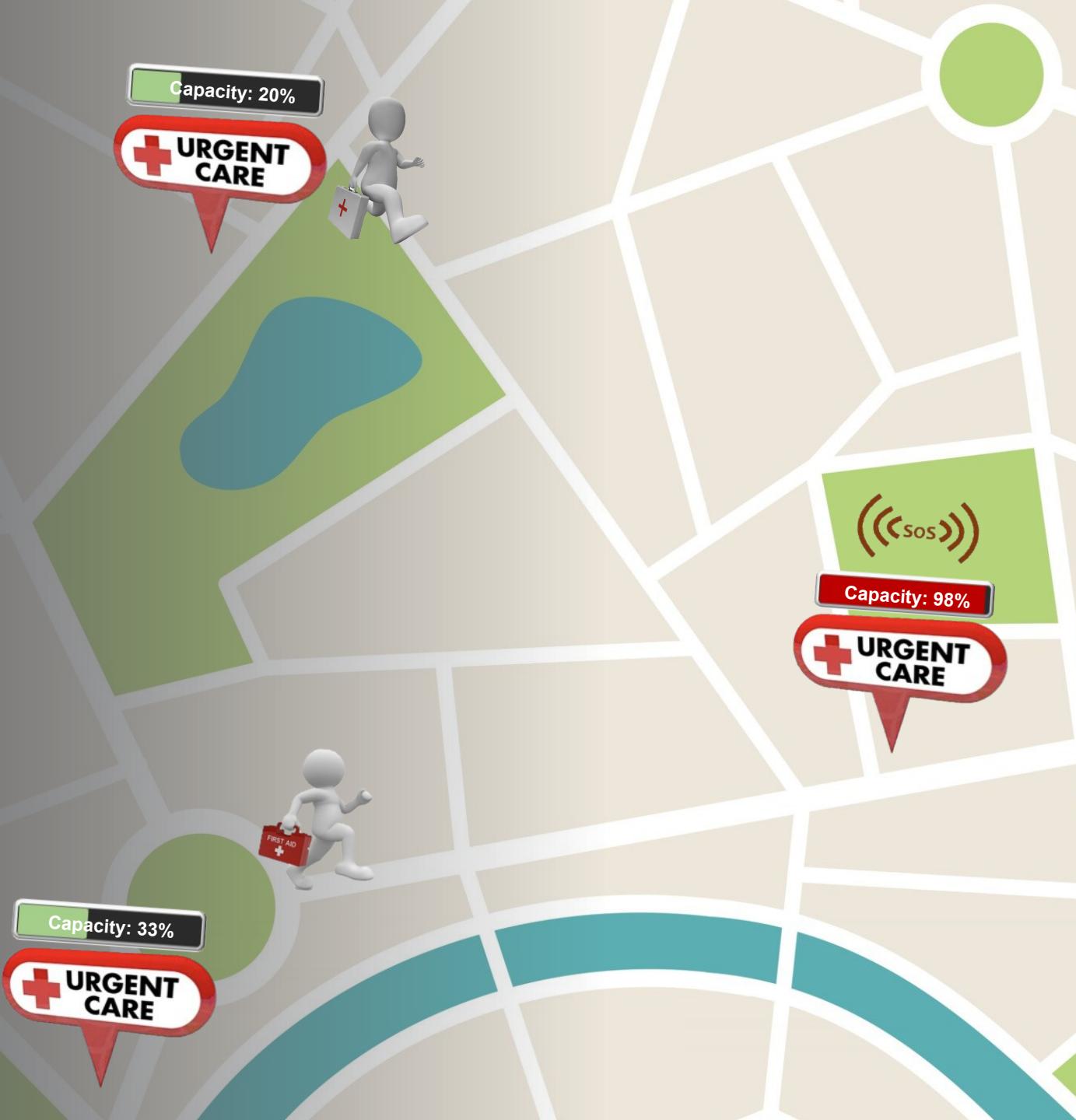


# TecNav

---

Clinic Monitoring & Technician  
Navigation Application



# 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

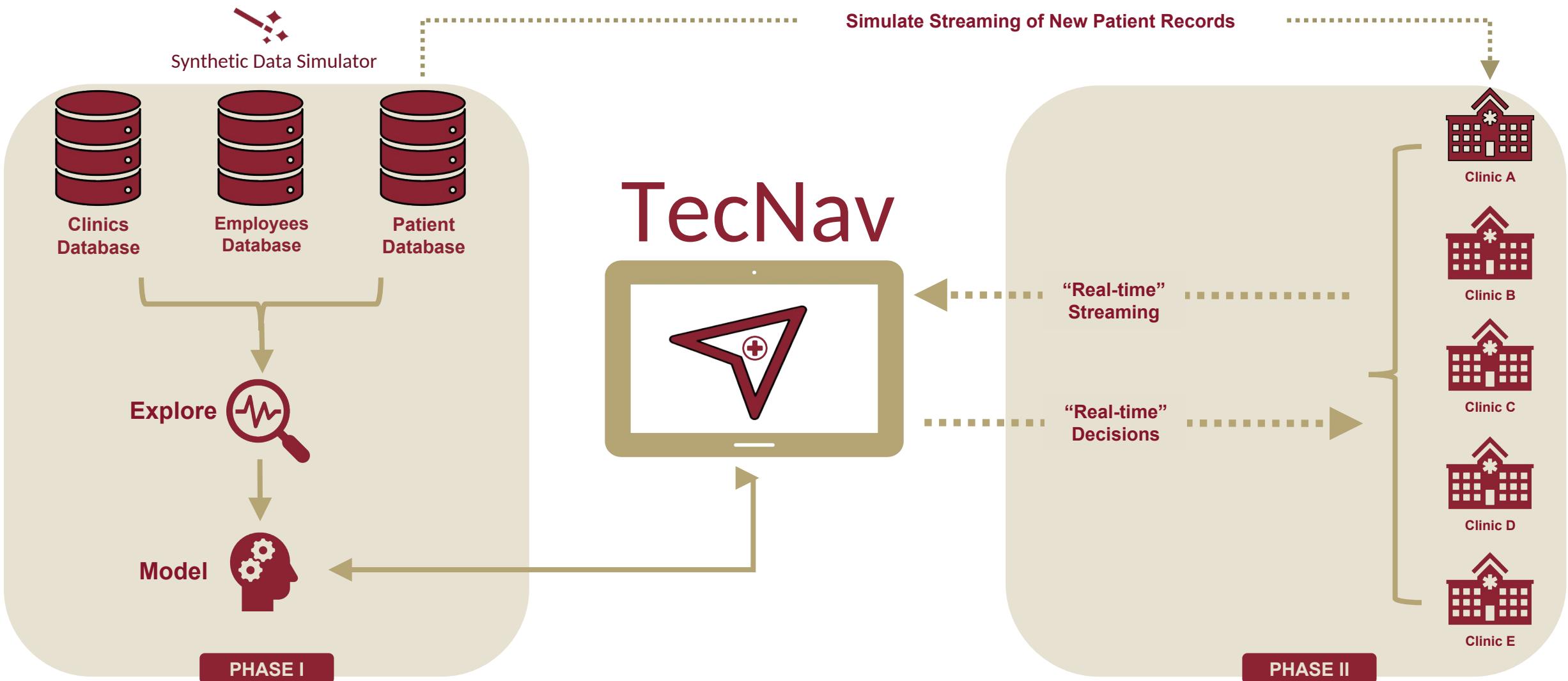
Automated Real-Time ML-powered Application:  
**TecNav**



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# Project Pipeline



# Synthetic Data Simulation

## Overview

### Data Source

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

### Objective

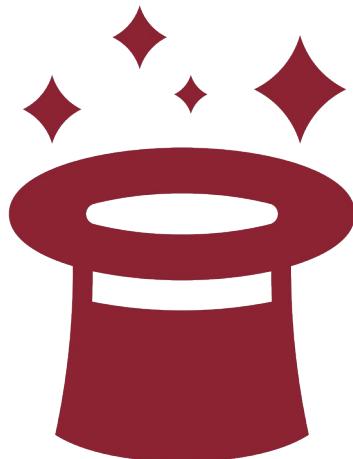
- Emulate real-world data

### 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)



# Synthetic Data Simulation

## Approach

### Patient Records

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

### Clinic Info

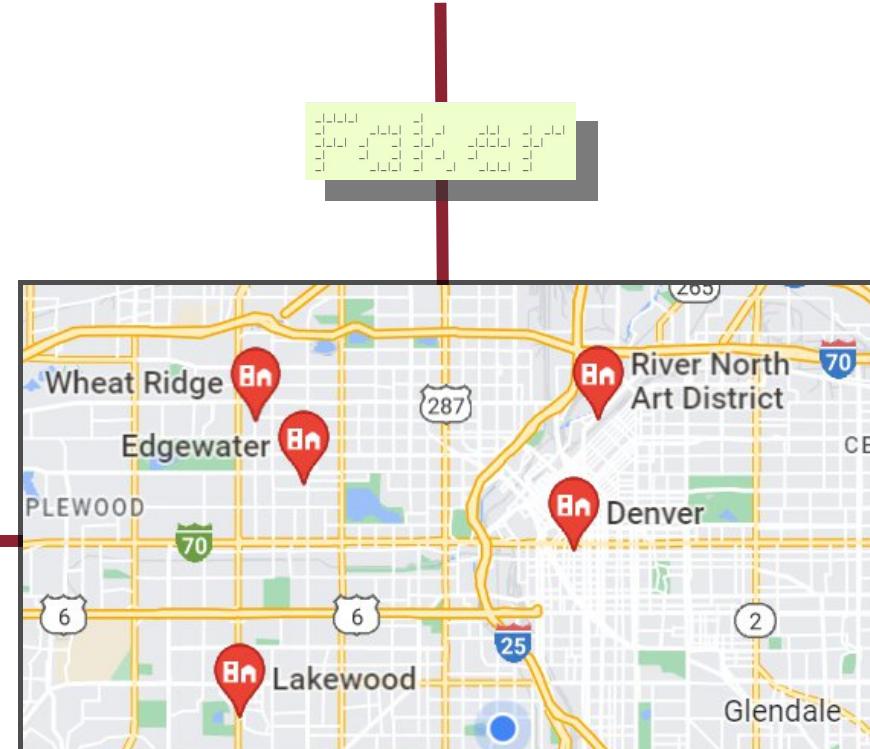
- Names / Locations
- Distances
- Capacity

### Employee Records

- IDs
- Names
- Roles

### Visit Records

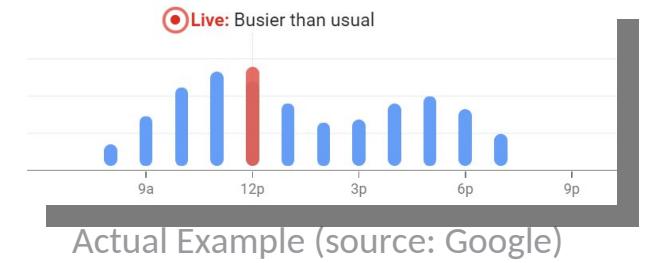
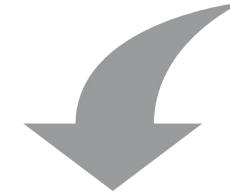
- Severity Level
- Visit Lengths
- Check-In Times



# Synthetic Data Simulation

## Patient Traffic – Check-in Times

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

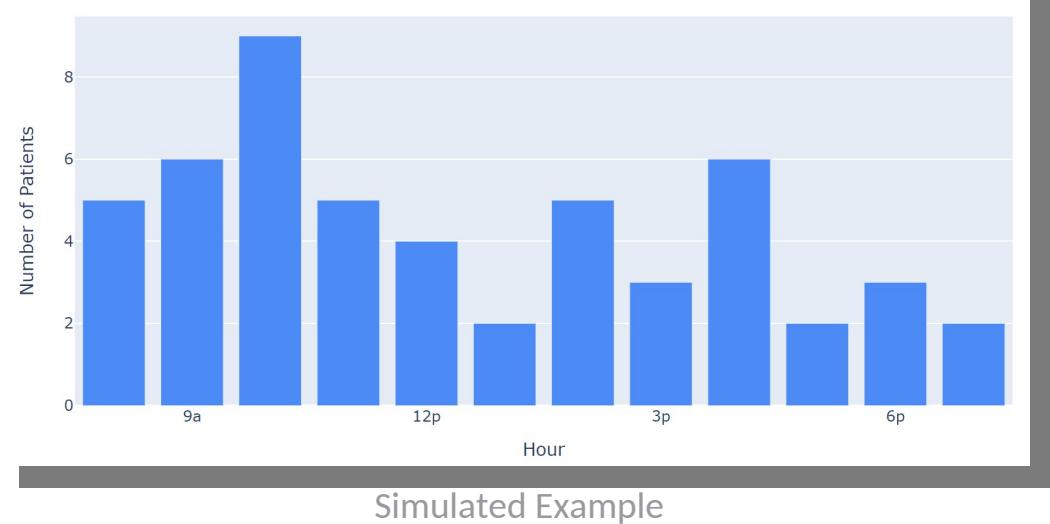


### Multi-modal

- Multiple peaks

### Variations

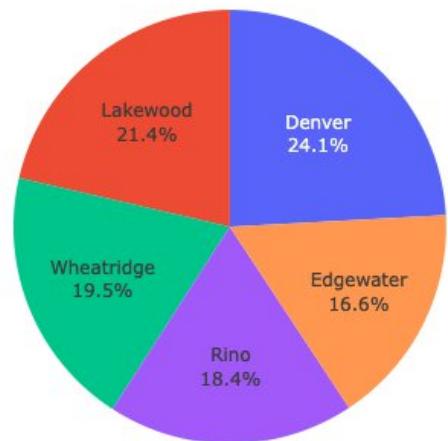
- Randomly sampled Means & SDs
- By day (weekday vs. weekend)
- By location



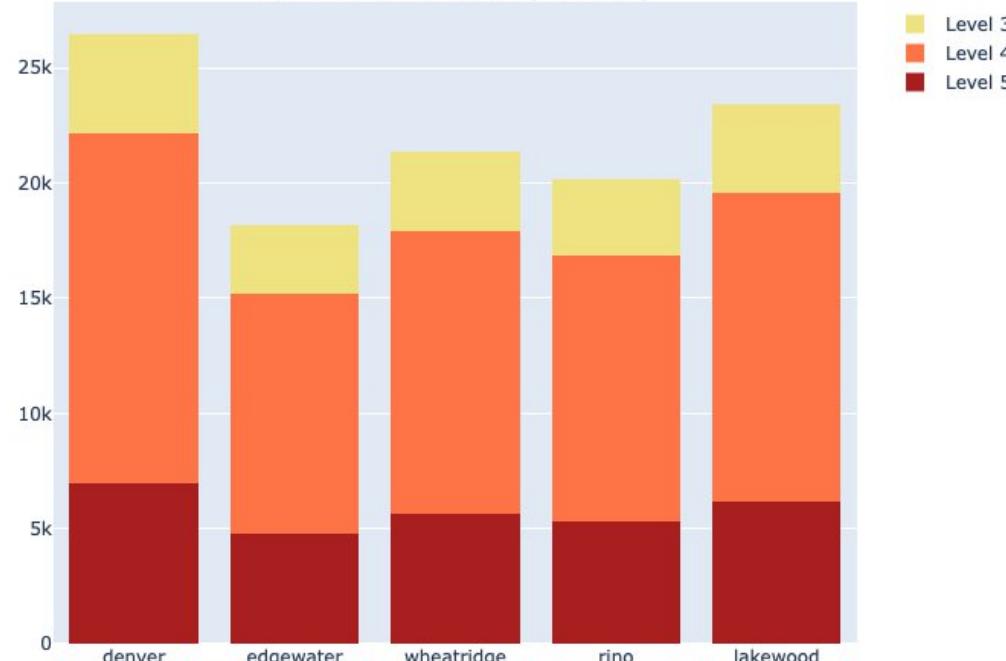
# Exploratory Data Analysis

## Patient Traffic by Location

Patient Distribution by Clinic



Location Breakdown by Severity



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

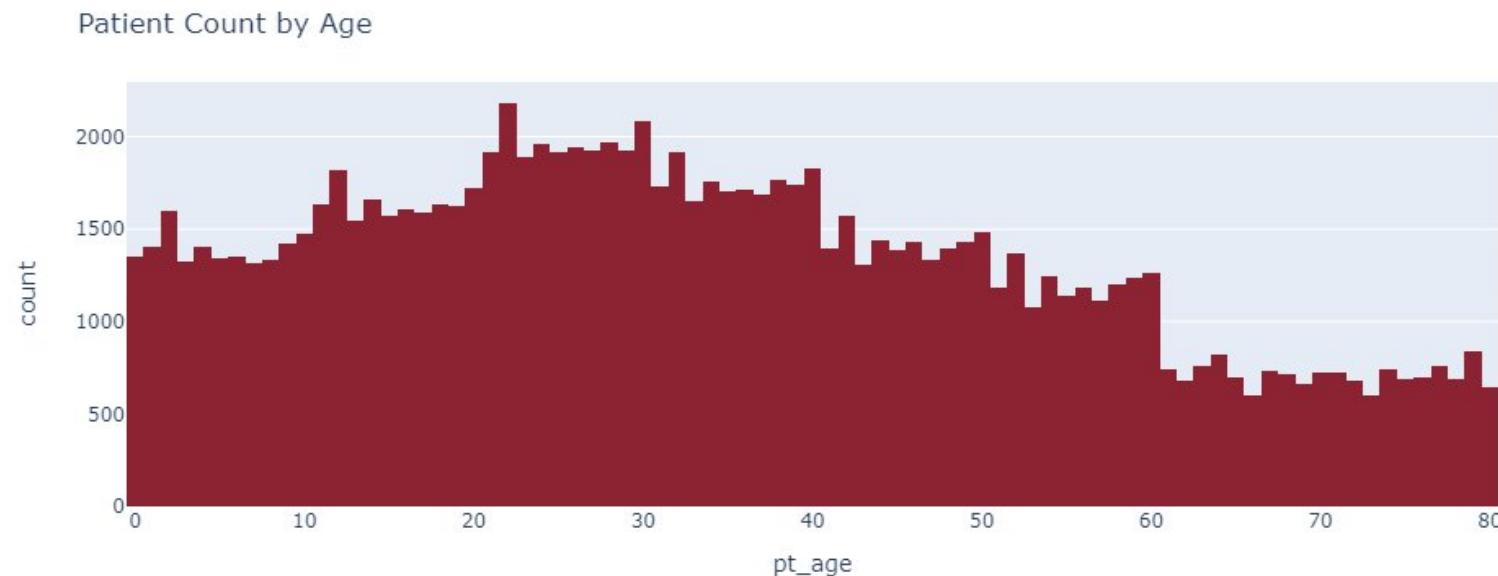


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# Exploratory Data Analysis

## 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%

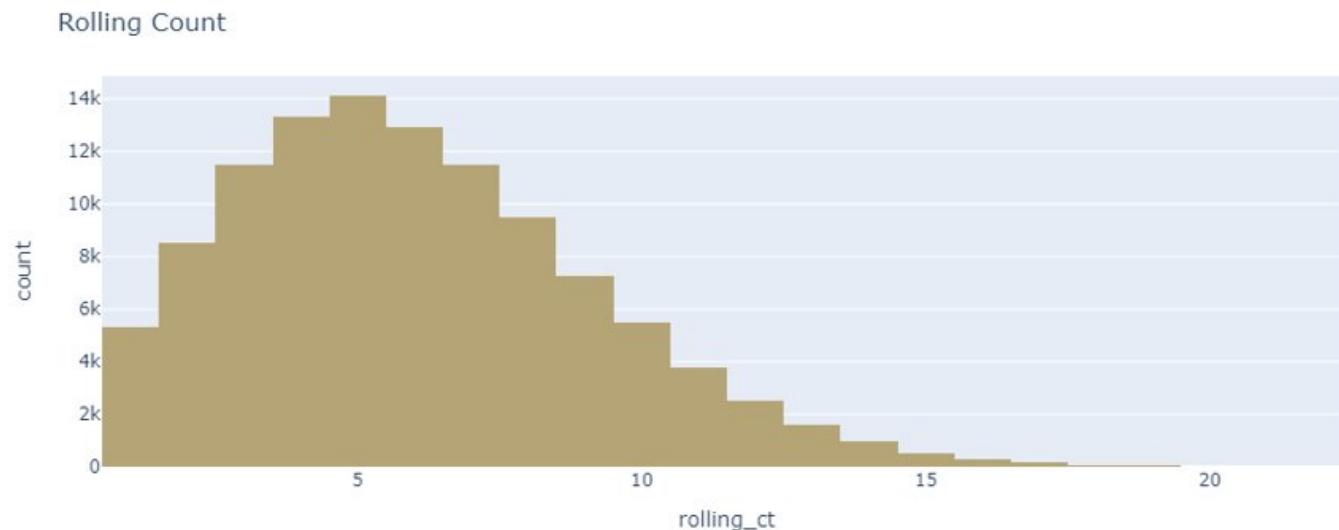


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# Exploratory Data Analysis

## 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



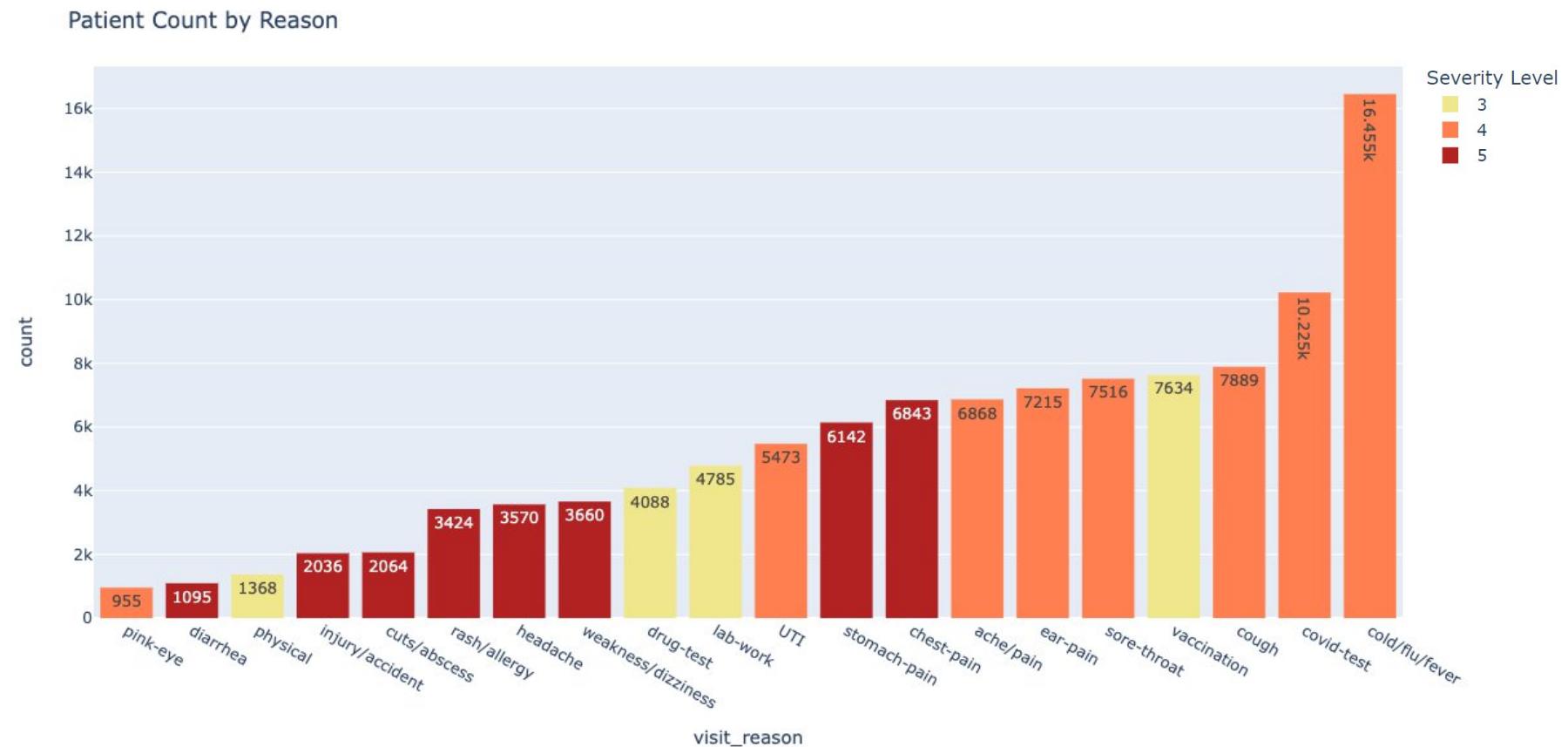
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# Exploratory Data Analysis

## 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

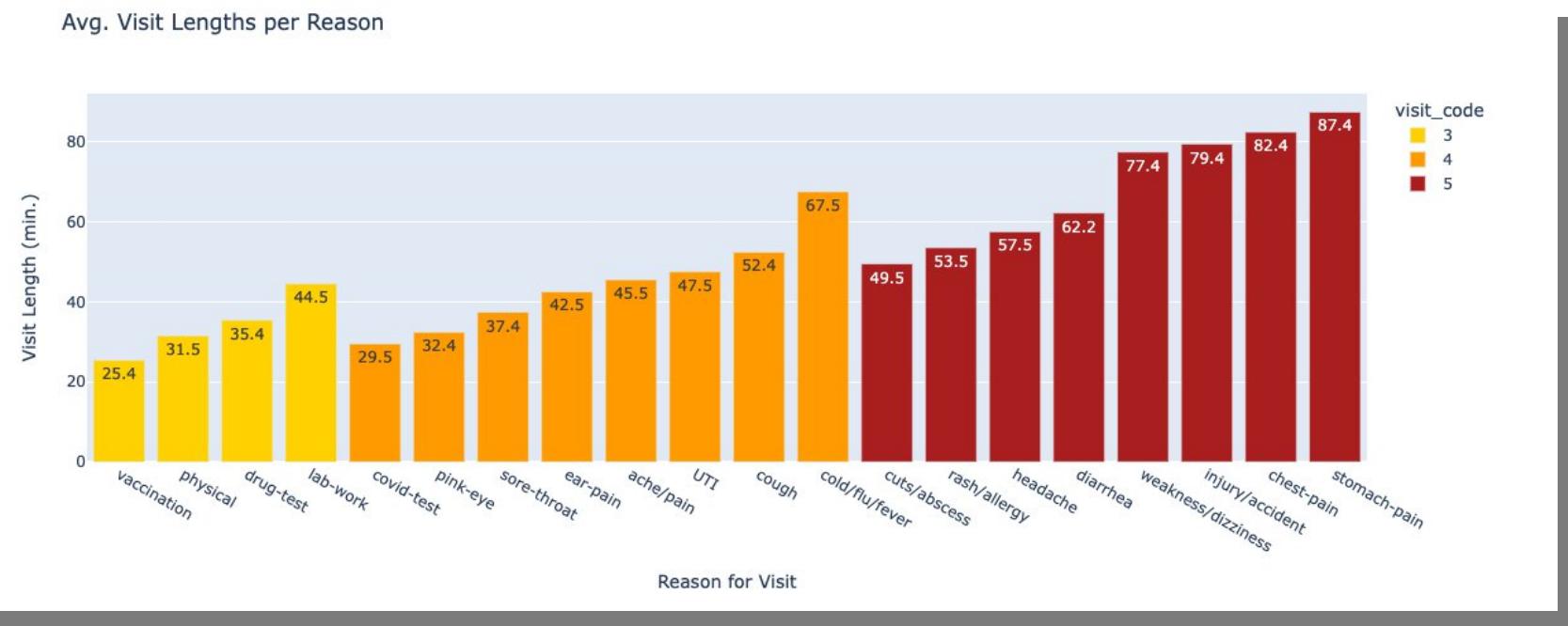


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# Exploratory Data Analysis

## Visit Length



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



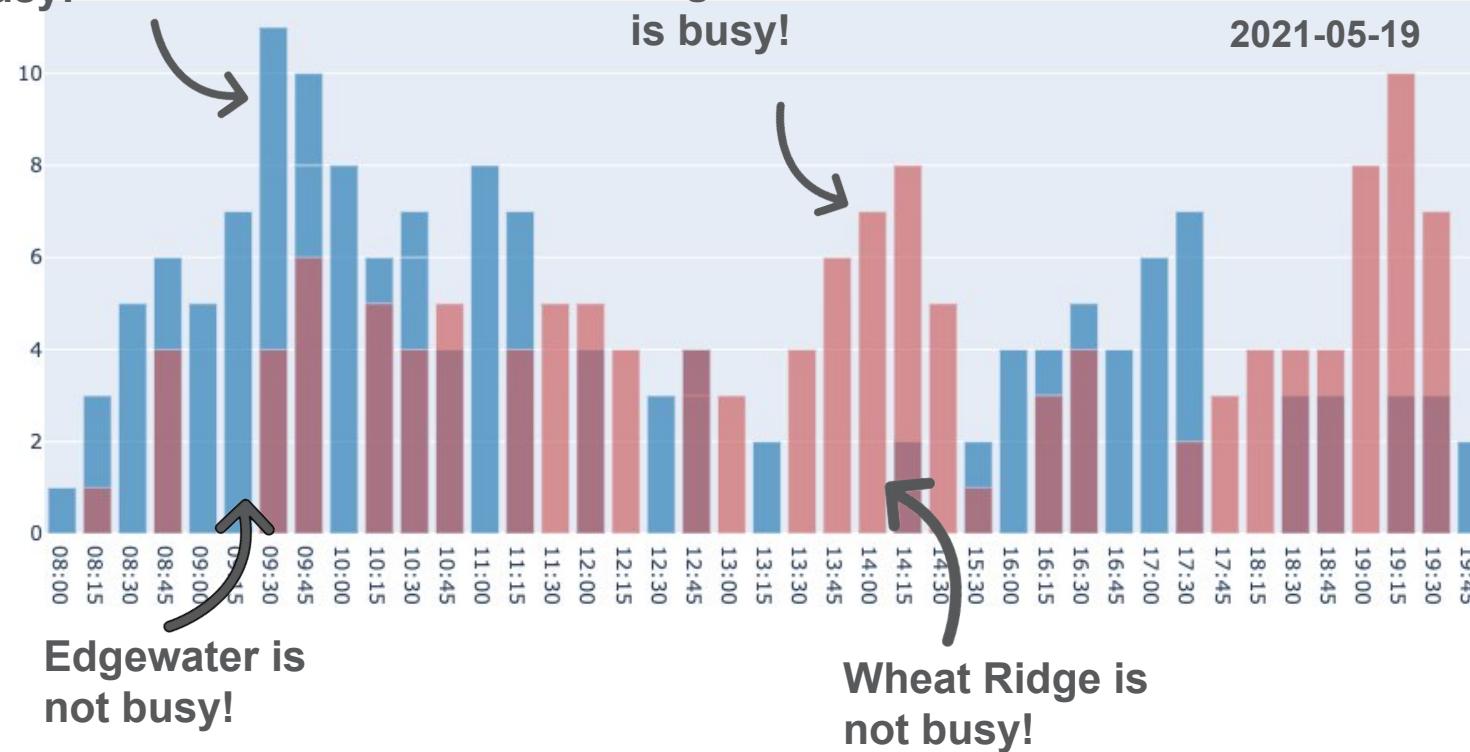
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# Exploratory Data Analysis

## Patient Traffic by Location

Wheat Ridge is busy!



Pt. Count @ Wheatridge clinic  
Pt. Count @ Edgewater clinic

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

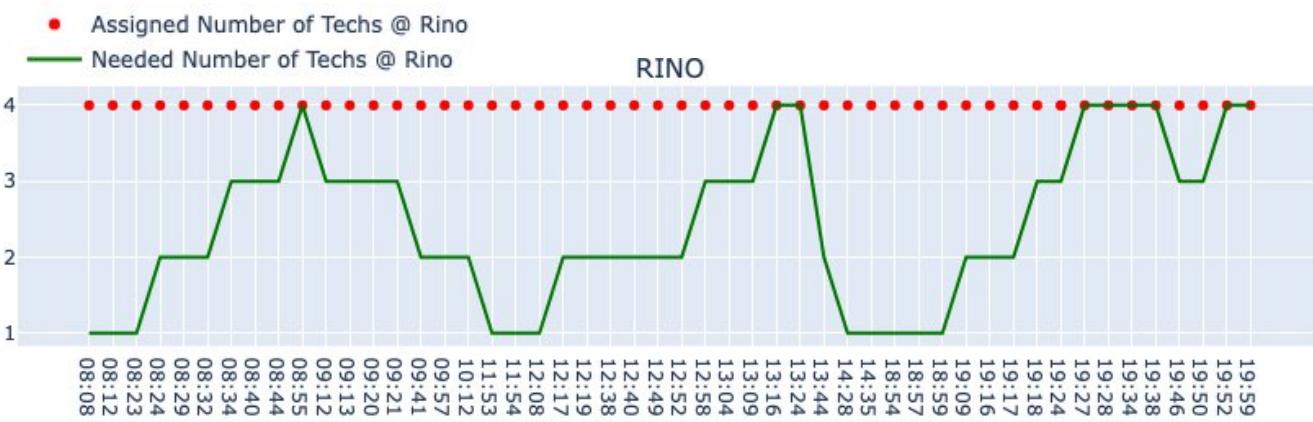


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# Exploratory Data Analysis

## Scheduled Technician Count



# Modeling

## ML - Regression

***“Is it feasible to transfer a technician?”***

**Model:** Random Forest Regressor

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

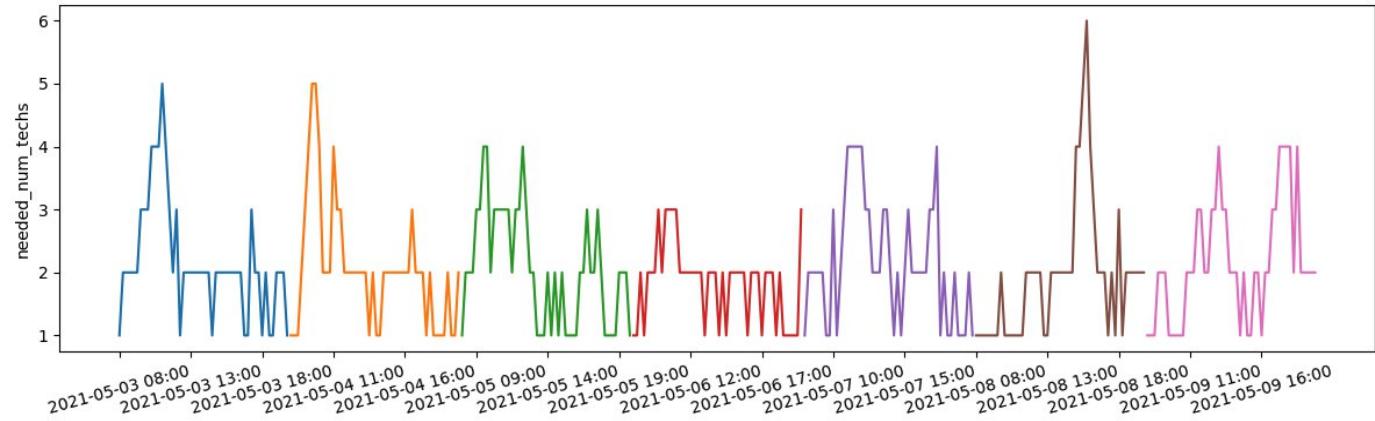
**Evaluation:** RMSE = 0.72 (< 1 technician)

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

# Modeling

## Time Series - ARIMA

(Integrated)  
**ARIMA**  
(Autoregressive) (Moving-Average)

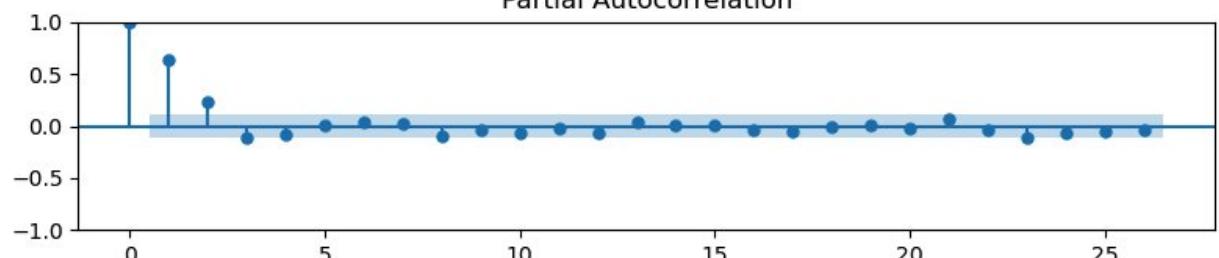
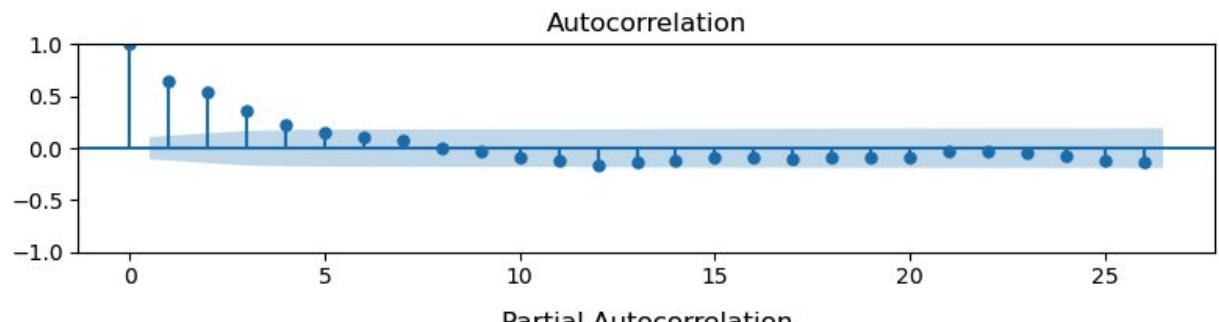


### Augmented Dickey-Fuller Test

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

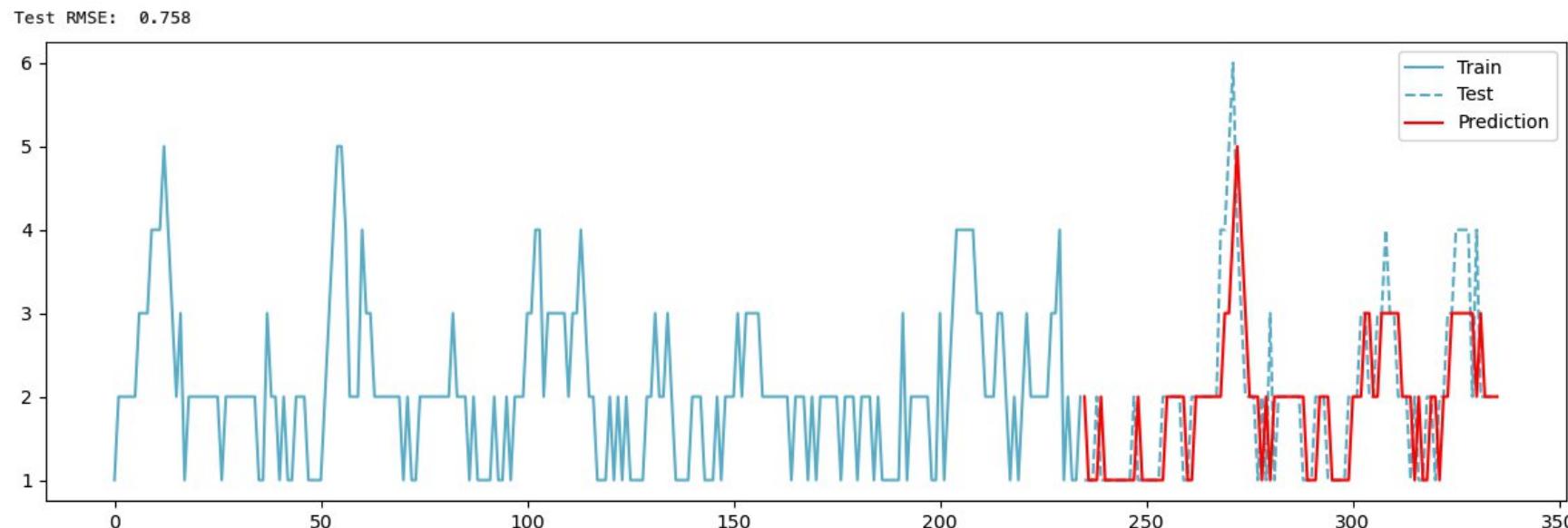
**REJECT  $H_0$ !**

✓ Data is stationary!



# Modeling

## Time Series - ARIMA



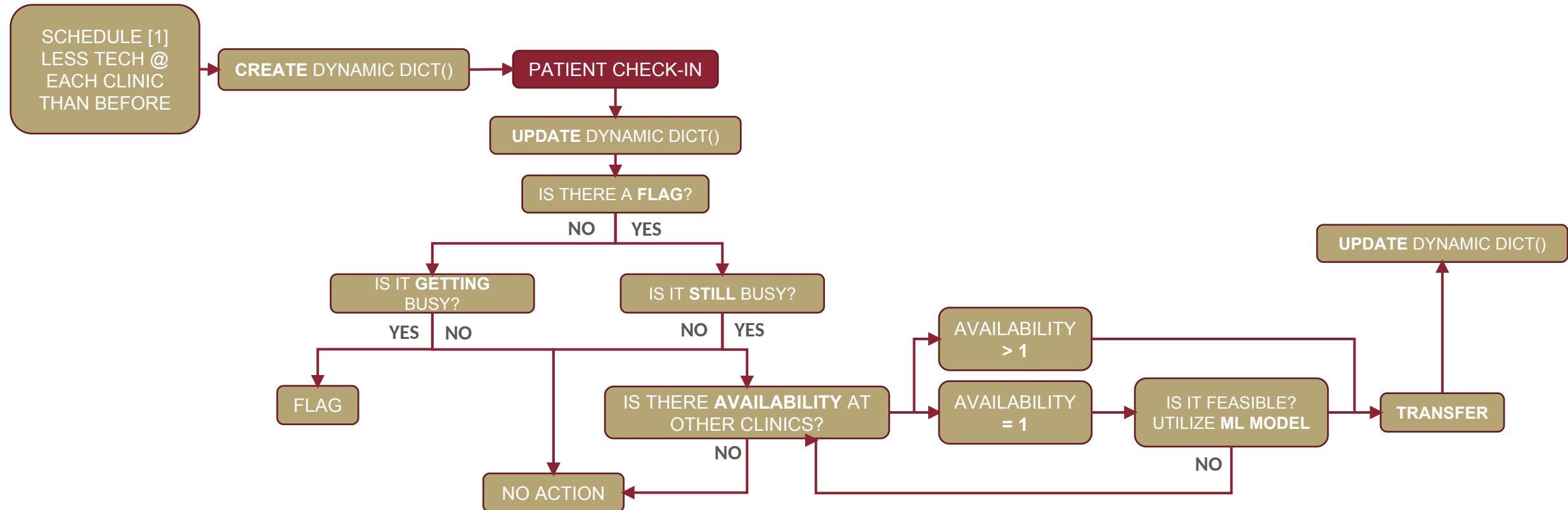
### RMSEs (05-2021):

- 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



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# Demo

## Interactive Prototype of Software Application

**TecNav**

**Rolling Patient & Tech Count on 2021-05-04:**

Date: 2021-05-04

Examine movement: Location: Rino

Simulate a past day: Date: 2021-05-04

Examine movement: Location: Rino

Rolling Patient & Tech Count on 2021-05-04:

Map showing patient and tech counts across Denver clinics. A color scale indicates the rolling count, ranging from 4 (yellow) to 12 (dark purple). Red dots represent locations like Woodridge, Edgewater, Lakewood, and Denver.

Navigation Activity Log for 2021-05-04:

08:55:13 - Rino Clinic needs a technician  
- Availability: ['Denver', 'Wheatridge', 'Lakewood']  
- Assessing if Denver is a feasible location to pull technician from.  
Denver only has 1 technician available  
Deploy ML model to assess if transfer is feasible:  
- Predicted amount needed = 1 | Current amount needed = 3  
Model anticipates Denver clinic to become less busy; feasible to pull from this location.  
- Pull technician from nearest clinic: Denver, 1 available  
- Technician from Denver left at 08:57:28  
- Technician from Denver arrived at Rino at 09:09:19  
- Rino: before count = 3 | after count = 4  
- Denver: before count = 4 | after count = 3

09:34:31 - Denver Clinic needs a technician  
- Availability: ['Edgewater', 'Wheatridge', 'Lakewood']  
- Assessing if Edgewater is a feasible location to pull technician from.  
Edgewater only has 1 technician available  
Deploy ML model to assess if transfer is feasible:  
- Predicted amount needed = 3 | Current amount needed = 1  
- ML model recommends no transfer from Edgewater  
- Assessing if Wheatridge is a feasible location to pull technician from.  
Wheatridge only has 1 technician available  
Deploy ML model to assess if transfer is feasible:  
- Predicted amount needed = 3 | Current amount needed = 4  
Model anticipates Wheatridge clinic to become less busy; feasible to pull from this location.  
- Pull technician from nearest clinic: Wheatridge, 1 available  
- Technician from Wheatridge left at 09:36:35  
- Technician from Wheatridge arrived at Denver at 09:56:41  
- Denver: before count = 4 | after count = 5  
- Wheatridge: before count = 5 | after count = 4

09:53:44 - Denver Clinic needs a technician  
- Availability: ['Rino', 'Wheatridge', 'Lakewood']  
- Assessing if Rino is a feasible location to pull technician from.  
Rino only has 1 technician available

RiNo (River-North Art District)

Graph showing Rolling Patient & Tech Count over time (08:00 to 19:30). The graph tracks Scheduled (dashed green line), Current (solid cyan line), and Needed (solid red line) counts. The Current count fluctuates between 1 and 4, while the Needed count follows a similar pattern but often stays lower than the Current count.

# 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\***

Savings can be applied to:

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

\*Minus a TecNav subscription fee ;-)



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# Project Reflections

## Challenges & Future Directions

### Technical Challenges

- Synthetic data tuning
- Translatable study design

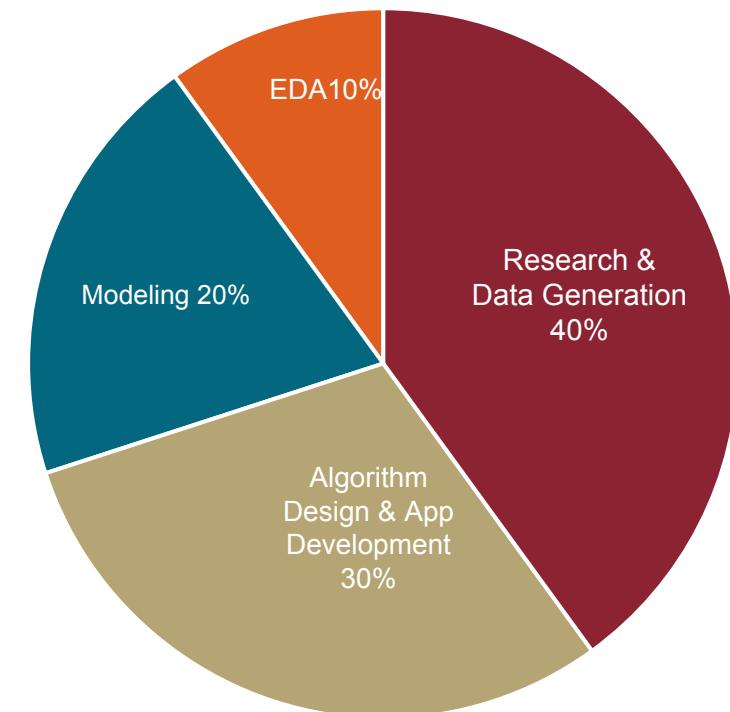
### Improvements

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

### Alternative Strategies

- Broaden applicability
- Wait-Time focus

Development Breakdown



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# Thank you!



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Connect with us!

