Forecasting Model for Disease Propensity Using EHR Data

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Healthgrades

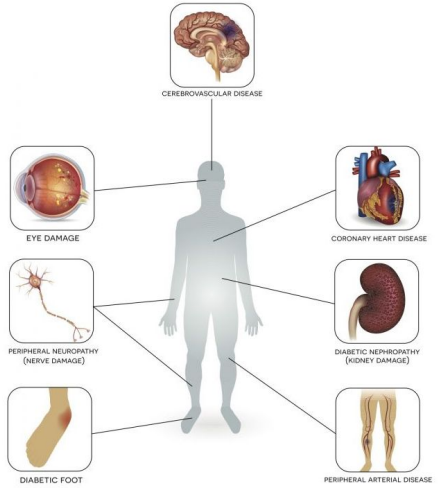
- Offers a comprehensive rating and comparison database on the quality of physicians, hospitals, and providers in the U.S. sourced from 500M+ federal and private claims
- Healthgrades Hospital Solutions: CRM, marketing, patient acquisition, etc.

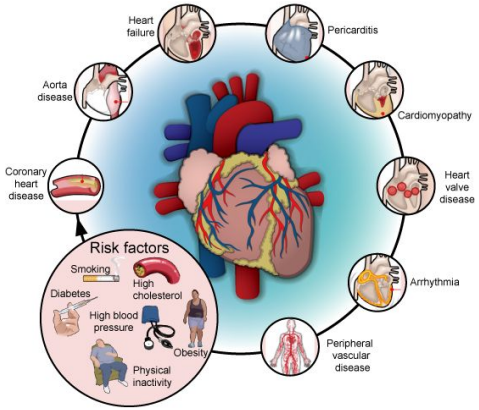
Healthgrades CRM Solutions

- Healthcare-specific predictive modeling: allowing providers to design effective, data-driven strategies through intervention and preventative care
- This is done by:
  - Identifying patients at risk for a medical event
  - Predicting future health needs

Introduction

- Certain conditions such as diabetes and heart failure are actionable
    - One to two years of early warning would represent a huge advance in preventing further complications





https://www.creative-diagnostics.com/Cardiac-Disease.htm

https://diabeticsweekly.com/6-dangerous-diabetes-complications-to-look-out-for/

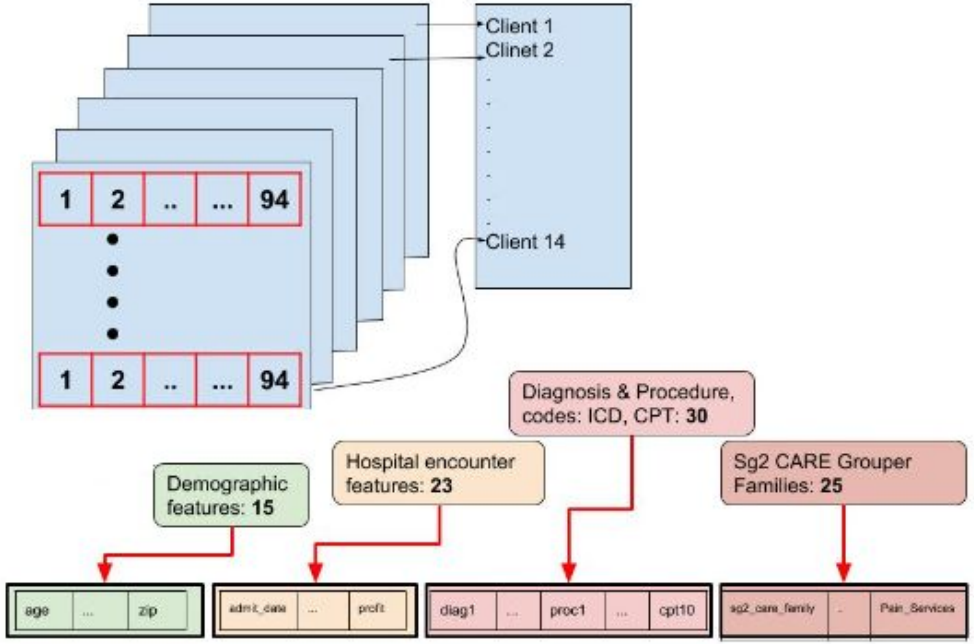
Objectives:

- Assessing risk of multiple actionable morbidities with EHR data on Amazon Web Service
- Ultimate goal is for project to be deployed into production after this semester at Healthgrades

Project Overview

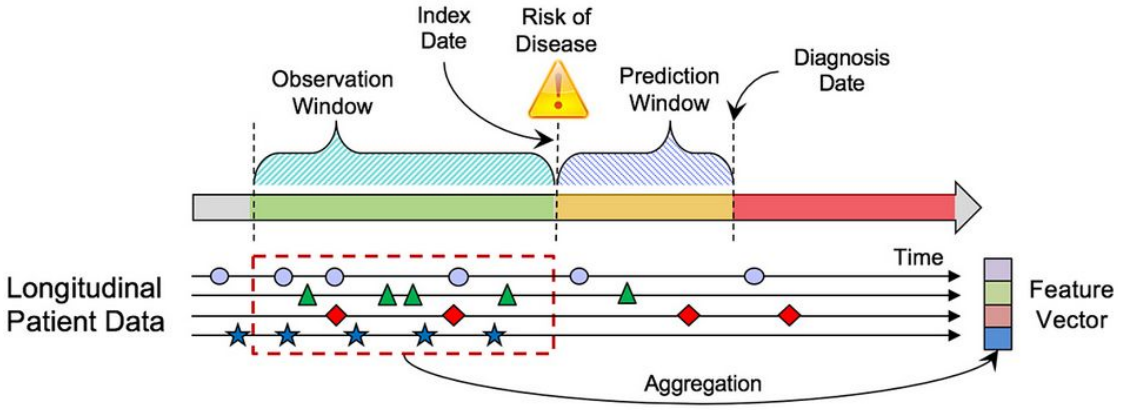
Introduction of the Database (EHR data)

- All our practices and data are HIPAA compliant
- 170 Million records from 14 clients
- Does **not** contain information such as:
  - Blood pressure
  - Weight
  - Height
  - Body mass index (BMI)
  - Blood sugar level
  - A1C score
  - Medication
  - Smoking



Condition Forecasting Setup

- **Phenotyping:**
  - Identifying patients with targeted conditions using ICD codes: positive cases for training model
  - Adding boolean features for risk factors
- Aggregating each patient medical history into one record



https://www.ibm.com/blogs/research/2017/04/using-ai-to-predict-heart-failure/

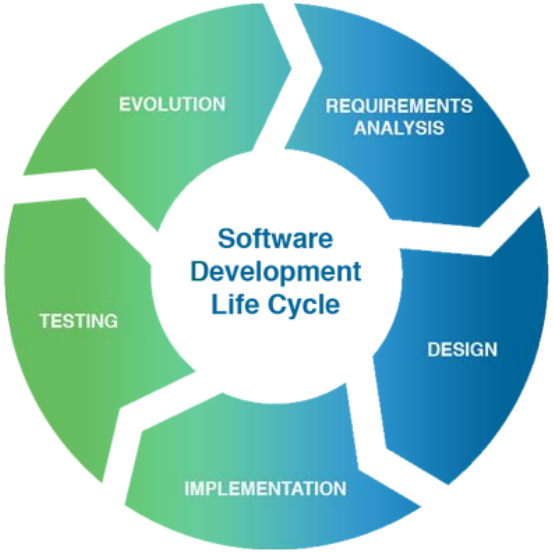
Diabetes Phenotyping

- Find patients that were diagnosed with type II diabetes using ICD codes for diagnosis
  - ICD-10: 'e11', 'e13', ...
  - ICD-9: '250', '249', '249', ...
- Excluding patients with type I diabetes
  - ICD-10: 'e10', …
  - ICD-9: '25001', '25003', ...
- Adding a boolean feature for prediabetes
  - ICD-10: 'e161', 'e162', …
  - ICD-9: 'r73', 'r81', 'r824', ...

Software Engineering For Big Data

Industry needs large scale solutions:

- Common practices of distributed computing programming
- Strict adherence to SDLC with emphasis on:
  - Extensibility:
    - Data validation at the beginning of the pipeline
    - Generic codes as much as possible
  - Continuous Integration:
    - Automating unit and integration tests using Travis CI
  - User Experience (UX):
    - Restful API for UI



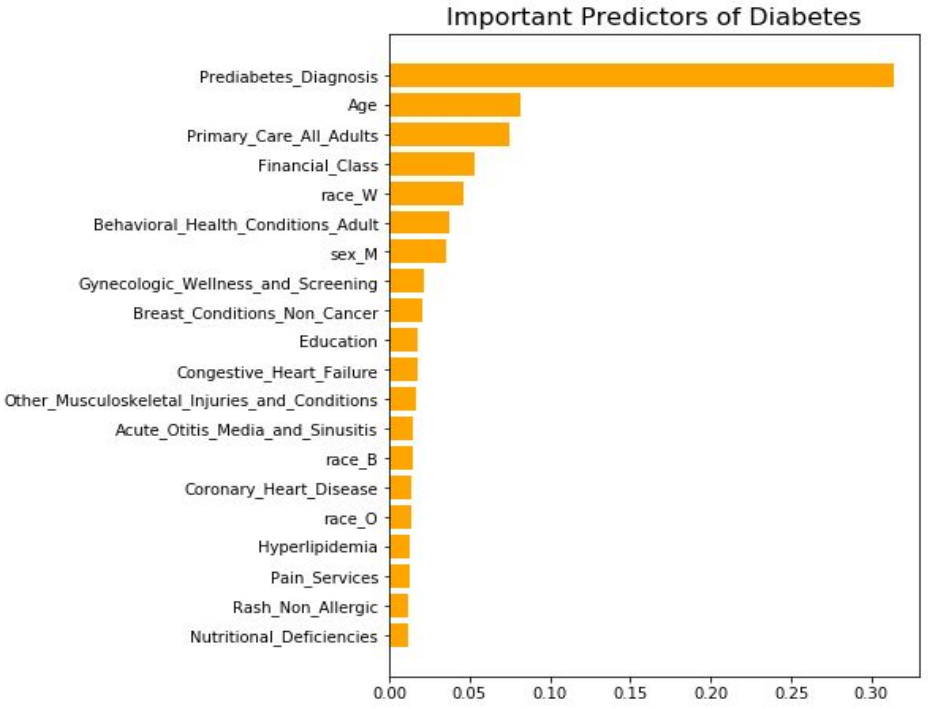
http://www.pinevalleyinstitute.co.za/introduction-software-development/sdlc/

Results

Model	Area Under Curve (AUC)
Boosting Methods XGBoost, Catboost, Light GB	78-79%
Wide and Deep	76%
Deep Neural Networks (DNN)	70%
Random Forest, Naive Bayes	69%

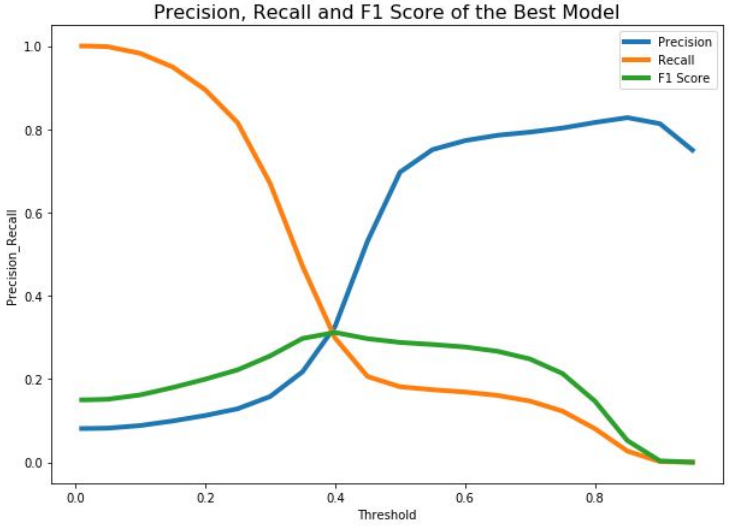
Feature Importance

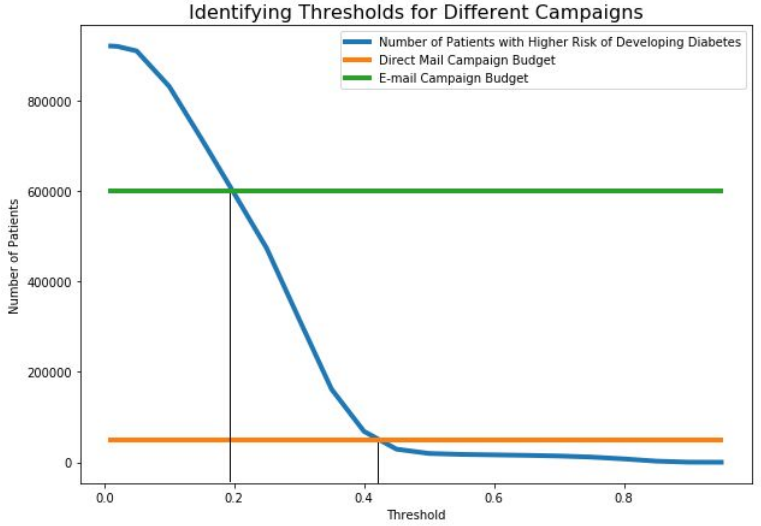
We use XGBoost to find the most important predictors of diabetes:



Make a Business Decision: Precision vs. Recall

- Depending on marketing purposes we sometimes need high precision and sometimes high recall (sensitivity).
  - High recall: Email campaign
  - High precision: Mail campaign



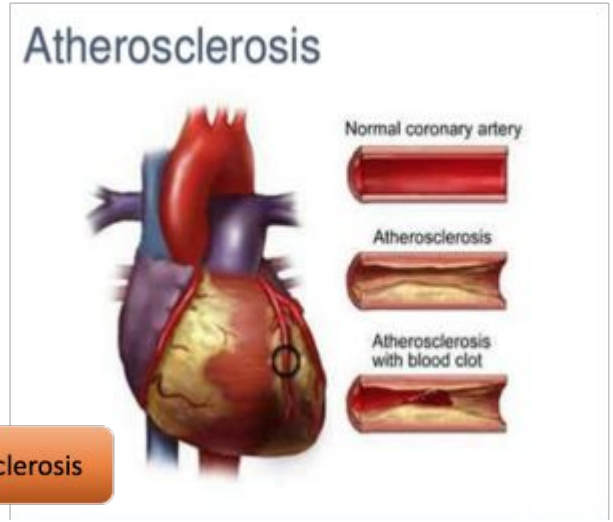


Findings and Contributions

1. Developed extensible forecasting models to assess imminent risk of diabetes, CV events and CVD in general for Healthgrades outreaching campaigns.
2. Through feature importance analysis we obtained a good insight into which health conditions affect the risk of developing certain diseases.

Future Work

https://www.slideshare.net/mpattani/atherosclerosis-59199971/1



Cardiovascular Diseases

General group

- Heart Failure
- Arrhythmia
- Cardiomyopathy
- Heart Valve Disease
- Aortic Diseases
- **Atherosclerosis**
  - Coronary Heart Disease
  - Stroke
  - Peripheral Arterial Disease

Specific group

Specific group

"Heart Disease and Stroke Statistics— 2019 Update", A Report From the American Heart Association. Mzr5, 2019. DOI: 10.1161/CIR.0000000000000659

Thank You for Your Attention!

We Welcome Your Questions,
Comments & Suggestions!