

# Digital Transformation of Healthcare

## Evaluating Predictions

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Michael Snow, M.D. Ph.D., Glen Ferguson, Ph.D.

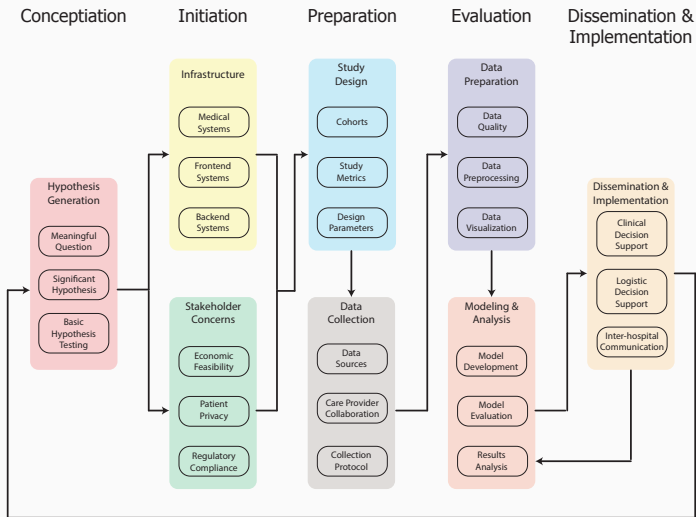
Center for Health Data Innovations

# Evaluating Predictions

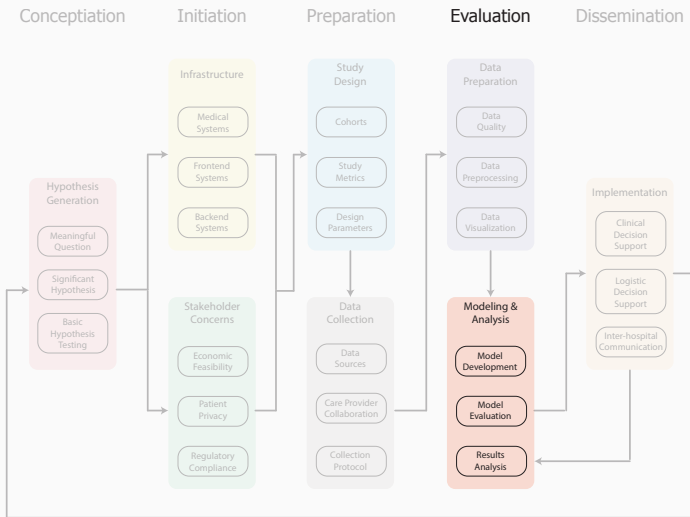
After this lecture students will be able to

- Calculate common classification and regression metrics
- Describe the role of simple classification metrics
- Evaluate the implementation of metrics for a study
- Articulate the information underlying common compound classification metrics
- Classify regression metrics
- Connect regression metric outcomes to facets of the associated models
- Identify transition points which can affect data quality
- Discuss methods for measuring and evaluating data quality

# Bioinformatics Pipeline



# Evaluating Predictions



# Metrics for Evaluation of Classification Models

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## Terms

- Accuracy
- Specificity
- Sensitivity
- Positive Predictive Value
- Negative Predictive Value
- Likelihood Ratio
- ROC & AUC
- F1 Score

## Questions

# Terms and Questions

## Terms

- Accuracy
- Specificity
- Sensitivity
- Positive Predictive Value
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- Likelihood Ratio
- ROC & AUC
- F1 Score

## Questions

- Is accuracy a useful metric?
- What information is conveyed by sensitivity vs specificity ?
- What information do the PPV and NPV add?
- Intuitively, how do sensitivity, specificity, likelihood ratios and ROC connect?
- Is the F1 score a more robust metric than the ROC and AUC?

- Low dose CT for detecting lung cancer (LDCT)<sup>1</sup>
- Ultrasound detection of abdominal aortic aneurysms (AAA)<sup>2</sup>
- Blood pressure monitoring in adolescents using home machines (HTN)<sup>3</sup>
- Detecting suicidality among adolescent outpatients by clinicians versus trained raters using the Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS-PL)<sup>4</sup>

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<sup>1</sup>National Lung Screening Trial Research Team. (2011). Reduced lung-cancer mortality with low-dose computed tomographic screening. *New England Journal of Medicine*, 365(5), 395-409.

<sup>2</sup>Thompson, S. G., Ashton, H. A., Gao, L., Buxton, M. J., Scott, R. A. P., & Multicentre Aneurysm Screening Study (MASS) Group. (2012). Final followup of the Multicentre Aneurysm Screening Study (MASS) randomized trial of abdominal aortic aneurysm screening. *British Journal of Surgery*, 99(12), 1649-1656.

<sup>3</sup>Stergiou, G. S., Nasothimiou, E., Giovvas, P., Kapoyiannis, A., & Vazeou, A. (2008). Diagnosis of hypertension in children and adolescents based on home versus ambulatory blood pressure monitoring. *Journal of hypertension*, 26(8), 1556-1562.

<sup>4</sup>Holi, M. M., Pelkonen, M., Karlsson, L., Tuisku, V., Kiviruusu, O., Ruuttu, T., & Marttunen, M. (2008). Detecting suicidality among adolescent outpatients: evaluation of trained clinicians' suicidality assessment against a structured diagnostic assessment made by trained raters. *BMC psychiatry*, 8(1), 97.



# Confusion Matrix

		Lung Cancer	
		p	n
Low-Dose CT	p'	649	17,497
	n'	5,532	49,792

		AAA	
		p	n
Ultrasound	p'	600	734
	n'	61	25,480

		HTN	
		p	n
Home Machine	p'	17	6
	n'	14	65

		K-SADS-PL	
		p	n
Trained Clinician	p'	32	23
	n'	30	133

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- When are sensitivity, specificity, PPV and NPV appropriate tests?

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- What is the accuracy of these tests?
- Are these good screening tests and/or diagnostic tests?
- How does the PPV and NPV affect your opinion of their utility?
- When are sensitivity, specificity, PPV and NPV appropriate tests?
- How are sensitivity, specificity, PPV and NPV affected by prevalence?

# Combined Statistics

Lung Cancer			AAA			HTN			K-SADS-PL		
Low-Dose CT	p	n	Ultrasound	p	n	Home Machine	p	n	Trained Clinician	p	n
	p'	n'		p'	n'		p'	n'		p'	n'
	649	17,497		600	734		17	6		32	23
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- What are 4 'sensible' pairings of the base stats
- What are the different ways to combine the base stats into summary statistics (hint: what are the basic ways to combine any numbers)?
  - Work through each of the four clinical cases

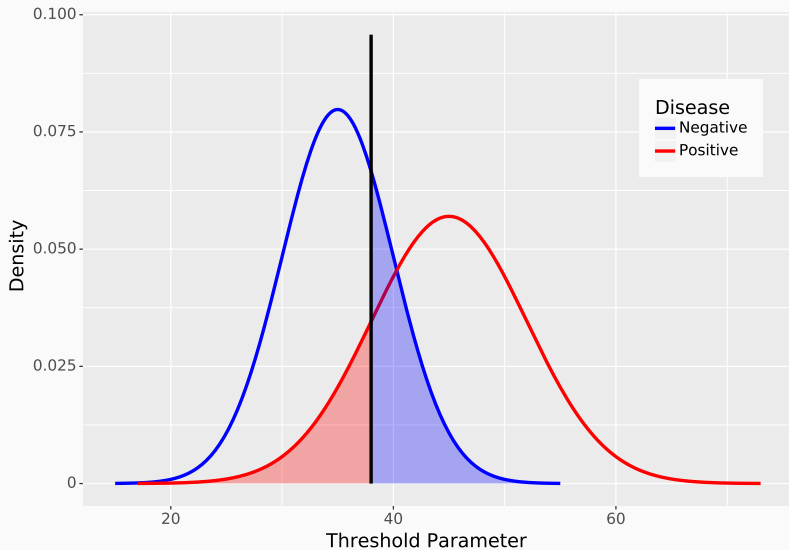


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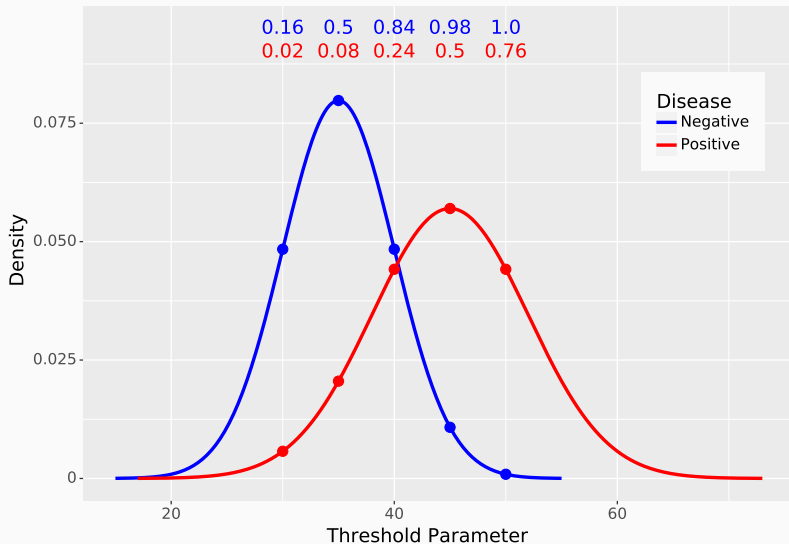
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- What are 4 'sensible' pairings of the base stats
- What are the different ways to combine the base stats into summary statistics (hint: what are the basic ways to combine any numbers)?
  - Work through each of the four clinical cases
- What determines the split of positive cases into TP vs FN and negative cases into TN vs FP?

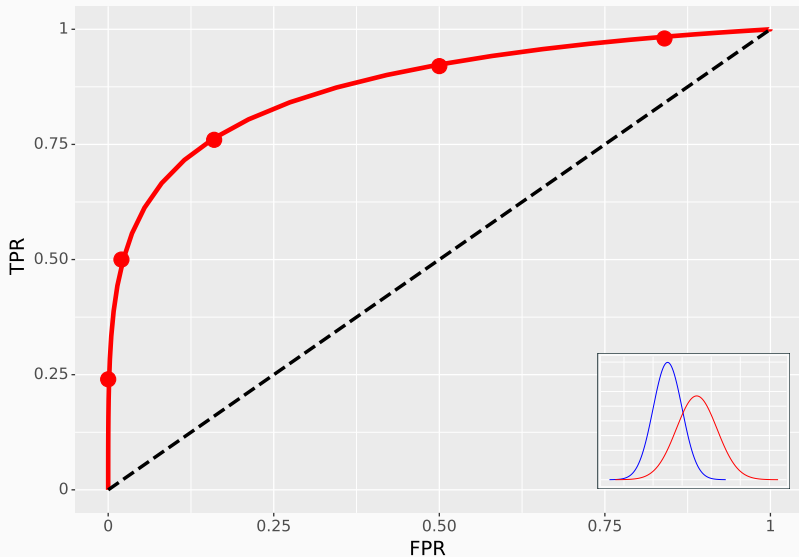
# Hypothesis Testing



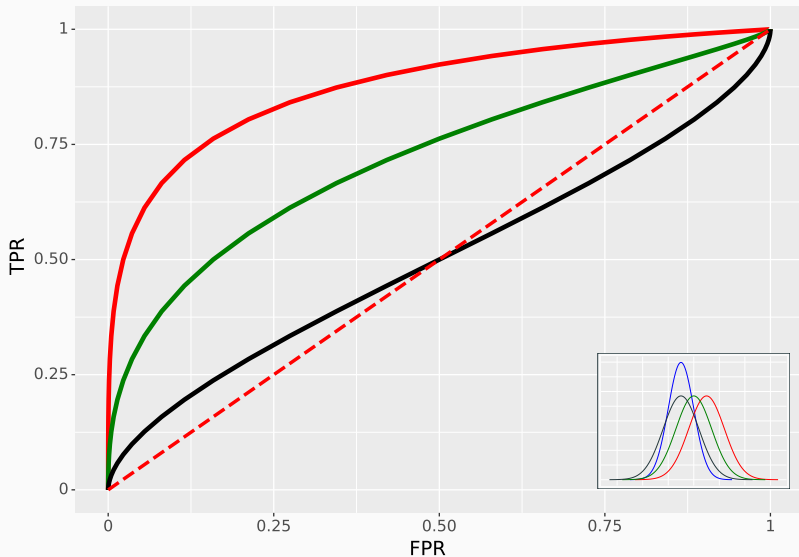
# Hypothesis Testing



# Receiver Operating Characteristic



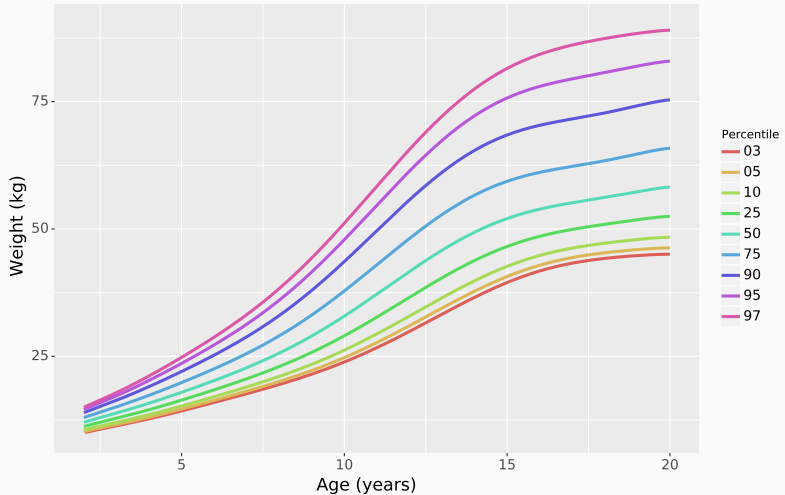
# Receiver Operating Characteristic



# Metrics for Evaluation of Regression Models

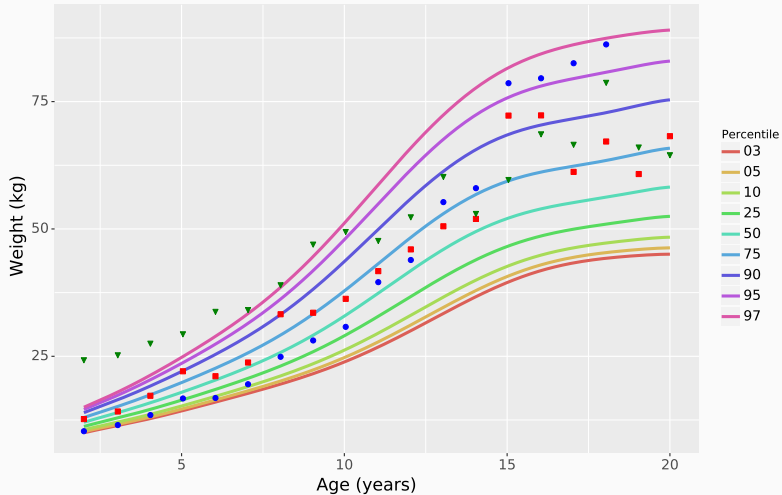
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# Growth Curves



Centers for Disease Control and Prevention, National Center for Health Statistics. CDC growth charts: United States.

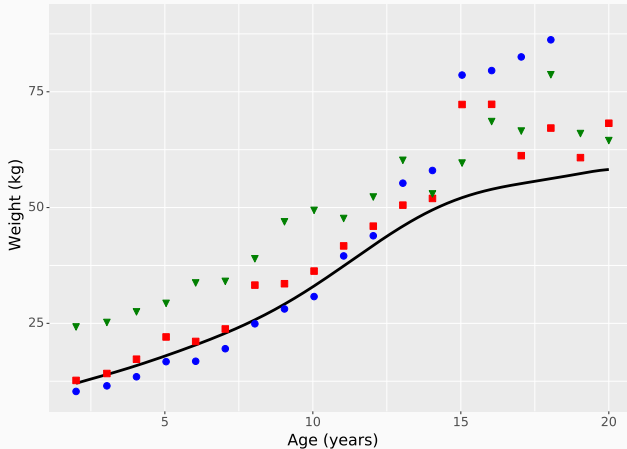
# Growth Curves



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# Regression Metrics



- What aspects of a model's predictions should I care about?
- What aspects of the model's predictions can I evaluate?