

# Pulse of Engagement

Visual Analytics for Economic Health in Engagement, OH

VAST Challenge 2022 – Challenge 3

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# Introduction

# VAST Challenge 2022 – Challenge 3

## Introduction

### The Challenge

- Analyze economic health of a fictional city
- Dataset: ~120 million data points
- 15 months of 5-minute granularity data

### Three Questions

1. Business Prosperity
2. Resident Financial Health
3. Employer Health & Turnover

#### Economic Analysis

Q1: Business

Q2: Residents

Q3: Employers

# Our Solution: Pulse of Engagement

## Introduction

[**SCREENSHOT: Main Dashboard Overview**]

Show the tabbed interface with all three question areas

Interactive web application built with **React + D3.js** frontend and **Python Flask** backend

# Question 1: Business Prosperity

# Q1: Business Prosperity

## Question 1: Business Prosperity

[PLACEHOLDER FOR THOMAS]

- Which businesses are thriving vs. struggling?
- Revenue trends over time
- Market share evolution

[SCREENSHOT: Business Visualizations]

# Q1: Key Findings

Question 1: Business Prosperity

[PLACEHOLDER FOR THOMAS]

**Prosperous Businesses**

**Struggling Businesses**

teammate

To be filled by teammate

# Question 2: Resident Financial Health

## Q2: Analysis Approach

### Question 2: Resident Financial Health

#### Three Complementary Lenses

##### Geographic

- Building heatmap
- Savings by location
- Identify red zones

##### Demographic

- Wage vs. cost
- K-Means clustering
- Education link

##### Trajectories

- Income vs. expenses
- Inequality trends
- Time evolution

# Geographic Financial Health

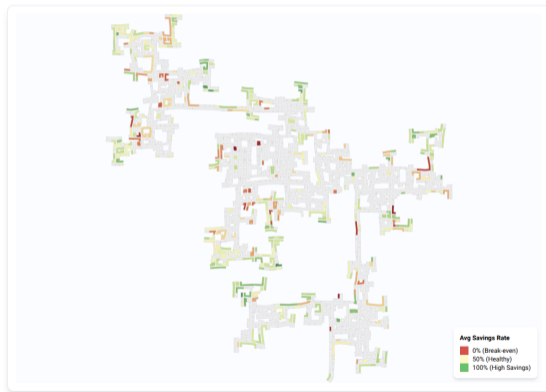
## Question 2: Resident Financial Health

### Building-Level Heatmap

- Colors by average savings rate
- Red: break-even or negative
- Yellow: moderate savings
- Green: high savings

### Insights

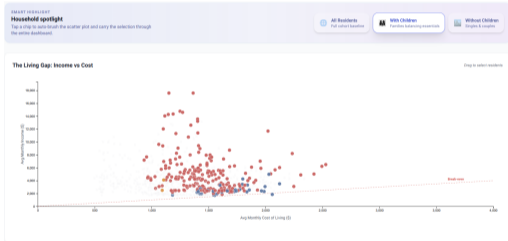
- “Red pockets” persist over time
- Chronic, not worsening, conditions
- Mini-clusters suggest local stressors



# The “Living Gap” Analysis

## Question 2: Resident Financial Health

### With Children



### Without Children



Diagonal = break-even • Families with children cluster near the line • Singles have more margin

# Cluster Patterns: Three Resident Profiles

## Question 2: Resident Financial Health

### K-Means Clustering

#### Affluent Achievers

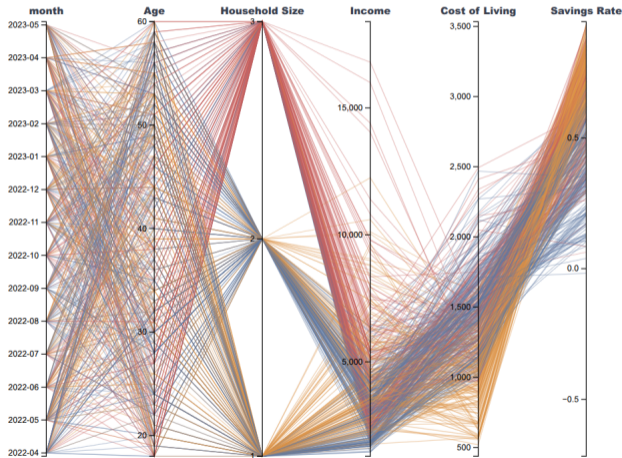
- High incomes, controlled costs

#### Stretched Households

- Lower income, little room to save

#### Lean Savers

- Singles, average income, low costs



# Inequalities Over Time

## Question 2: Resident Financial Health

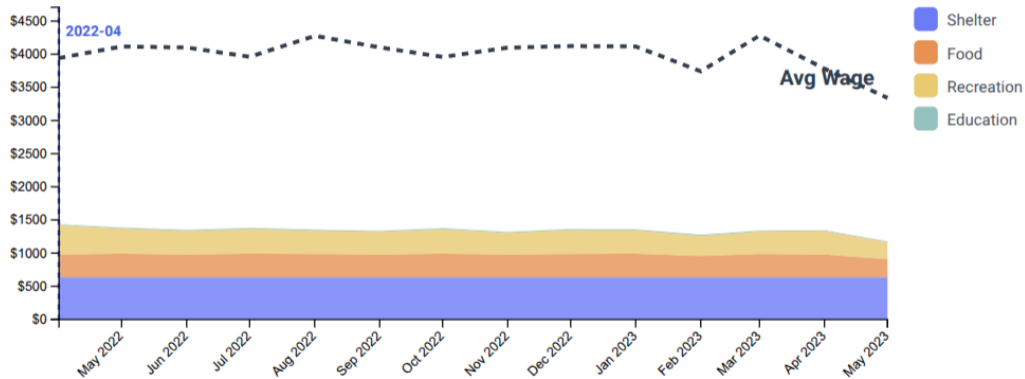


## Inequality Trends

- Gini coefficient tracks disparity
- Income inequality stable over time
- Savings inequality slightly higher

# Expense Dynamics Over Time

## Question 2: Resident Financial Health



# Question 3: Employer Health

## Q3: Employer Health & Turnover

### Question 3: Employer Health

[PLACEHOLDER FOR MICHAL]

- Employment patterns across the city
- Turnover rate analysis
- High/low turnover areas

[SCREENSHOT: Employer Visualizations]

## Q3: Key Findings

### Question 3: Employer Health

[PLACEHOLDER FOR MICHAL]

Healthy Employers

High Turnover Areas

teammate

To be filled by teammate

# Design Decisions

## Frontend

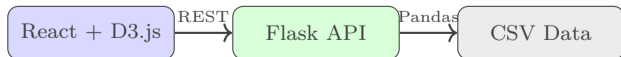
- **React 18** – Component architecture
- **D3.js v7** – Visualization rendering
- **TailwindCSS** – Styling
- **Axios** – API communication

## Infrastructure

- **Docker Compose** – Orchestration
- **Nginx** – Reverse proxy

## Backend

- **Python 3.11** – Core language
- **Flask** – REST API
- **Pandas/NumPy** – Data processing
- **Scikit-learn** – K-Means clustering
- **Pytest** – Testing



## Visualization Choices

- **Tabbed interface**  
Separate concerns per question
- **Global time slider**  
Consistent temporal context
- **Linked views**  
Brushing propagates across charts
- **Color consistency**  
Same cluster colors everywhere
- **Color consistency**  
TODO: Add more points here

## Data Processing

- **Monthly aggregation**  
Reduce 120M rows to manageable size
- **Caching**  
Pickle cache for expensive computations
- **TODO: Add more points here**

# Interactive Features

## Design Decisions

**[SCREENSHOT: Interactive Features Demo]**

Show hover tooltips, time slider, household filter chips



Hover tooltips



Time slider



Smart filters

# Team Organization

# Work Organization

## Team Organization

### Division of Work

- One question per team member
- Shared infrastructure setup
- Code reviews via Git

<b>Thomas</b>	Q1: Business Prosperity
<b>Michal</b>	Q3: Employer Health
<b>Jan</b>	Q2: Resident Financial Health

### Shared Components

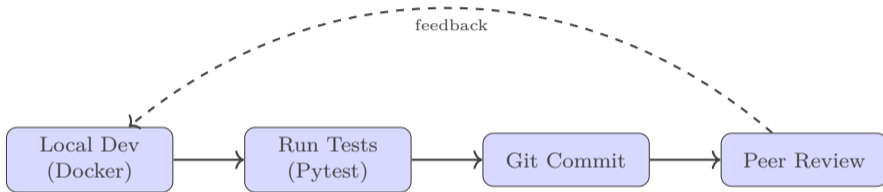
- Docker infrastructure
- API structure
- Test framework

### Communication

- Regular syncs and feedback
- Clear API contracts

# Development Workflow

## Team Organization



### Testing Strategy

- Backend: Pytest for each router (business, resident, employer)
- Docker Compose test configuration
- Tests run before each commit

# Lessons Learned

## What Worked Well

- ✓ Docker for reproducibility
- ✓ Clear question separation
- ✓ Caching for large datasets
- ✓ React + D3 integration
- ✓ Test-driven development

## Challenges

- ✗ TODO

## Would Do Differently

- TODO

# Thank You!


Questions?

Thomas Gantz    Michal Sterzel    Jan Marxen

Q1: Business

Q3: Employers

Q2: Residents

 [github.com/janmarxen/VAST-challenge](https://github.com/janmarxen/VAST-challenge)