TecNav

Clinic Monitoring & Technician Navigation Application

Tomer Danon & Romith Challa

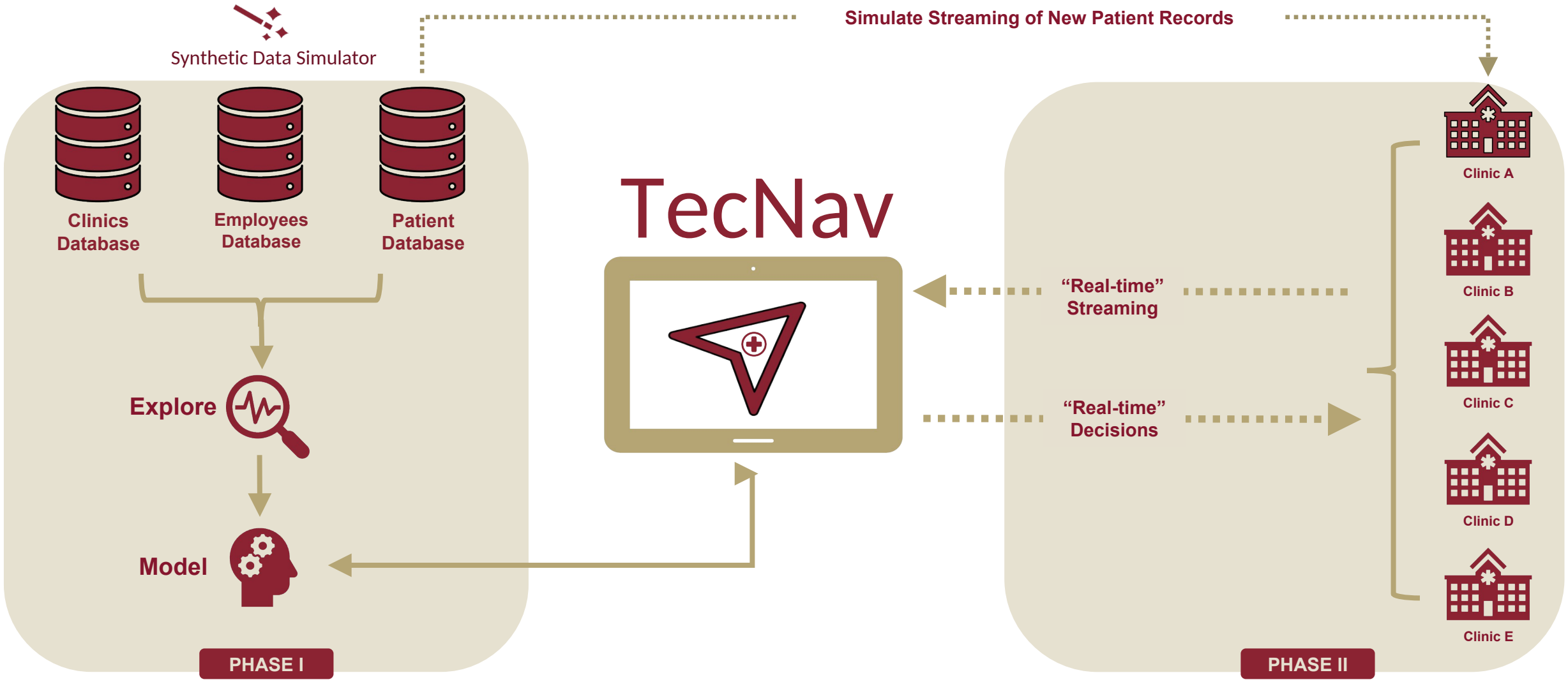
Project Overview

Background & Pitch

Background	Rapid growth of on-demand care
Challenge	Unpredictable patient traffic
Use-Case	Shuffle technicians across clinic branches on per-need basis
Pitch	Automated Real-Time ML-powered Application: **TecNav**

UNIVERSITY of DENVER
DANIEL FELIX RITCHIE SCHOOL
OF ENGINEERING & COMPUTER SCIENCE

Project Pipeline



Synthetic Data Simulation

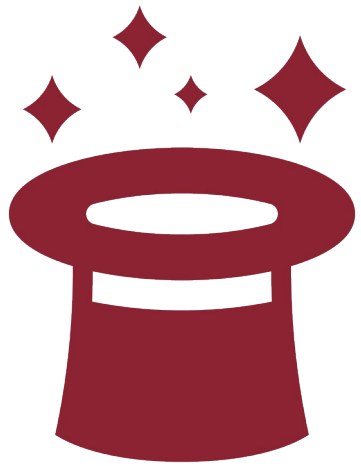
Overview

Data Source
- No publicly-available sources – simulate!
- Road-Block: Patient registration logs

Objective
- Emulate real-world data

Challenges
- Strategize based on secondary research
- Balance between consistency across datasets, while maintaining real-world variation

Datasets
- Past patient records, clinic info, employee records, new patient logs (for streaming)



UNIVERSITY of DENVER
DANIEL FELIX RITCHIE SCHOOL
OF ENGINEERING & COMPUTER SCIENCE

Synthetic Data Simulation

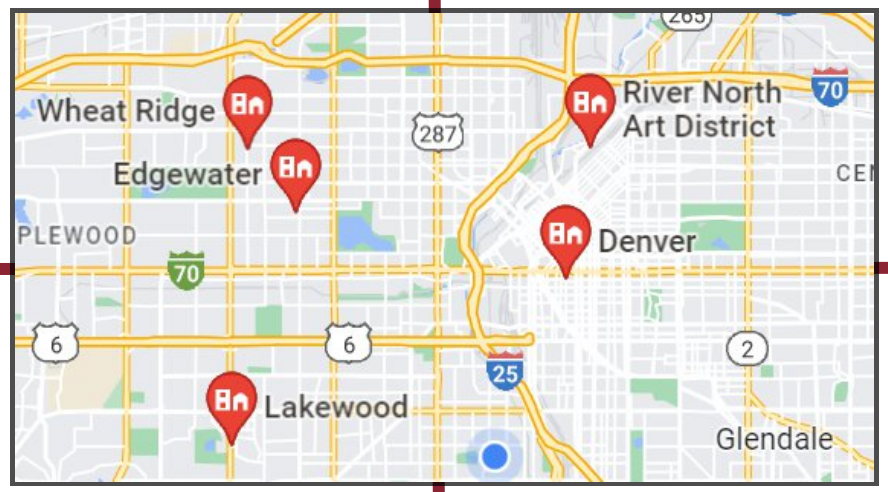
Approach

Patient Records

- IDs
- Ages
- Visit Reasons
- Names, D.O.B.

Employee Records

- IDs
- Names
- Roles



Clinic Info

- Names / Locations
- Distances
- Capacity

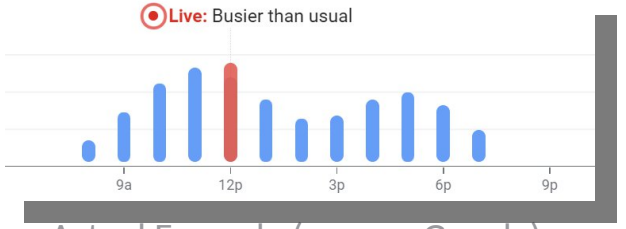
Visit Records

- Severity Level
- Visit Lengths
- Check-In Times

Synthetic Data Simulation

Patient Traffic – Check-in Times

```
# Denver-Clinic:
denver_ctime_specs = {
    'weekday_means1': [8, 8.25, 8.5, 8.75, 9],          # First weekday peak possibilities of Denver location
    'weekday_means2': [11, 11.25, 11.5, 11.75],         # Second weekday peak possibilities of Denver location
    'weekday_means3': [16, 16.25, 16.5, 16.75],         # Third weekday peak possibilities of Denver location
    'weekday_sigmas': [1.8, 1.9, 2.1, 2.2],             # Possible weekday variations (standard-deviations)
    'weekend_means1': [10.5, 11, 11.5, 12],             # First weekend peak possibilities of Denver location
    'weekend_means2': [14, 14.5, 15, 15.5],             # Second weekend peak possibilities of Denver location
    'weekend_means3': [17, 17.25, 17.5, 17.75],         # Third weekend peak possibilities of Denver location
    'weekend_sigmas': [1.8, 1.9, 2.1, 2.2]              # Possible weekend variations (standard-deviations)
}
```



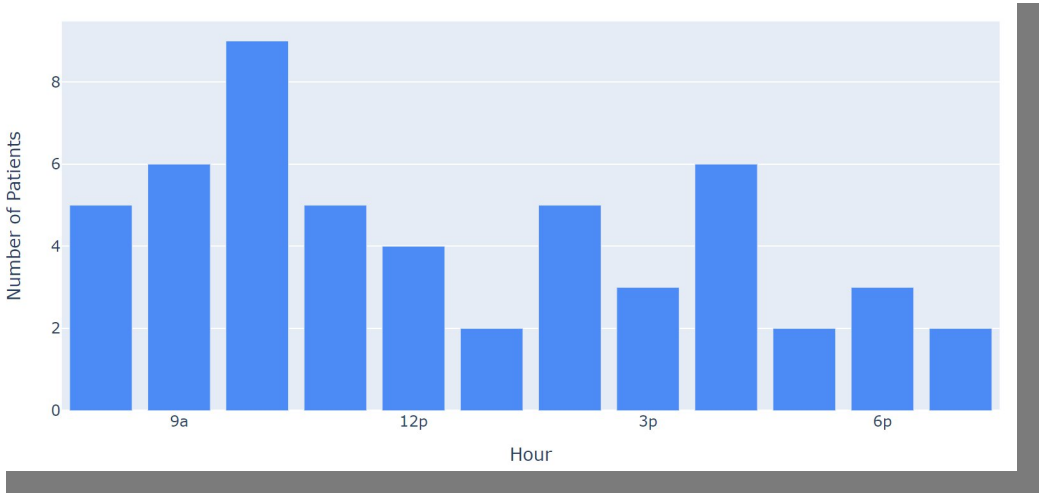
Actual Example (source: Google)

Multi-modal

- Multiple peaks

Variations

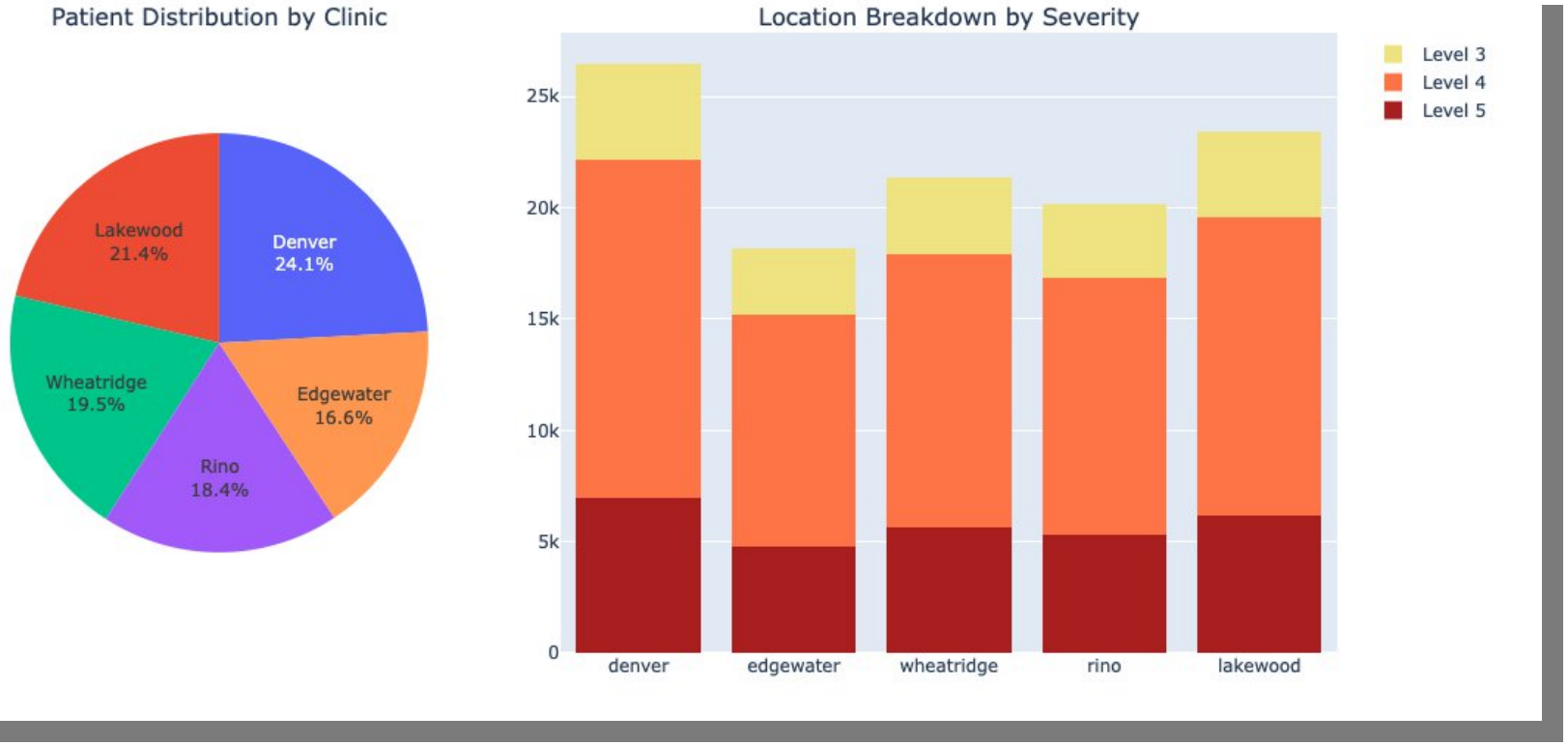
- Randomly sampled Means & SDs
- By day (weekday vs. weekend)
- By location



Simulated Example

Exploratory Data Analysis

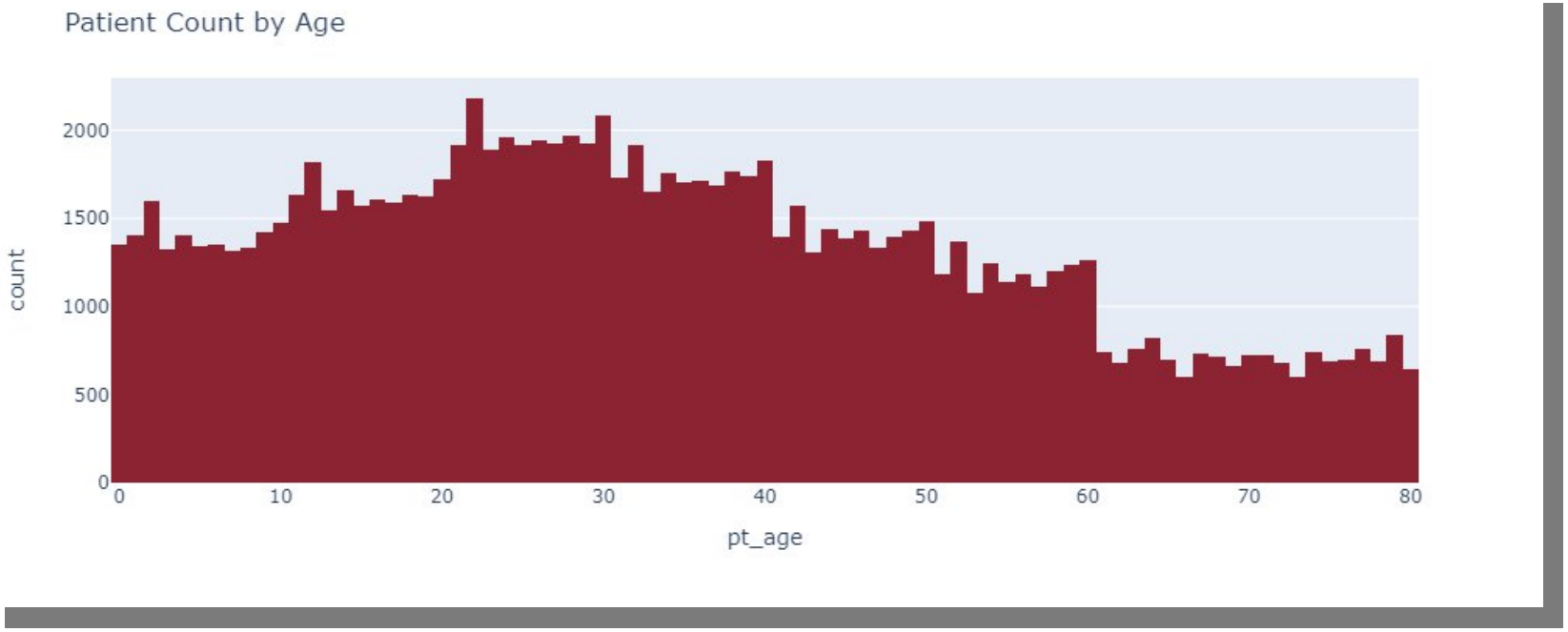
Patient Traffic by Location



- Denver (most-populated) sees highest patient traffic
- Edgewater (least-populated) has smallest capacity
- Distribution of severity levels standardized across locations

Exploratory Data Analysis

Patient Demographics



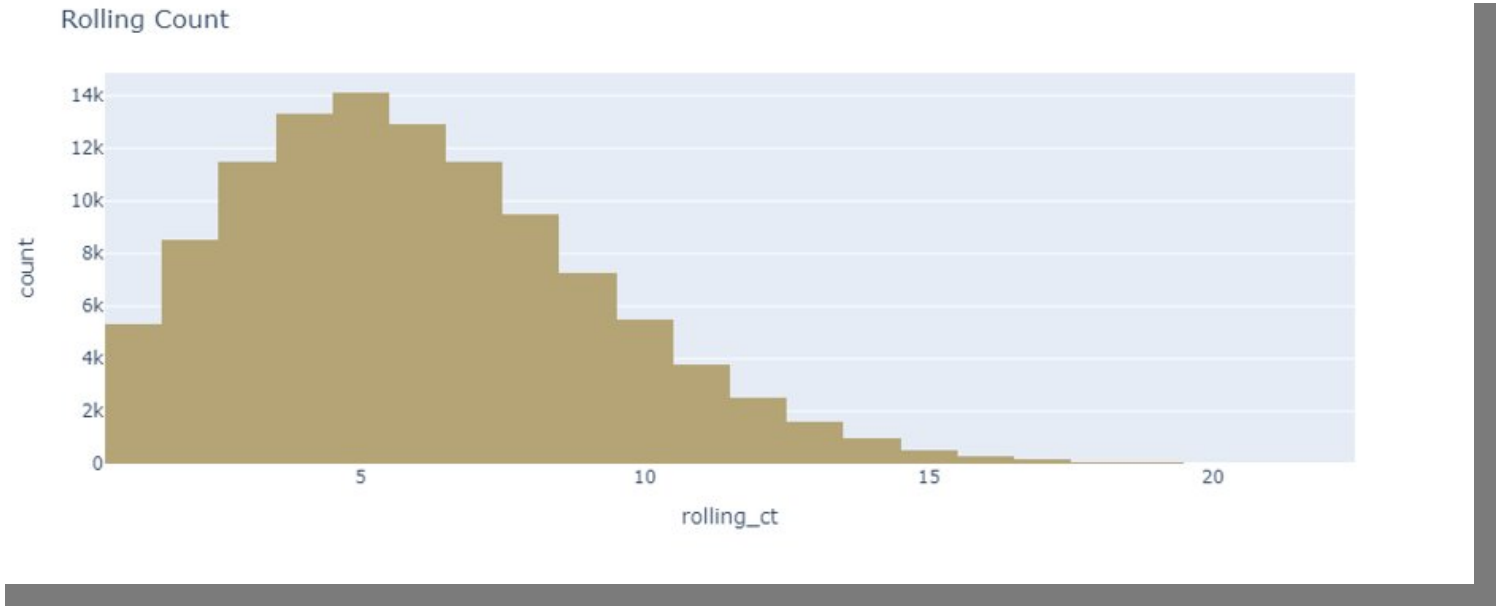
Age-Group Breakdown

- Infant to 10: 14%
- 11 - 20: 15%
- 21 - 30: 18%
- 31 - 40: 16%
- 41 - 50: 13%
- 51 - 60: 11%
- 61+: 13%

UNIVERSITY of DENVER
DANIEL FELIX RITCHIE SCHOOL
OF ENGINEERING & COMPUTER SCIENCE

Exploratory Data Analysis

Rolling Patient Count



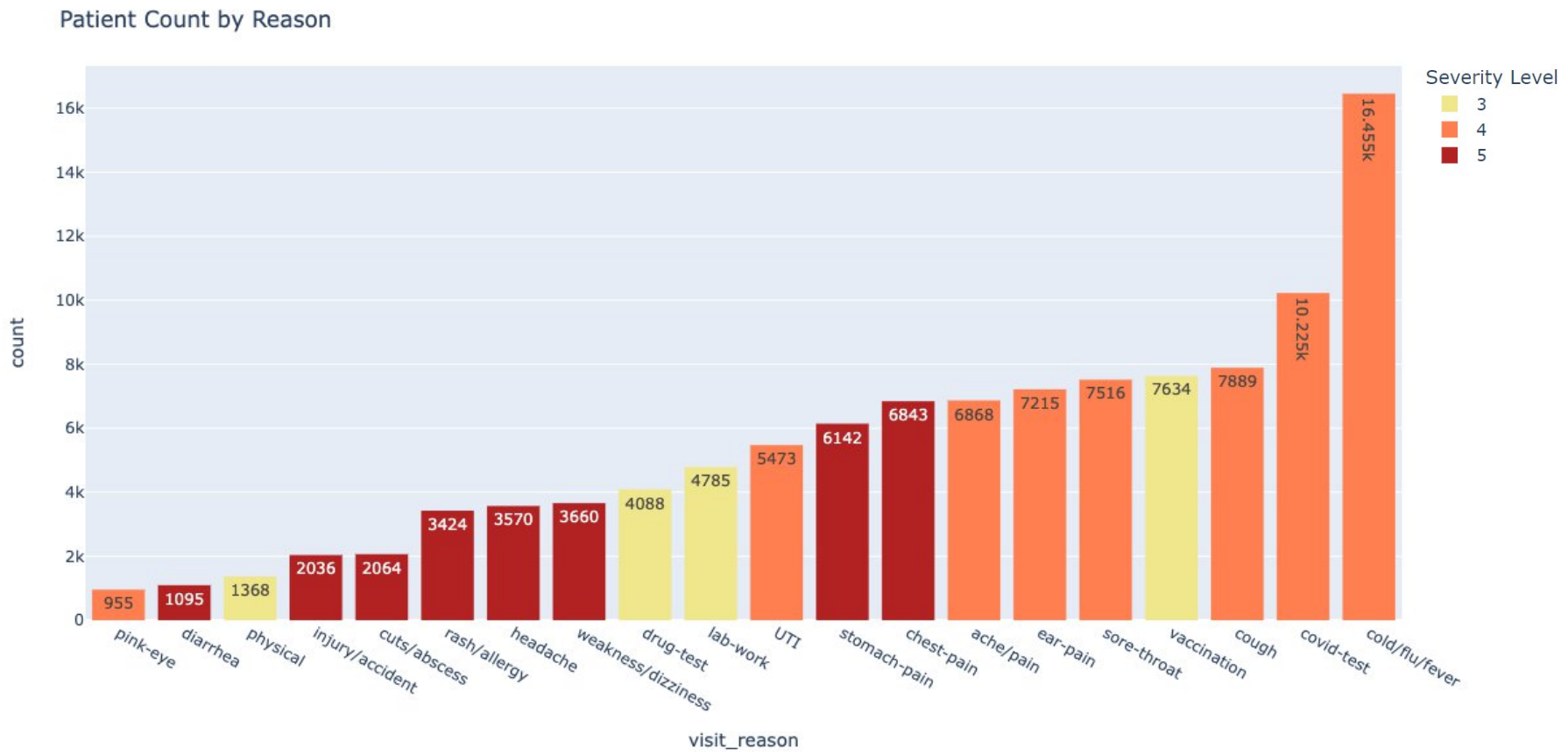
Based on past patient records (May 2021 – Apr 2022):

- Most common rolling count: 5-6
- Can extend up to 20
- Slight variations based on clinic location

Exploratory Data Analysis

Visit Reasons

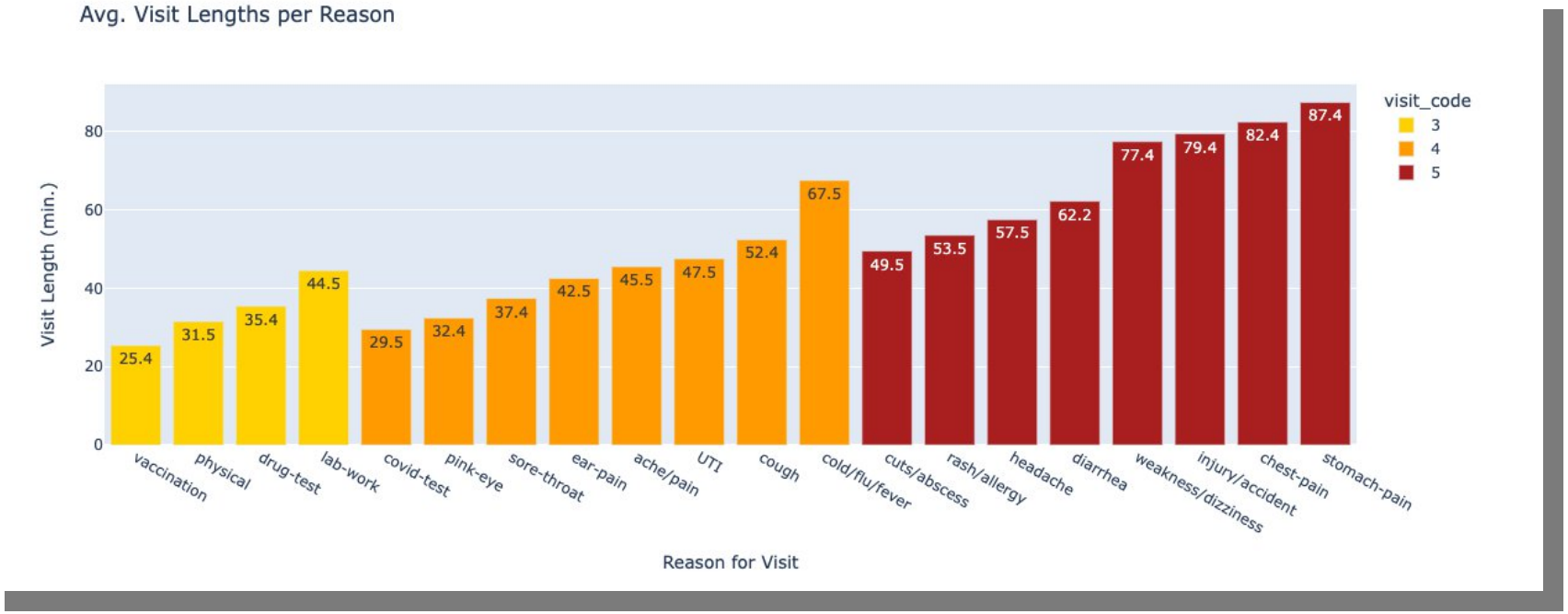
- Visit reason proportions emulate CDC's ER estimates
- Cold/Flu/Fever: most common reason for visit
- Severity Level-4 visits are most common



UNIVERSITY of DENVER
DANIEL FELIX RITCHIE SCHOOL
OF ENGINEERING & COMPUTER SCIENCE

Exploratory Data Analysis

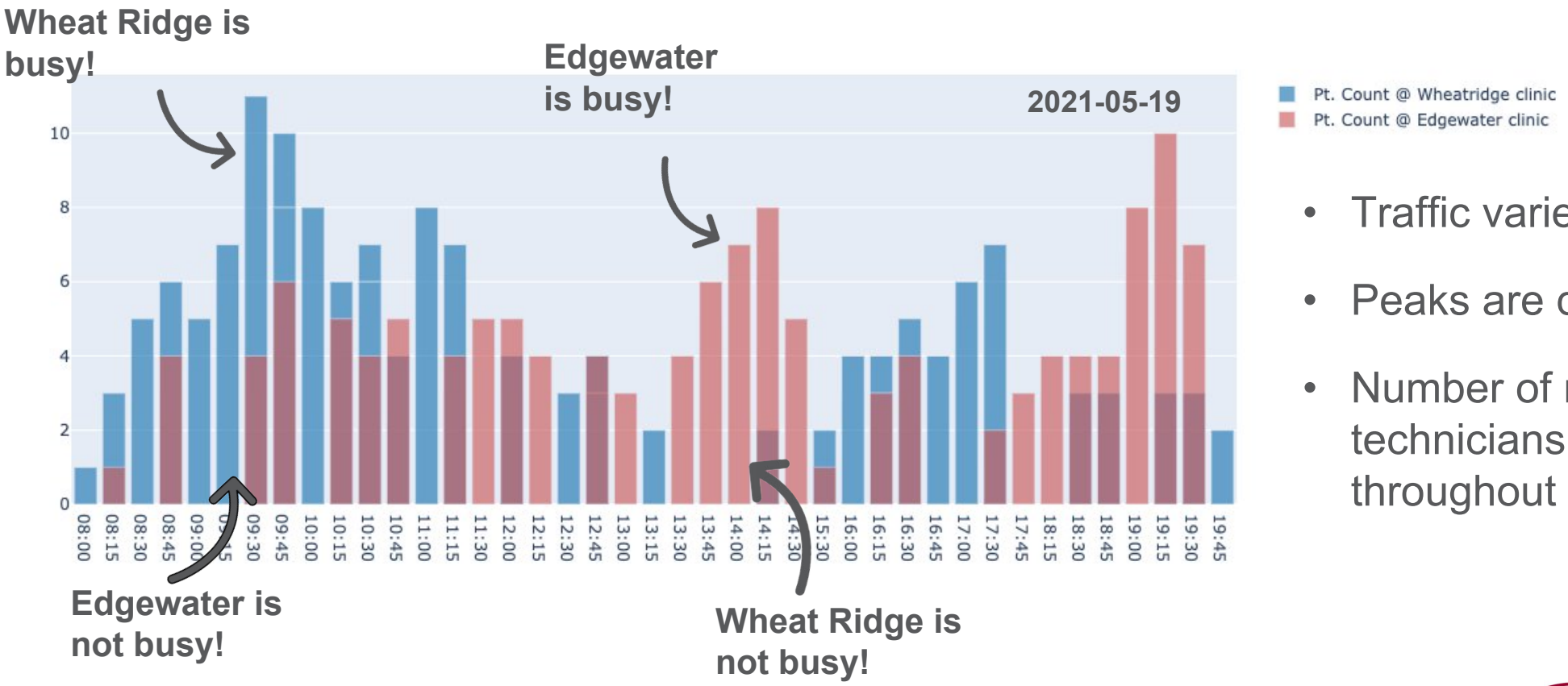
Visit Length



- Level-3 visits ("non-urgent") have quickest visit times
- Level-5 visits have longest durations
  - Additional diagnostic or therapeutic measures

Exploratory Data Analysis

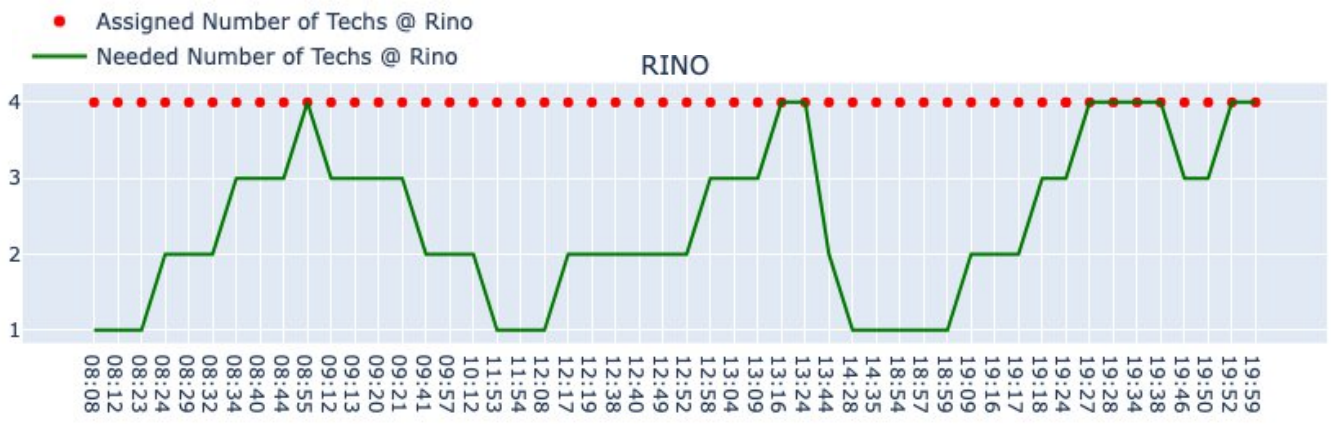
Patient Traffic by Location



- Traffic varies by clinic
- Peaks are different
- Number of required technicians changes throughout the day

Exploratory Data Analysis

Scheduled Technician Count



Scheduling technicians based on anticipated "peak" hours leads to inefficient use of resources (red dotted line)

Dynamic scheduling that adapts based on clinic's current needs can mitigate these inefficiencies

Modeling

ML - Regression

"Is it feasible to transfer a technician?"

Model: Random Forest Regressor

Prediction: How many technicians are needed in the next hour?

Evaluation: RMSE = 0.72 (< 1 technician)

Use: Assess whether a technician can be transferred at a given time

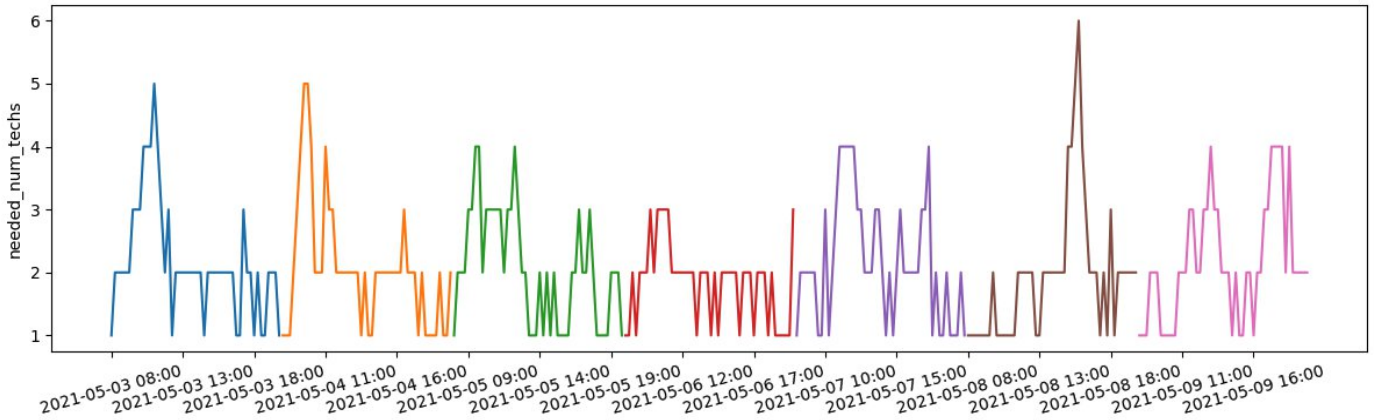
Modeling

Time Series - ARIMA

(Integrated)

AR I MA

(Autoregressive) (Moving-Average)

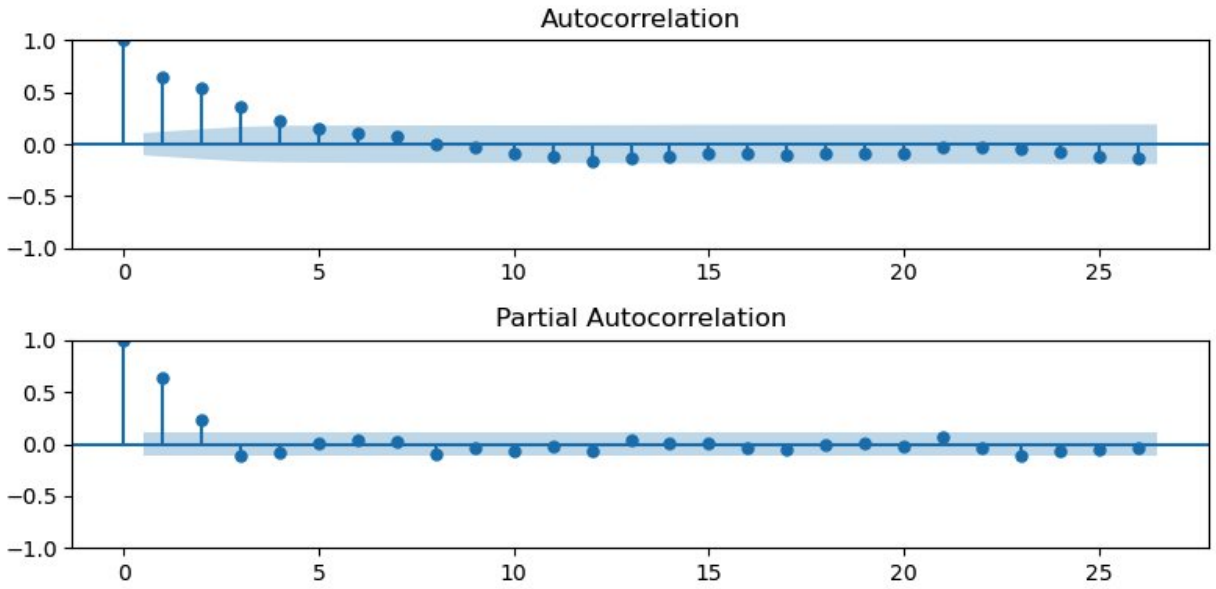


Augmented Dickey-Fuller Test

```
ADF Test Statistic:  -6.393478079011247
p-value:  2.0781867199569106e-08
# of Lags Used:  2
# of Obs. Used:  333
```

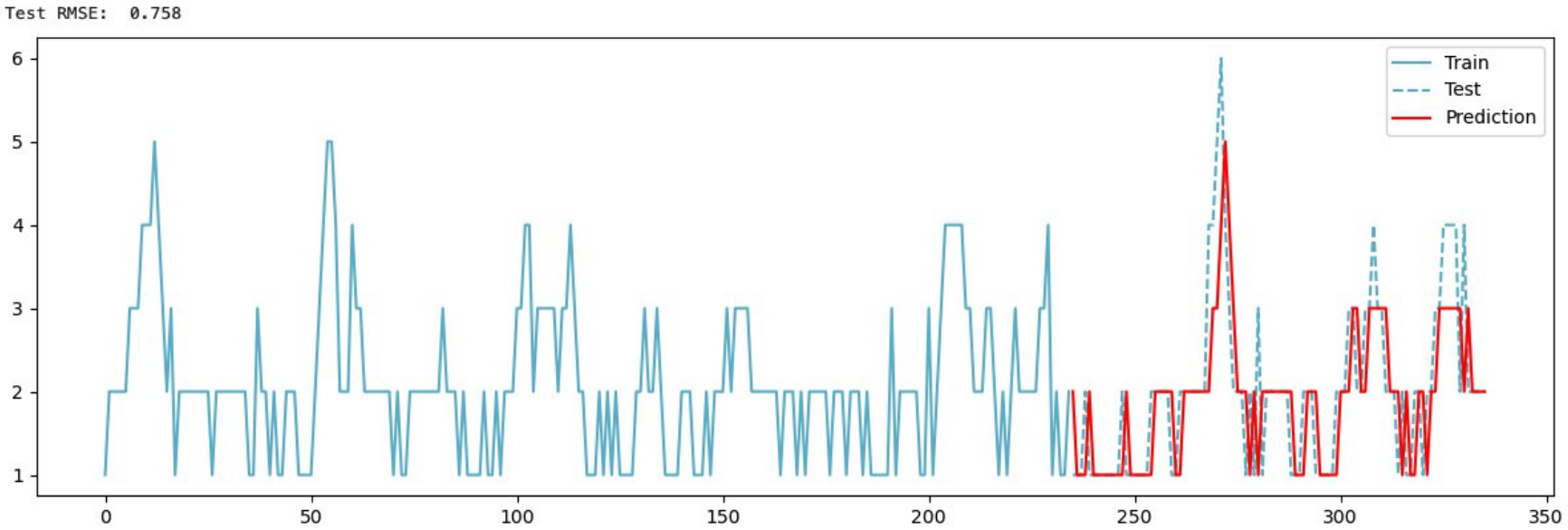
REJECT H_0!

✓ Data is **stationary!**



Modeling

Time Series - ARIMA



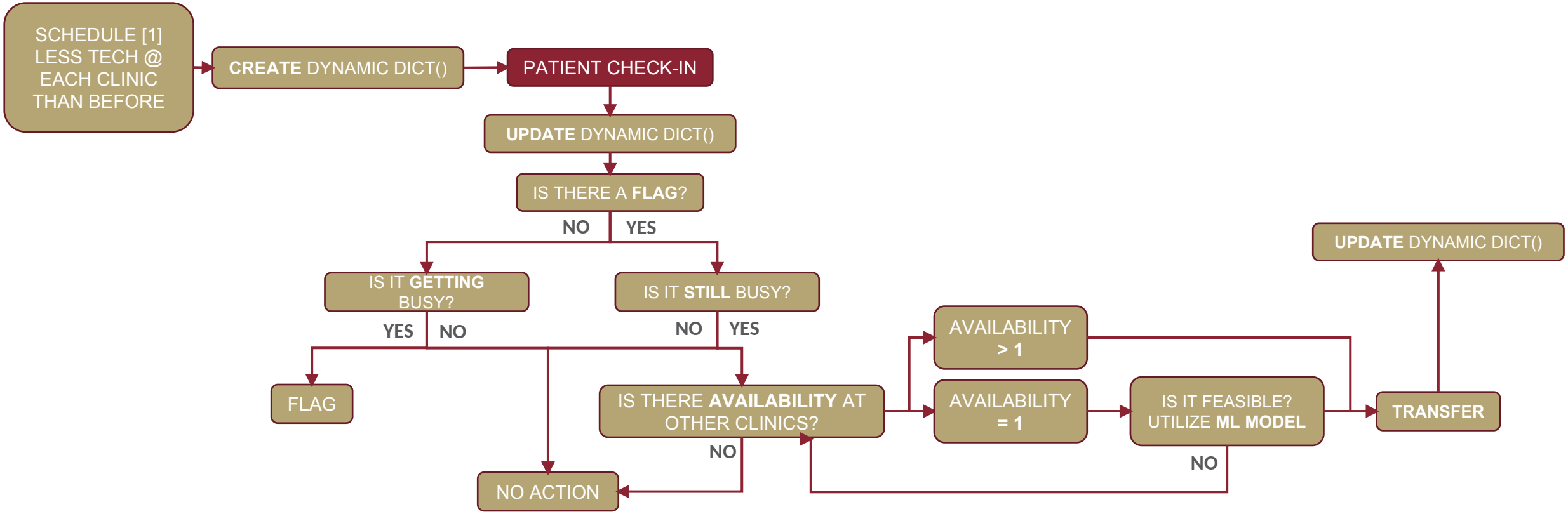
RMSEs (05-2021):

- Denver: 0.69
- Wheat Ridge: 0.67
- Edgewater: 0.72
- RiNo: 0.65
- Lakewood: 0.67

CONSIDERATIONS: Model Performance | Time / Model Complexity | Algorithm Integration

TecNav Algorithm

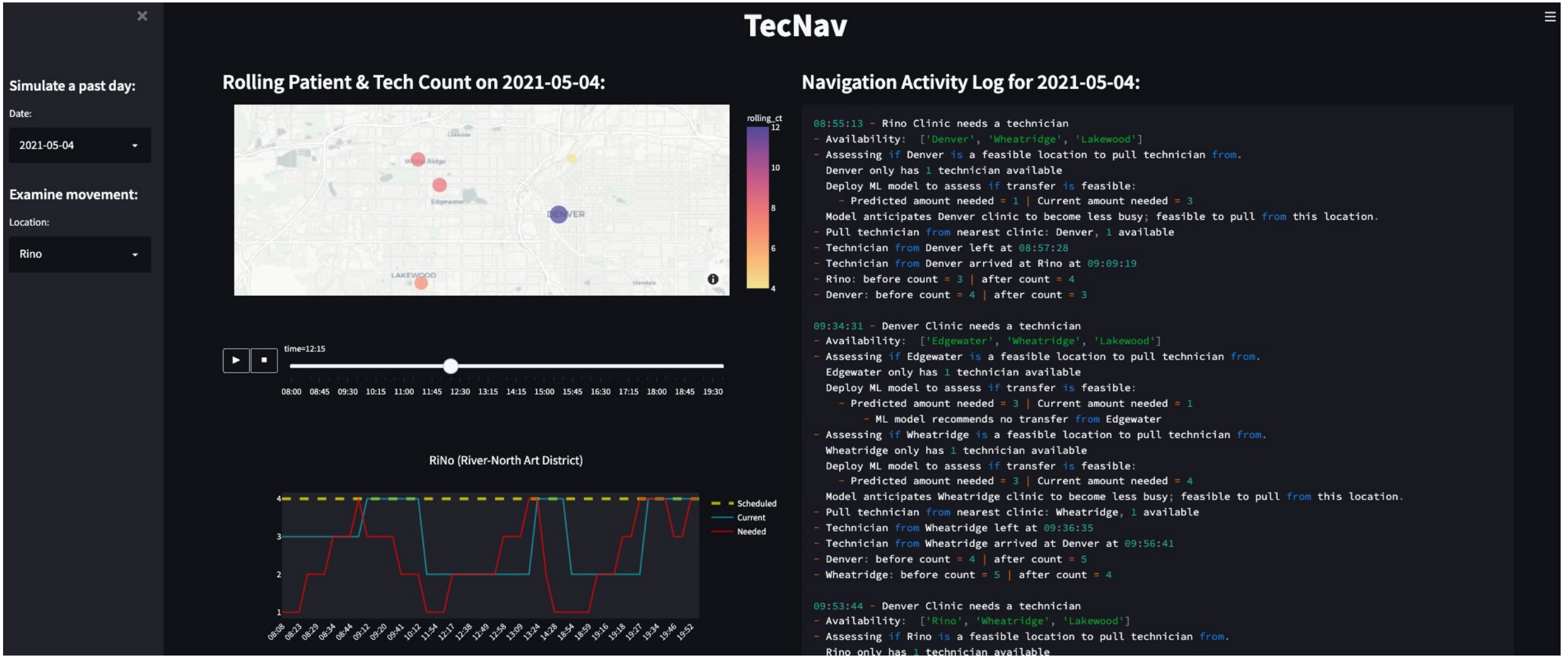
Custom Decision-Tree



UNIVERSITY of DENVER
DANIEL FELIX RITCHIE SCHOOL OF ENGINEERING & COMPUTER SCIENCE

Demo

Interactive Prototype of Software Application



Conclusions & Recommendations

Client Success Metrics

For our chain of 5 clinics, TecNav recommends:

- **5 less** technicians per day
  - No need for navigator
- **$91,980** savings in yearly compensation ($7665/month)
  - ~$21/hr (avg. Denver wage)
- **357** moves a month
  - Gas reimbursements: **$264**
  - Based on distances & Denver gas prices
- **Total yearly savings: $88,812***

**Minus a TecNav subscription fee* ;-)

Savings can be applied to:

- Expand scope of services
  - Advanced diagnostic tools
  - Imaging equipment
- Minimize cost to patients

UNIVERSITY of DENVER
DANIEL FELIX RITCHIE SCHOOL
OF ENGINEERING & COMPUTER SCIENCE

Project Reflections

Challenges & Future Directions

Technical Challenges

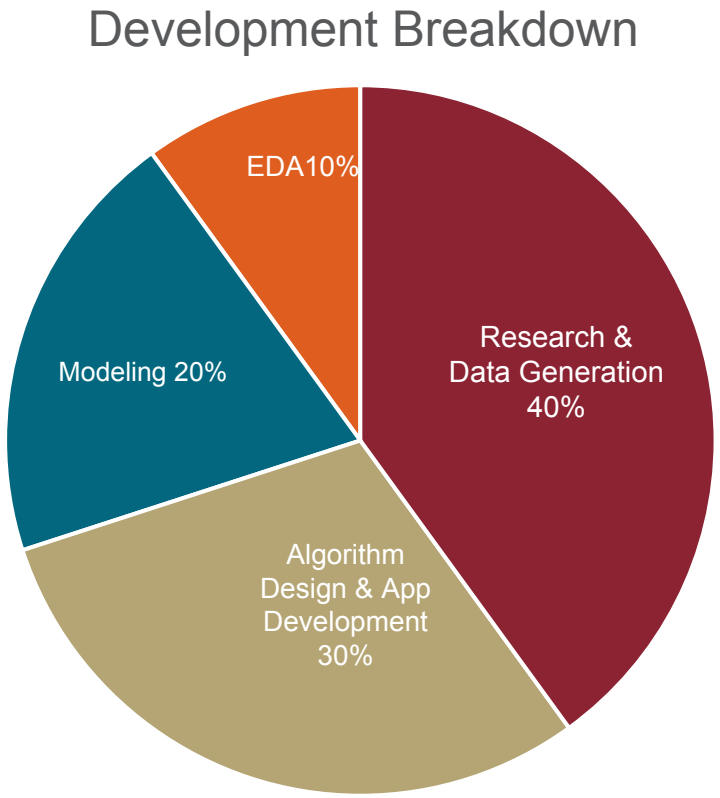
- Synthetic data tuning
- Translatable study design

Improvements

- Extra layers of sophistication
- Manual "Grid-Search"

Alternative Strategies

- Broaden applicability
- Wait-Time focus



UNIVERSITY of DENVER
DANIEL FELIX RITCHIE SCHOOL OF ENGINEERING & COMPUTER SCIENCE

Thank you!

Tomer.Danon@du.edu

Romith.Challa@du.edu

Connect with us!