Baltimore City Salary Forecast

Time Series Analysis

Baltimore City Data from 2011 - 2021

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I am...

Nazar Mohl

- Experienced:
  - IT Program/Project Manager
  - Federal Gov't Contractor
  - Data Science Student
- Driven by:
  - Societal Improvements
  - Data Driven Policy Evolution

Agenda

Overview

Executive Summary

Data Analysis / Modeling
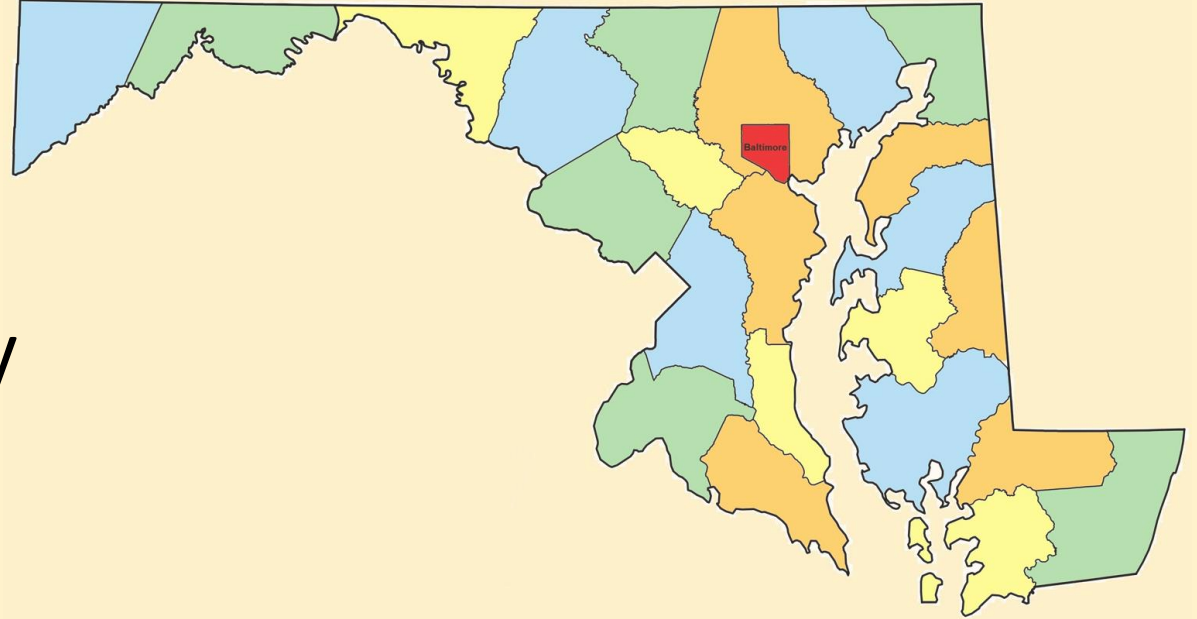
Results

Next Steps

OVERVIEW

Big Picture

Stakeholder:

- Large recruiting company
  - Interested in state and local public sector

Business Need:

- Analyze employment/salary data in the City of Baltimore.
- **Can salary growth be predicted?**

Maryland

- Baltimore - Largest city
- Maryland industries:
  - Federal sector
  - Medical (NIH, NIST, etc.)
  - SSA and CMS -> Insurance jobs.

- What about state/local public sector jobs?

Data Introduction

Baltimore City Salary Data

All Years		2021	
# Years:	11	# Departments:	63 *
# Records:	154,187	# Job Classes:	1,982
		# Employees:	14,179

* Selected 3 larger public security departments

EXECUTIVE SUMMARY

Executive Summary

- Predictions **appear** to be good.
  - Within several hundred dollars.

- However:
  - Closest prediction for any value in time is the value immediately preceding it.

DATA ANALYSIS / MODELING

Public Security Departments

Police Department
(3,202 Employees)

Fire Department
(1,696 Employees)
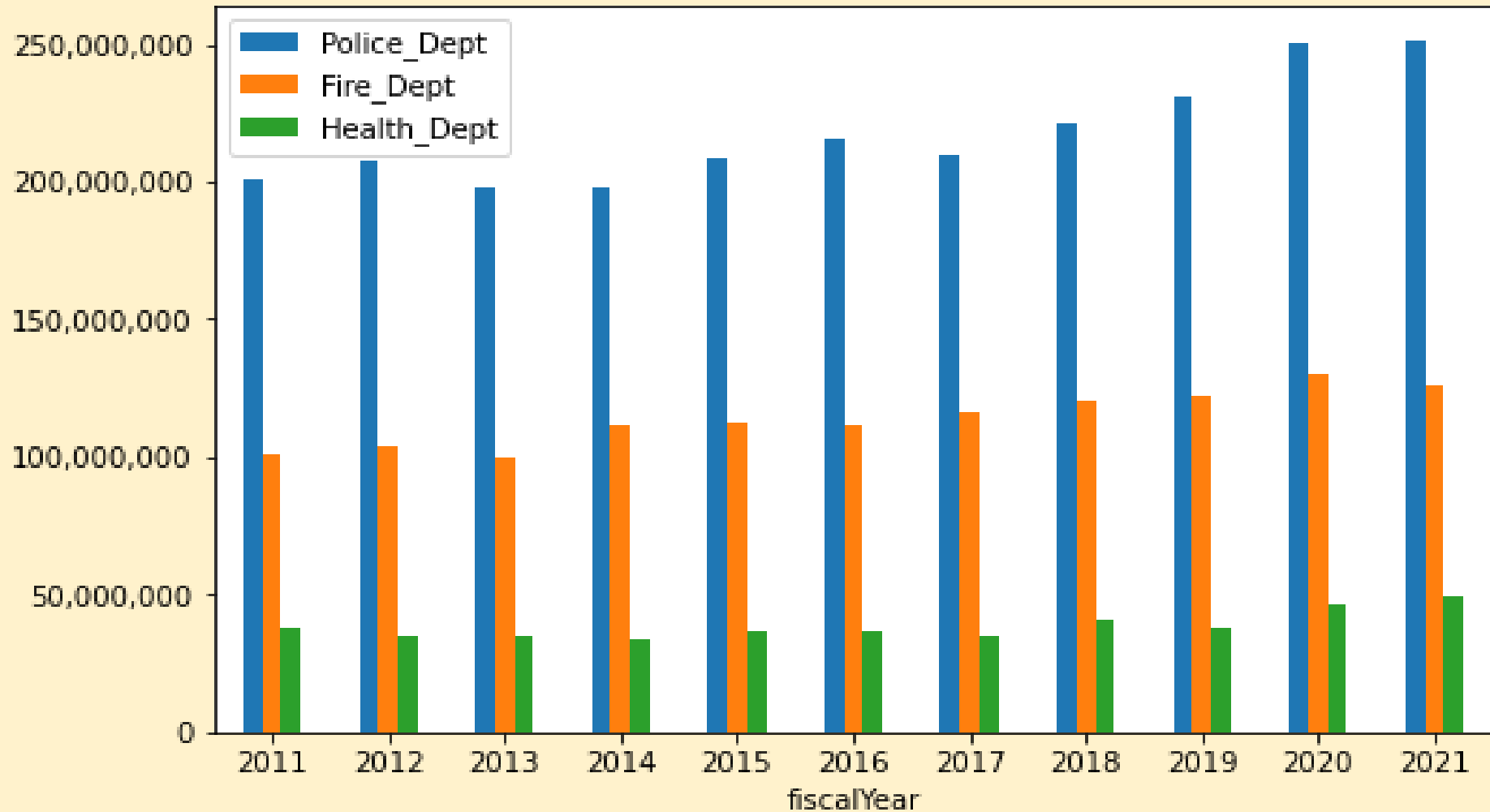

Health Department
(1,070 Employees)

Department Payroll Summary

	Police	Fire	Health
2011	$ 200.9M	$ 100.9M	$ 37.4M
:	:	:	:
:	:	:	:
2019	$ 231.2M	$ 121.9M	$ 38.1M
2020	$ 250.2M	$ 129.6M	$ 46.4M
2021	$ 251.6M	$ 125.8M	$ 49.6M

Upward Payroll Trend – Except...

Covid Impact?

Department Payroll Totals
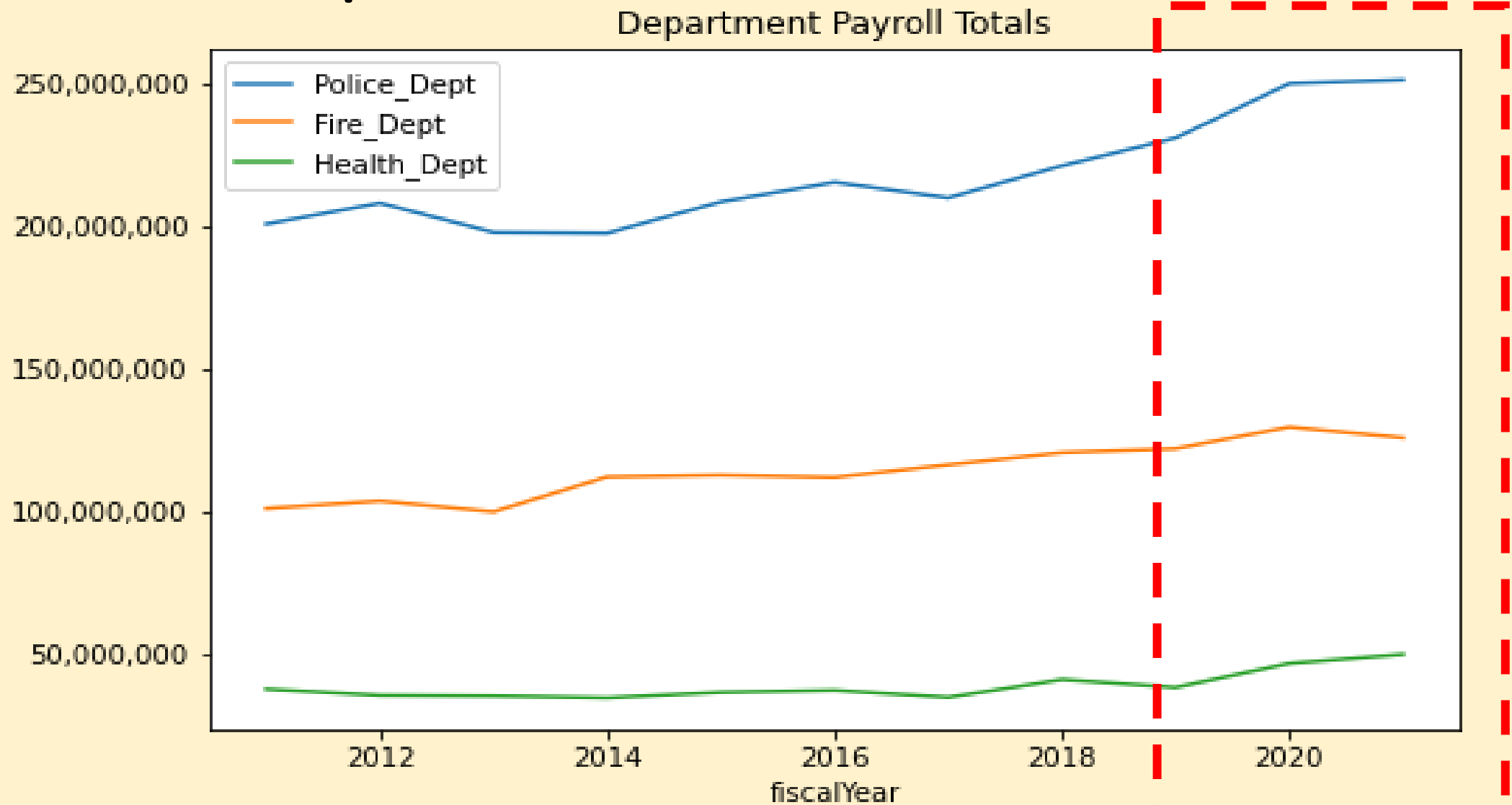
Health Salaries Declined?

Department Average Salary
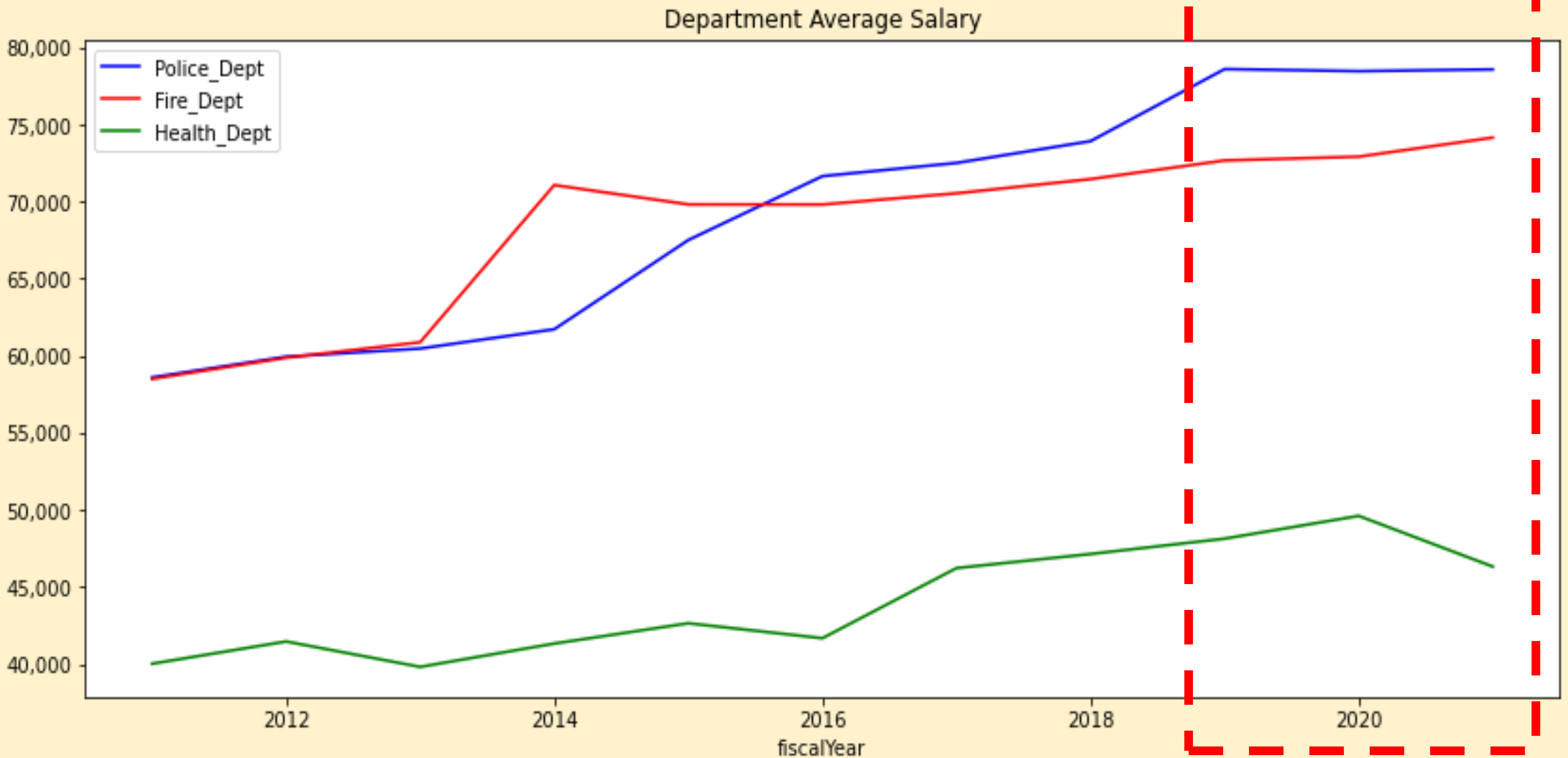
Preprocessing

"Cleaned" Data:

• Null fields
  • Substituted values
  • Deleted records

Analysis:

• Sliced/diced dataset by agencies, years, job titles, etc.

Calculated/Charted:

• Totals, means, etc.

Modeling Process / Evaluation metrics

Models Applied:

- Naive Model with Shift of 1

- ARIMA

Evaluation metrics:

Root Mean Square Error (RMSE)

RESULTS

Model Results

Naive Model with Shift of 1

Department	2021 Actual	2021 Predicted	RMSE
Police	$ 78,576	$ 78,460	$ 115
Fire	$ 74,152	$ 72,915	$ 1,237
Health	$ 46,325	$ 49,614	$ 3,290

ARIMA Model with Differencing of 1

Department	2021 Actual	2021 Predicted	RMSE
Police	$ 78,576	$ 78,597	$ 98
Fire	$ 74,152	$ 72,670	$ 1,062
Health	$ 46,325	$ 48,138	$ 1,653

Comments on Models

- With current data:
  - ARIMA model NOT Conducive to making a prediction at an ANNUAL DEPARTMENT level.
  - Closest prediction for any value in time is the value immediately preceding it.

- Future:
  Create model at the job title level on a MONTHLY/QUARTERLY basis.

NEXT STEPS

Further Analysis

• **Job titles:**
   • # Jobs
   • Salary movements
   • Tenure in department
   • Career paths
	• **Budget/Jobs**
	   • # Jobs
	   • Types
	   • Ranks

Correlate with local politics/events	

Q & A

Thank You!

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