



THE UNIVERSITY OF CHICAGO
GRAHAM SCHOOL
CONTINUING LIBERAL AND PROFESSIONAL STUDIES

Hospital Re-admission Rates

Solving Patient Needs with Big Data and Machine Learning

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Big Data Platforms

Master of Science in Data Science

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Problem Statement

Hospital costs are rising partially because of high readmission rates within 30 days of patient release. Readmission rates have long been a trusted measure of effective and responsible care and have become a primary assessment driver in the healthcare industry.

The Goal

The goal is to research and design a Big data solution that will meet the patient analytics needs of a large health care provider with 500,000 customers (patients) around the world. The big data analytics platform would identify at-risk patients based on past history, chart information, and patient trends. The provider should be able to use this data to identify at-risk patients and provide the necessary care to reduce readmission rates.

Data

Data would be refreshed at numerous intervals, including at patient admission, treatment, and exit.

| Personal Information | Medical Information | Hospital Records | Financial Information |
|----------------------|-----------------------------|----------------------|-----------------------------------|
| Date of birth | Blood group | Date of admission | Insurance provider |
| Contact information | Medical history | Cause of illness | Bill amount |
| Next in kin | Test reports/Medical images | Duration of stay | Insurance claims |
| Demographics | Hospital records | Doctor-in-charge | Credit related to medical history |
| Family | Admission history | Treatments/surgeries | Employment details |

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- Clustering model that groups patients based on the propensity to re-admit; this model would help understand characteristics better of these two groups and can be used when the other predictive models disagree as a subjective tie-breaker

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- Once the at-risk patients are identified, a model will be deployed that provide follow-up recommendations to help improve readmission rates

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Analytics would be performed at numerous points in time, including patient entry, daily/intermittently as medical records are updated, patient exit (throughout the extent of possible readmission classification

Big Data Technology

Data Storage format and compression technique

- ORC stores collections of rows in one file and within the collection the row data is stored in a columnar format. This allows parallel processing of row collections across a cluster. It uses specific encoders for different column data types to improve compression further.

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Database and Query Execution Engine

- Hive for SQL like queries – as you can simply map HDFS files to Hive tables and query the data. Even the HBase tables can be mapped and Hive can be used to operate on that data.
- Hbase for real-time querying of data. It is used if the application requires random read or random write operations or both.

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Cloud vs. On premise decision

- Hosting it on the cloud may cost more if there is consistent long term usage
- It may cost less to actually build your own Hadoop cluster on premise

Estimating Data Capacity Requirements

- Number of patients: 500,000
- Average size of electronic medical records including images: 80MB
- Assuming that the readmission rate: 20%
- Growth of data: 20%

Total starting size: $500,000 \times 80MB = 0.04PB$, or about 150TB

Cluster/Node Capacity

- $H = RCS \times (1 + T) \times (1 + G)$
- Assuming $T = 10, G = 20, R = 3, C = 1, S = 0.04PB$
- $H = 3 \times 1 \times 0.04 \times (1.1) \times (1.2) = 0.1584PB = 158.4TB$
- Assuming each node has a capacity of 24 TB

$$n = \frac{H}{d} = \frac{1584}{24} = 6.6; \text{ therefore 7 nodes for initial data}$$

- R: Replication factor. Usually 3 in a production cluster.
- C: Compression ratio. When no compression is used, $C = 1$.
- S: Initial size of data that needs to be moved to HDFS.
- G: Data growth factor
- T: Temporary Space; Usually 10-25% of working space
- d: size of each data node

Monthly Cost on Average

- Hardware cost (7x per node cost): 63, 000
- Software cost (7x per node cost): 28, 000
- Environment, Power, Cooling, etc: 31, 000
- Full time employees (1x): 110, 000

Total cost: 232, 000

Approximate monthly cost: 20, 000

Architecture Diagram

Patient Predictive Engine

Powered by Machine Learning and Hadoop Cluster technology

