Predicting antibiotic resistance

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6.S897
May 17, 2017

Problem Statement

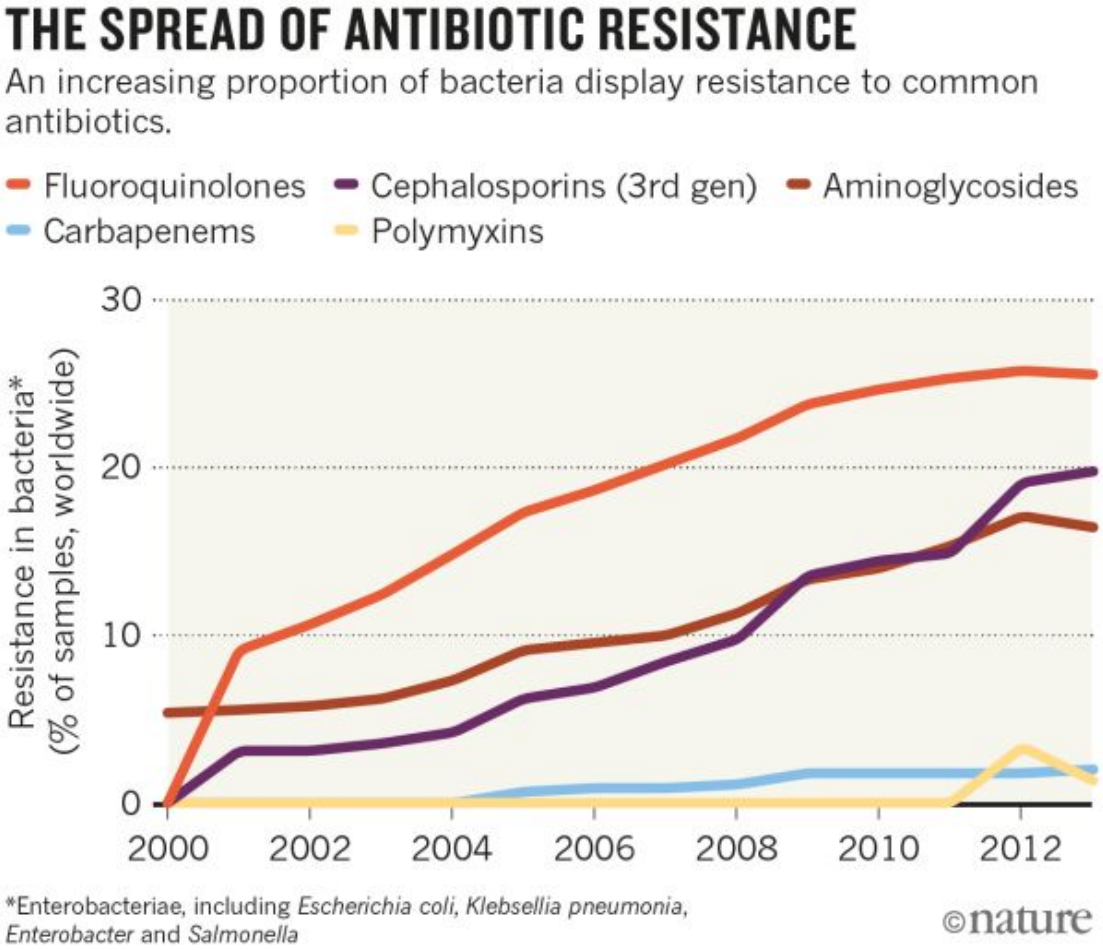
Predict resistance of a bacterial population to an antibiotic for a given patient based on Electronic Medical Records

- Patient demographic information: insurance, gender, ethnicity, age
- Medical conditions and procedures: ICD9 and CPT codes

From a doctor's perspective:

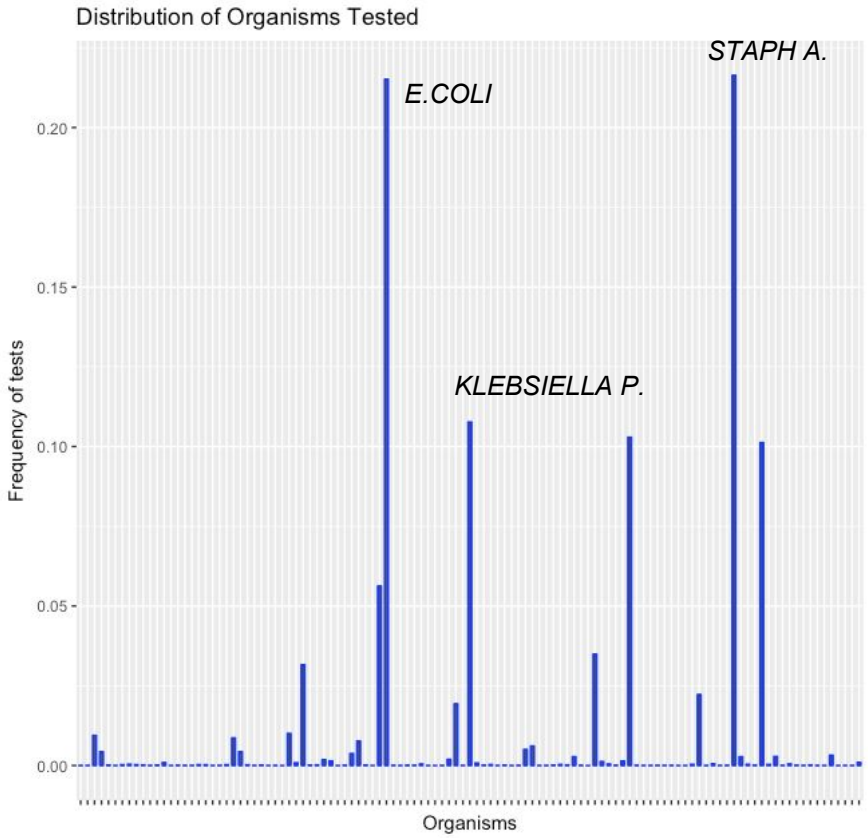
> Faced with limited information about patient, how to make empiric decision of which antibiotics to prescribe ?

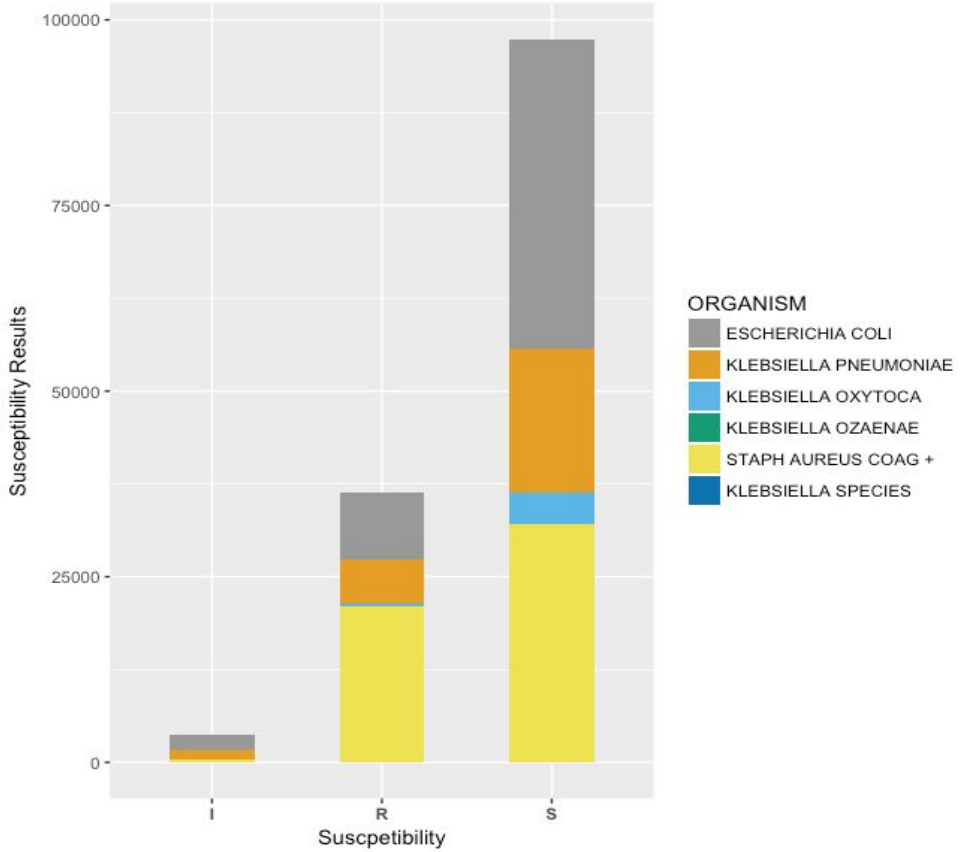
Problem Statement



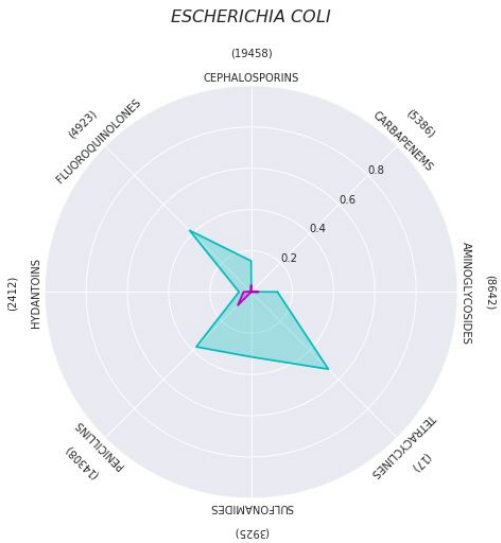
http://www.nature.com/news/spread-of-antibiotic-resistance-gene-does-not-spell-bacterial-apocalypse-yet-1.19037

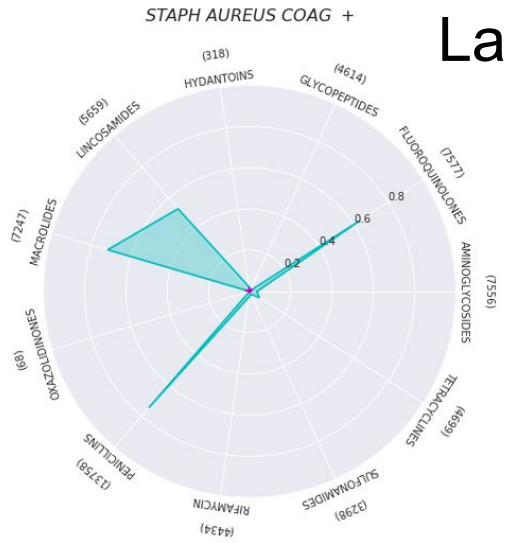
MIMIC-III Dataset Description





Landscape of antibiotic resistance

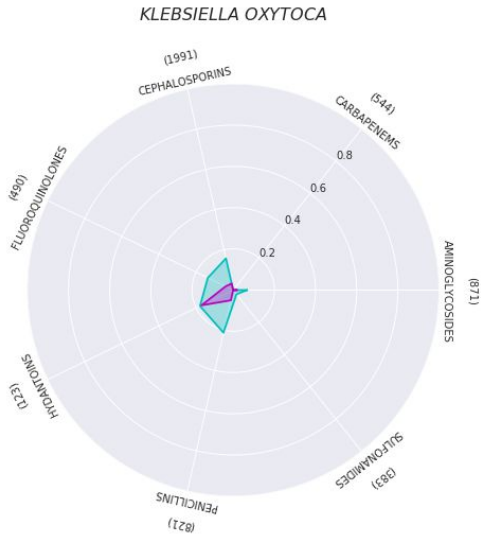


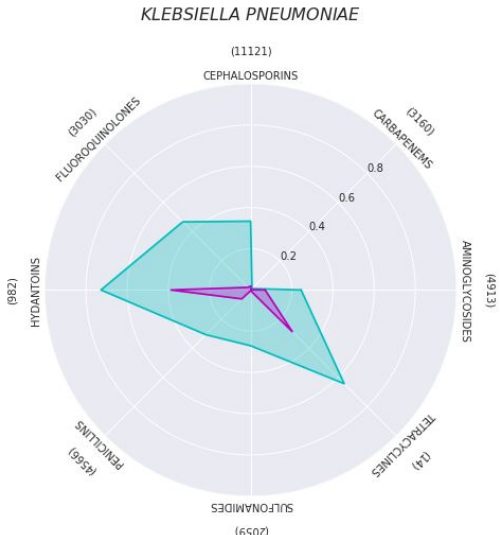


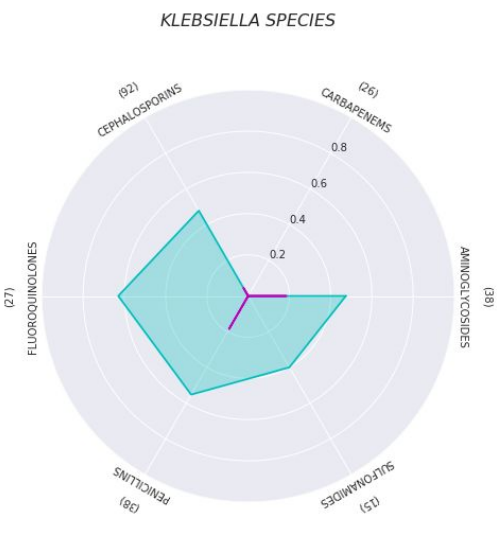
Intermediate

Resistant

(based on **M**inimum **I**nhibitory **C**onc.)



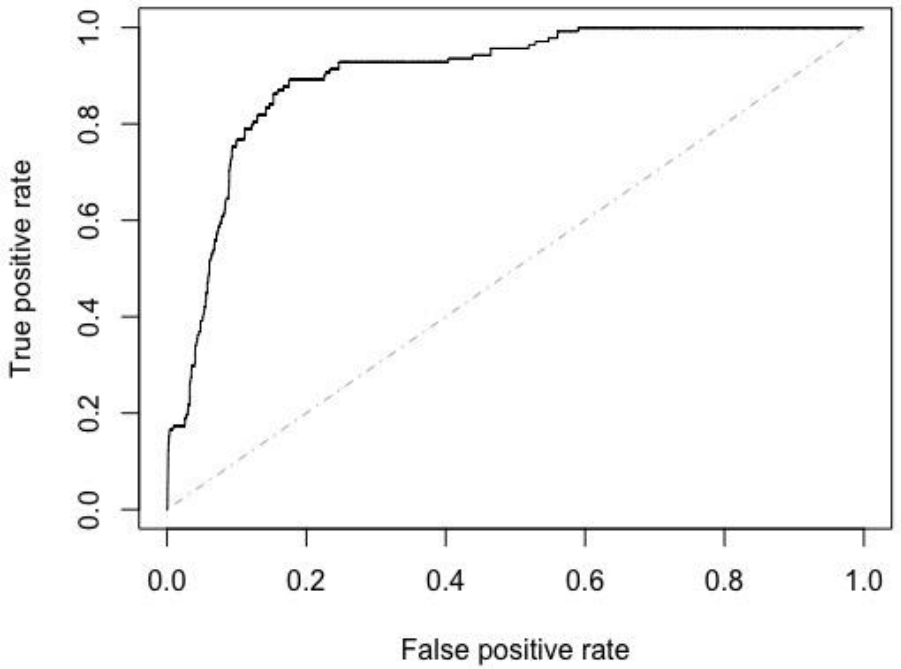




Models

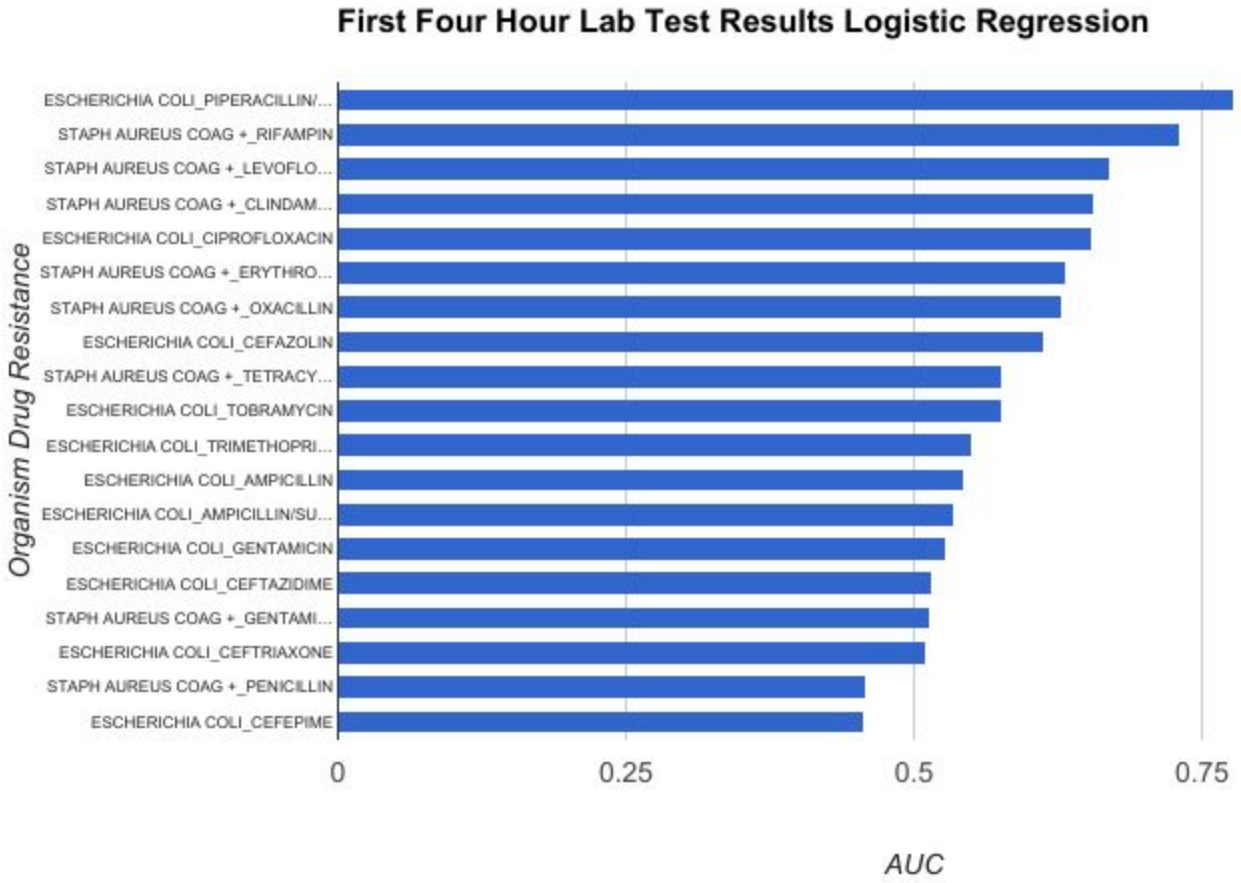
- Supervised learning (“S” vs. “R”/“I”)
- Features
  - Demographic data
  - Previous incidences of resistant infections
  - Initial lab test results and vital signs (first 4 hrs)
  - Microbiological events

Predicting Organism-Drug Susceptibility



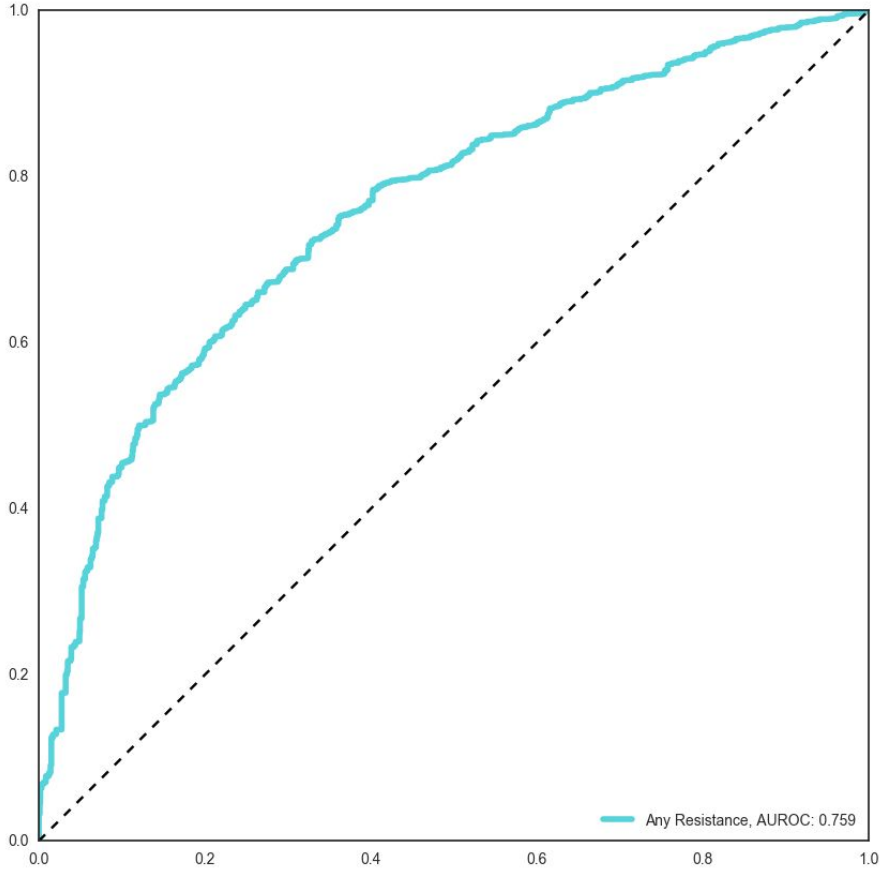
Predicting
Escherischia coli / Levoflocacin
from all other Organism-Drug pairs
& patient demographics

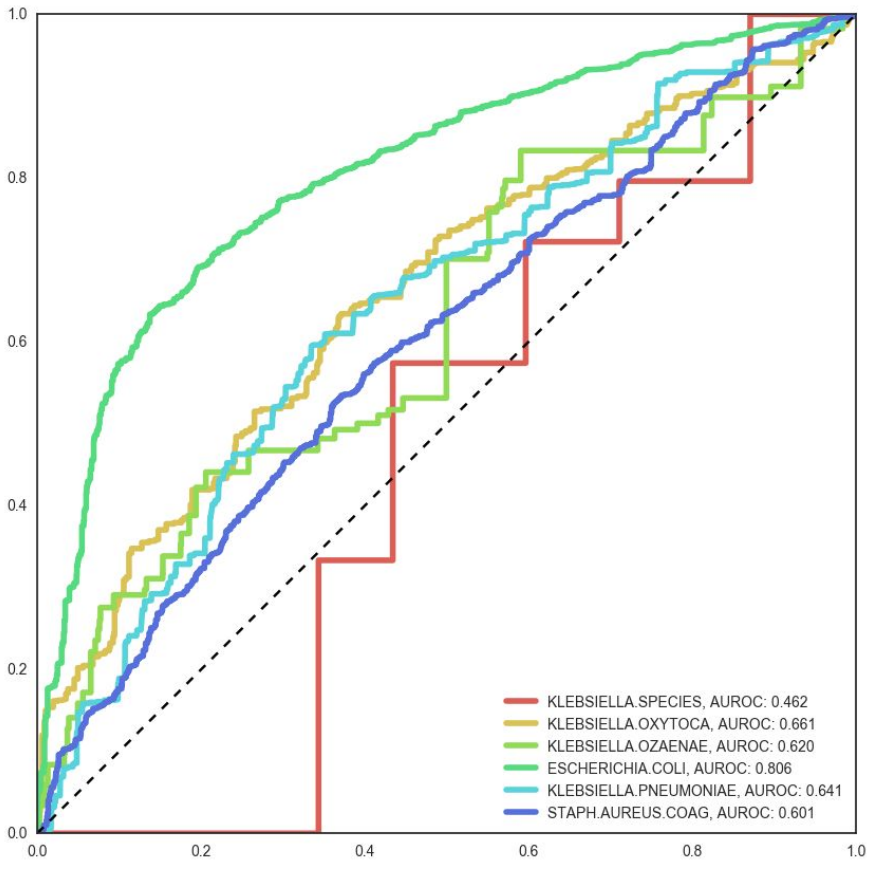
(using ElasticNet)



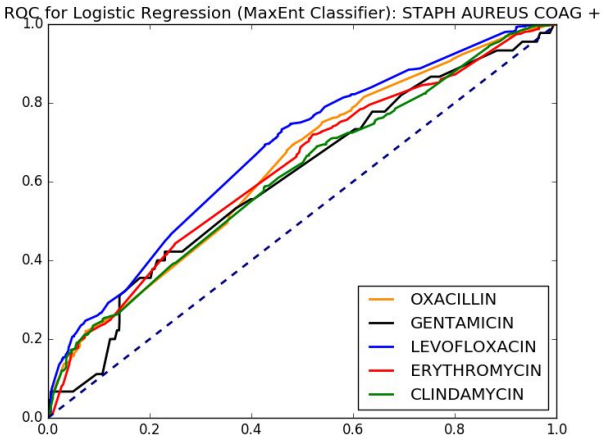
Features:
'heartrate', 'sysbp', 'diasbp', 'meanbp', 'resprate', 'tempc', 'spo2', 'glucose_chart', 'gcs', 'gcsmotor', 'gcsverbal', 'gcseyes', 'endotrachflag', 'bg_so2', 'bg_po2', 'bg_pco2', 'bg_pao2fio2ratio', 'bg_ph', 'bg_baseexcess', 'bg_bicarbonate', 'bg_totalco2', 'bg_hematocrit', 'bg_hemoglobin', 'bg_carboxyhemoglobin','bg_methemoglobin', 'bg_chloride', 'bg_calcium', 'bg_temperature', 'bg_potassium', 'bg_sodium', 'bg_lactate', 'bg_glucose', 'aniongap', 'albumin', 'bands', 'bicarbonate', 'bilirubin', 'creatinine', 'chloride', 'glucose', 'hematocrit', 'hemoglobin', 'lactate', 'platelet', 'potassium', 'ptt', 'inr', 'pt', 'sodium', 'bun', 'wbc', 'urineoutput'

Bacterial Resistance Per-Species (Logistic Regression)

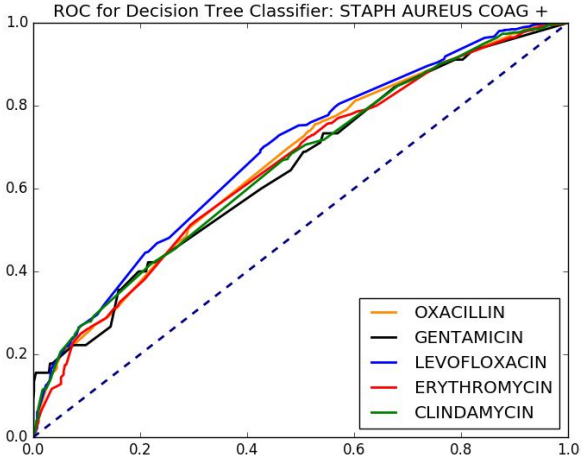




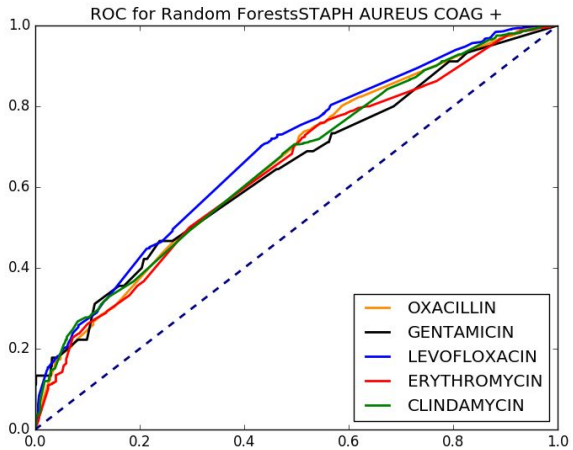
ROC Curves for *Staph aureus* Coag + and Different Antibiotics



Logistic Regression



Decision Tree



Random Forest

Future Directions

- Time-series - known correlation between history of antibiotics and resistance
- Disentangling “global” patient predictors and “local” microbial predictors of resistance
- Combined microbial genomics data and EMRs
- Counterfactual inference of factors leading to resistance