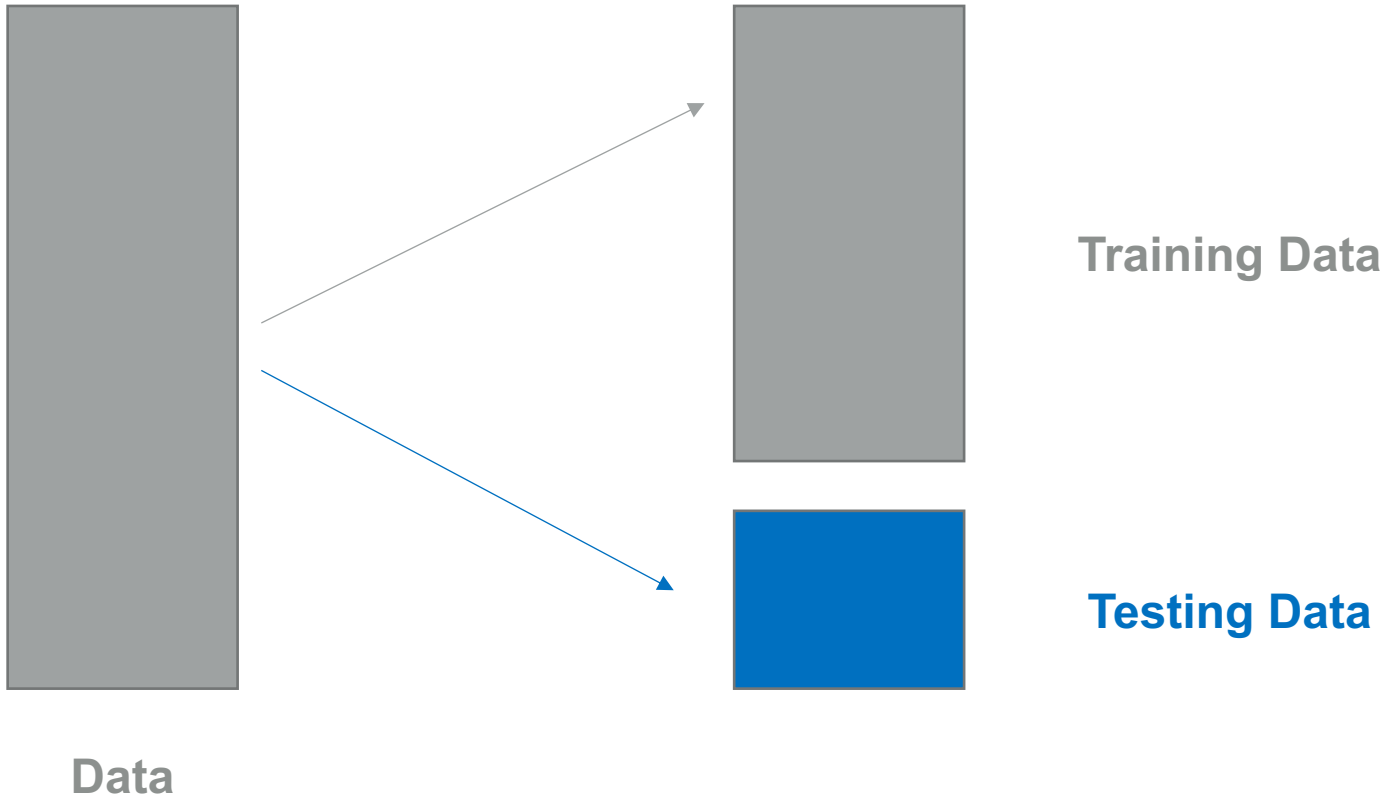
Predictive Model: Classification

Suppose you want to predict whether someone's breast cancer is malignant

Estimate class probability (e.g., with a logistic regression)



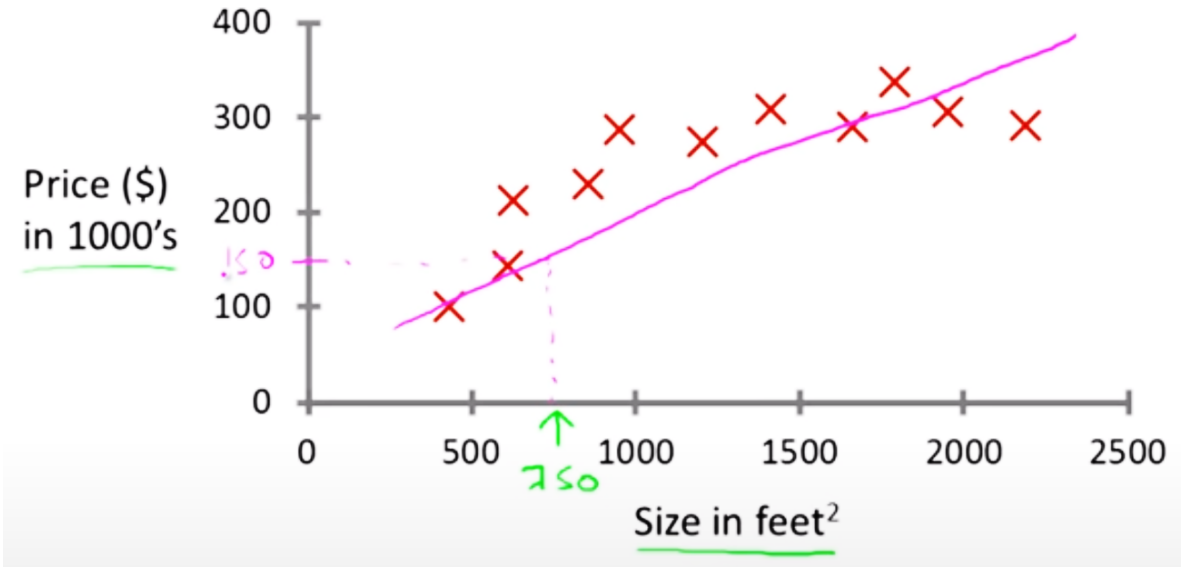
Predictive Model: Data Splitting



Predictive Model: Regression Performance

Error = Predicted – Actual

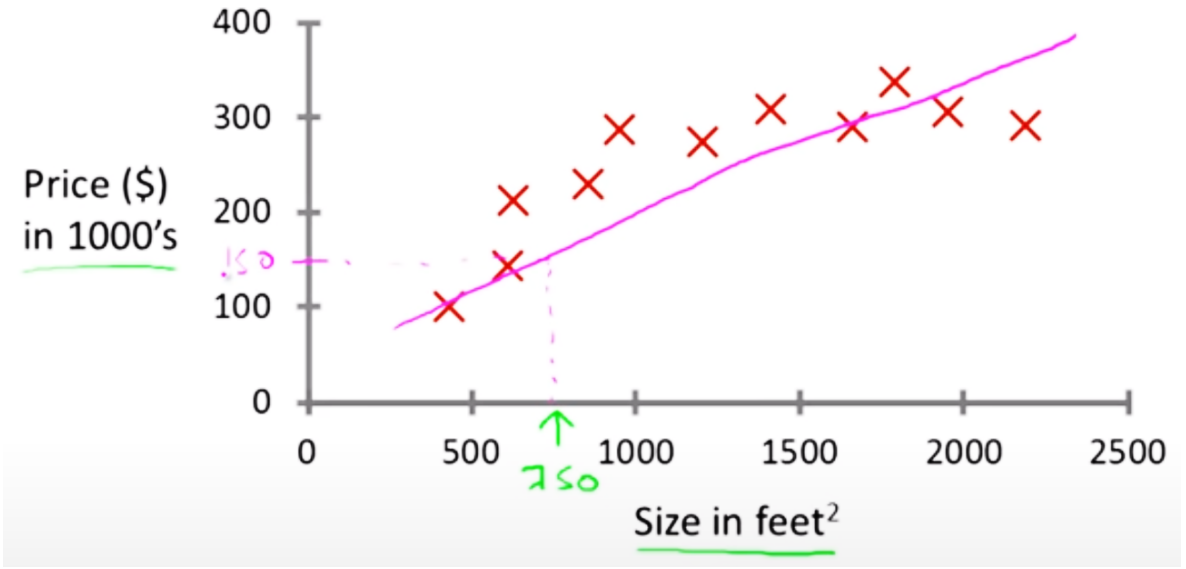
- To quantify the total amount of error, we take the square of each error and then sum all the squares, creating a measure called **Total Sum of Squared Error (Total SSE)**



Predictive Model: Regression Performance

Error = Predicted – Actual

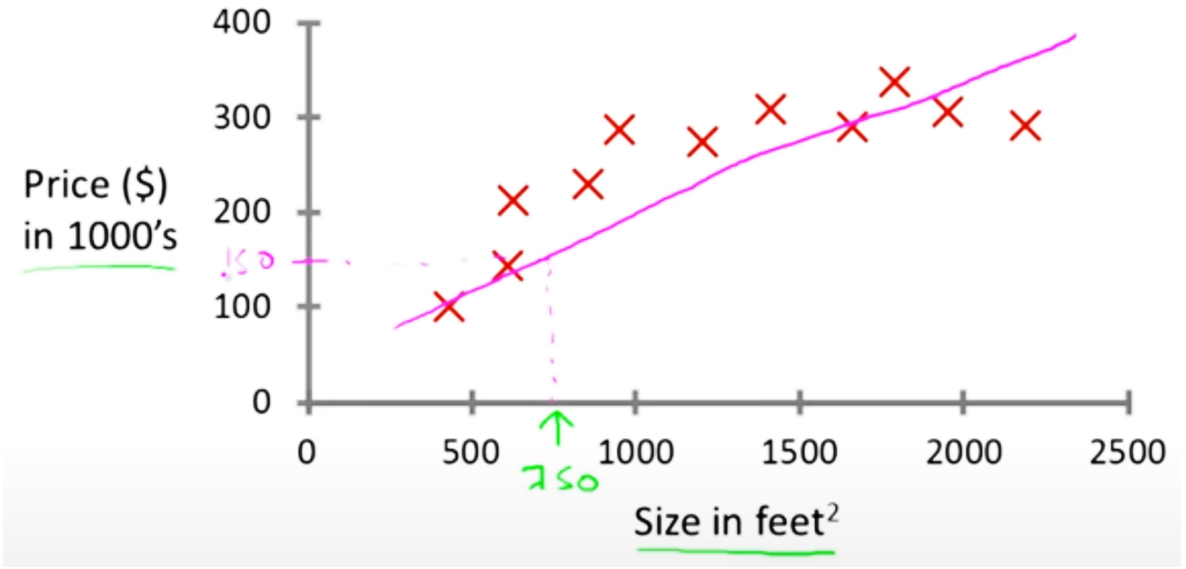
- Other popular measures that focus on error are **RMSE** (root mean squared error); **MAE** (mean absolute error); and **MAPE** (mean absolute percentage error)



Predictive Model: Regression Performance

Error = Predicted – Actual

- RMSE is useful because intuitively, it captures how much the predicted values diverge from the actual values on average



Predictive Model: Classification Performance

Accuracy = Number of correct classifications made / Total number of classifications

Predictive Model: Classification Performance

The **confusion matrix**

- Separates out the decisions made by the model, making explicit how one class is being confused for another

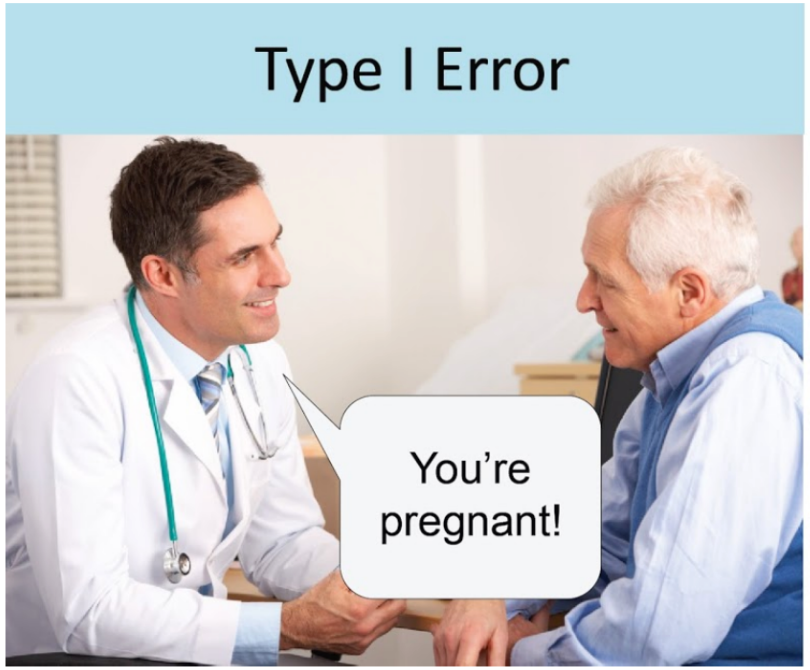
Type I Error

		Actual	
		Positive	**Negative**
Predicted	**Positive**	True Positives	**False Positives**
	Negative	**False Negatives**	True Negatives

Type II Error

Predictive Model: Classification Performance

False Positive



False Negative

Predictive Model: Classification Performance

The **F-Measure**

- Special-purpose combination of precision and recall
  - Precision = true positives / true positives + false positives
  - Recall = true positives / true positives + false negatives

- Always between 0 (worst performance) and 1 (best performance)

Things to Consider

- Is there a specific, quantifiable target that you are interested in predicting?
  - If yes, is it a **class or a number**?
    - Think about the decision

- Do you have data on the target?
  - Do you have **enough** data?
    - If the target is a class, a min of ~500 for each class type is needed

Another Thing to Consider

- Do you have relevant data **prior** to the decision?
  - Think about the timing of decision and action leading up to it

https://www.kaggle.com/alexisbcook/data-leakage#Example

Leakage

The use of data in the model training process that would not be available in practice at the time you would want to use the model to make a prediction, leading to **unrealistically good predictions**

- Leaking from the future into the past
- Leaking test data into the training data

Leakage (Example)

Suppose you want to predict who will get pneumonia. Below is a preview of your data:

got_penumonia	age	weight	male	took_antibiotic	…
false	65	100	false	false	…
false	72	130	true	false	…
true	58	100	false	true	…

People take antibiotics after getting pneumonia in order to recover. Using **took_antibiotic** to predict **got_pneumonia** will lead to data leakage

Avoiding Leakage

- Do you have relevant data **prior** to the decision?
  - Think about the timing of decision and action leading up to it

Summary

- A model is not reality, but rather a simplified version of it that serves a specific purpose
- Good models are useful, all models are wrong
- Predictive models estimate an unknown value, which can be a class (classification) or a number (regression)

Summary

- When building a predictive model, split data into training and testing sets (70-30 or 80-20)
- We evaluate classification models differently than regression models
- Many things to consider when building predictive models, including the data type of target variable, how much data are available, and issues of leakage

Thank You!