

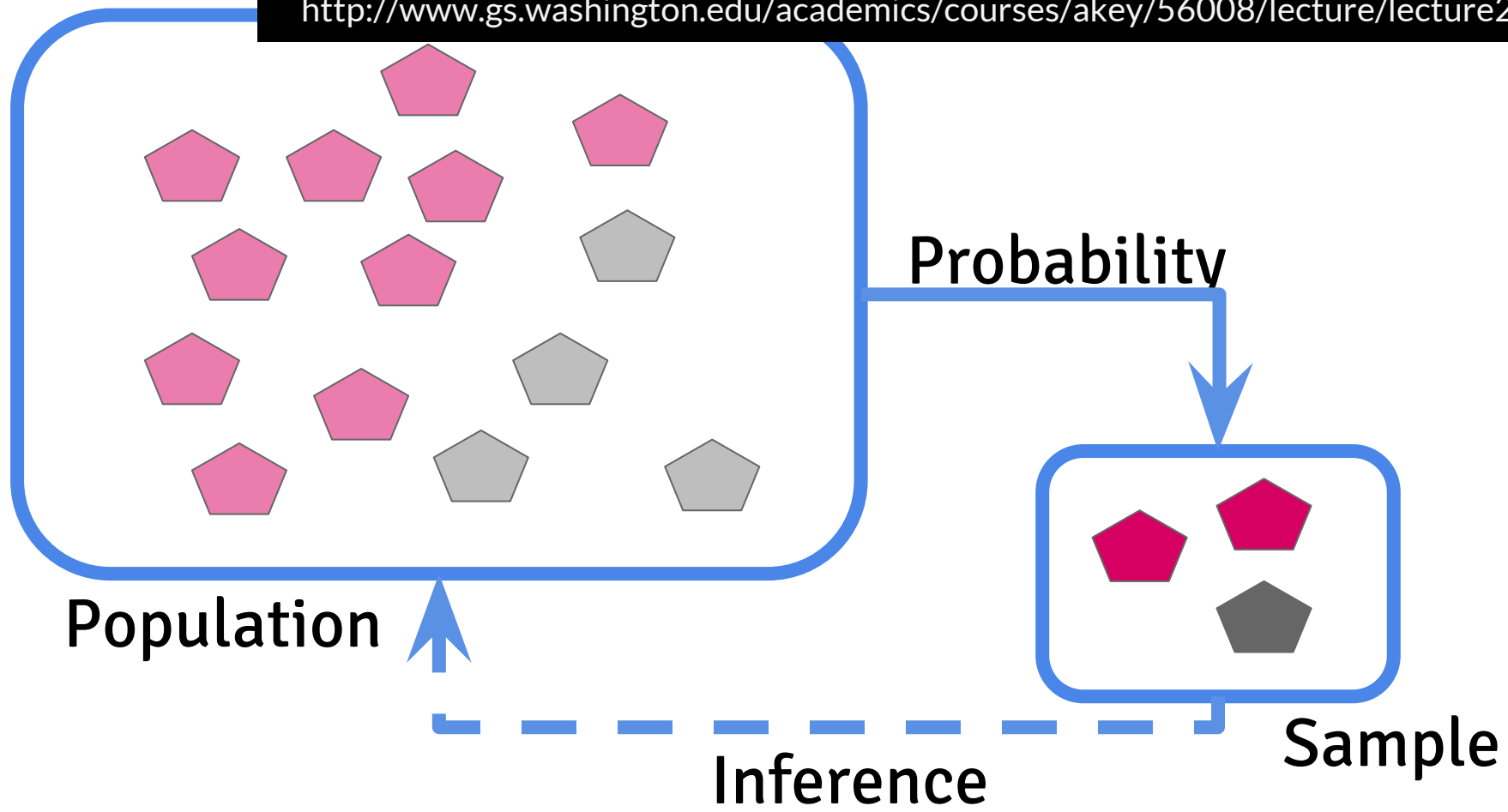
Knowing when and where to get help

Jeff Leek

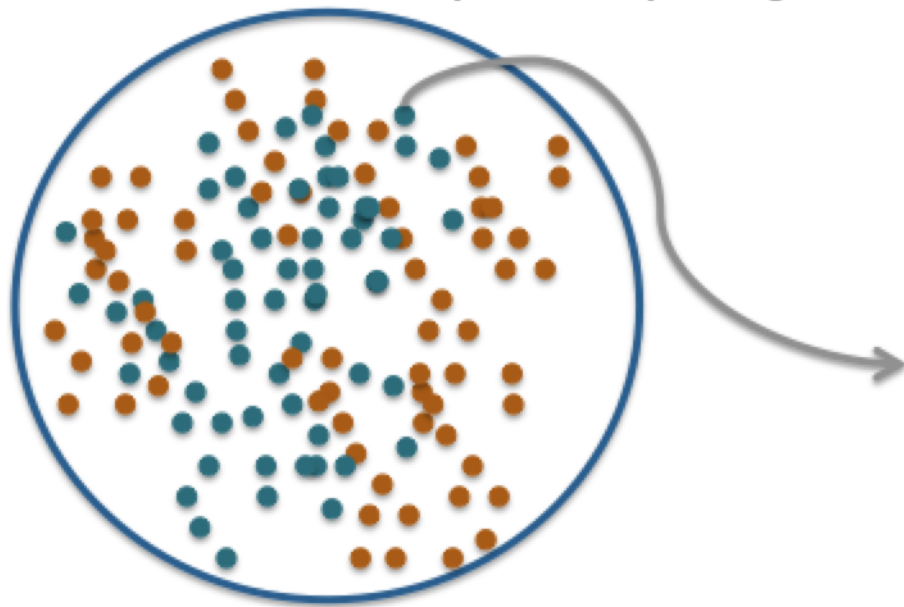
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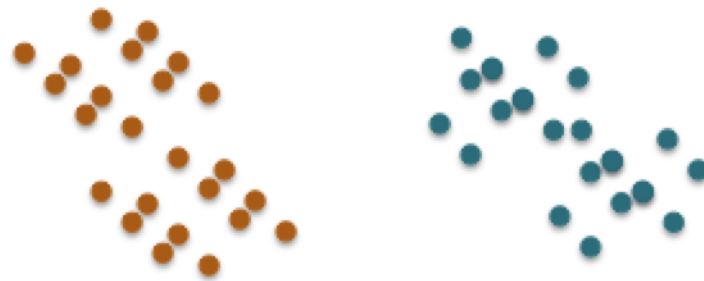
Inference vs. prediction



Probability/Sampling

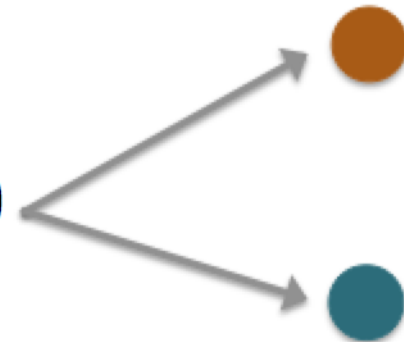


Training Set

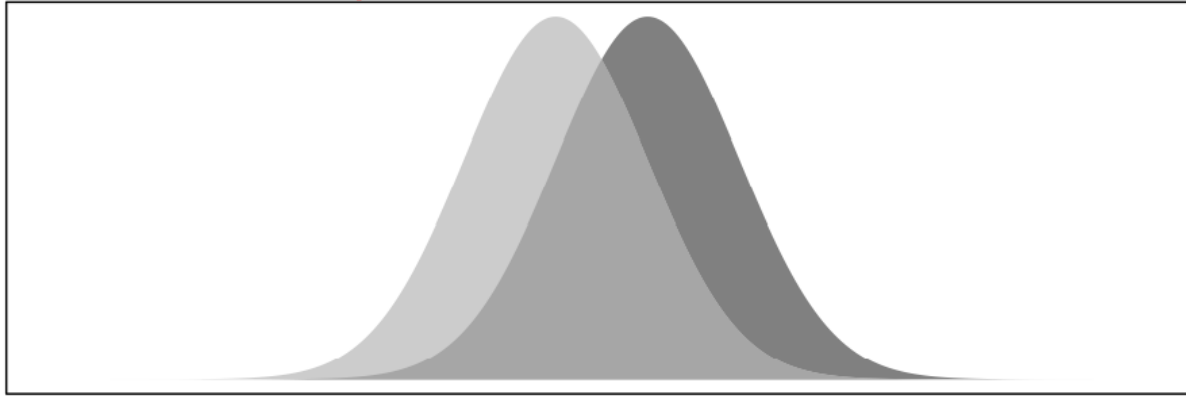


Prediction function

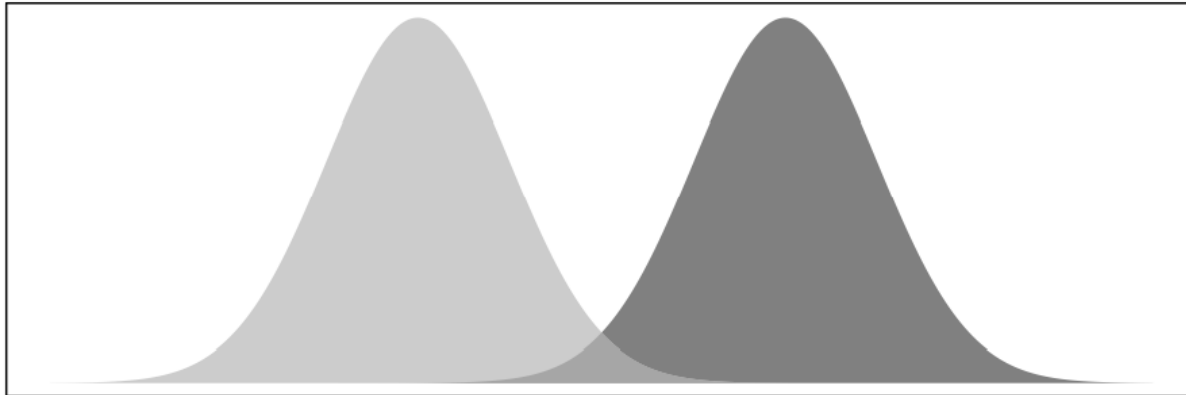
$f(\bullet)$



Definitely different, but not predictive



Different and predictive



Key quantities

		DISEASE	
		+	-
TEST	+	TP	FP
	-	FN	TN

		DISEASE	
		+	-
TEST	+	TP	FP
	-	FN	TN

Sensitivity

→ $\Pr(\text{positive test} \mid \text{disease})$

Specificity

→ $\Pr(\text{negative test} \mid \text{no disease})$

Positive Predictive Value

→ $\Pr(\text{disease} \mid \text{positive test})$

Negative Predictive Value

→ $\Pr(\text{no disease} \mid \text{negative test})$

Accuracy

→ $\Pr(\text{correct outcome})$

DISEASE

		DISEASE	
		+	-
TEST	+	TP	FP
	-	FN	TN

Sensitivity

$$\rightarrow TP / (TP + FN)$$

Specificity

$$\rightarrow TN / (FP + TN)$$

Positive Predictive Value

$$\rightarrow TP / (TP + FP)$$

Negative Predictive Value

$$\rightarrow TN / (FN + TN)$$

Accuracy

$$\rightarrow (TP + TN) / (TP + FP + FN + TN)$$

An example

Assume that some disease has a 0.1% prevalence in the population. Assume we have a test kit for that disease that works with 99% sensitivity and 99% specificity. What is the probability of a person having the disease **given the test result is positive**, if we randomly select a subject from

- ▶ the general population?
- ▶ a high risk sub-population with 10% disease prevalence?

		DISEASE	
		+	-
TEST	+	99	999
	-	1	98901

		DISEASE	
		+	-
TEST	+	99	999
	-	1	98901

Sensitivity

$$\rightarrow 99 / (99+1) = 99\%$$

Specificity

$$\rightarrow 98901 / (999+98901) = 99\%$$

Positive Predictive Value

$$\rightarrow 99 / (99+999) \approx 9\%$$

Negative Predictive Value

$$\rightarrow 98901 / (1+98901) > 99.9\%$$

Accuracy

$$\rightarrow (99+98901) / 100000 = 99\%$$

HEALTH

Vast Study Casts Doubts on Value of Mammograms

By GINA KOLATA FEB. 11, 2014



At risk subpopulation

		DISEASE	
		+	-
TEST	+	9900	900
	-	100	89100

		DISEASE	
		+	-
TEST	+	9900	900
	-	100	89100

Sensitivity

$$\rightarrow 9900 / (9900 + 100) = 99\%$$

Specificity

$$\rightarrow 89100 / (900 + 89100) = 99\%$$

Positive Predictive Value

$$\rightarrow 9900 / (9900 + 900) \approx 92\%$$

Negative Predictive Value

$$\rightarrow 89100 / (100 + 89100) \approx 99.9\%$$

Accuracy

$$\rightarrow (9900 + 89100) / 100000 = 99\%$$

Notes and further reading

- Prediction is a whole class (no joke): <https://www.coursera.org/course/predmachlearn>
- Prediction with genomics underlies precision medicine
- So far this has been a major challenge