

Pulse of Engagement

Visual Analytics for Economic Health in Engagement, OH

VAST Challenge 2022 – Challenge 3

Thomas Gantz Michal Sterzel Jan Marxen

December 2025



Introduction

VAST Challenge 2022 – Challenge 3

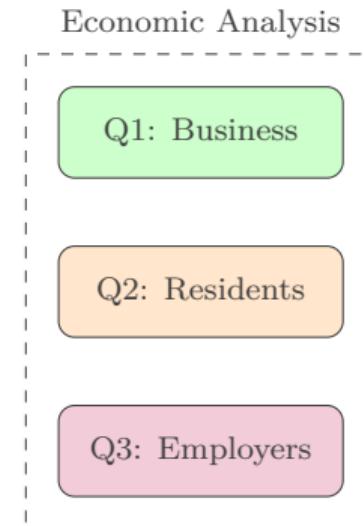
Introduction

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



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

teammate

Struggling Businesses

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

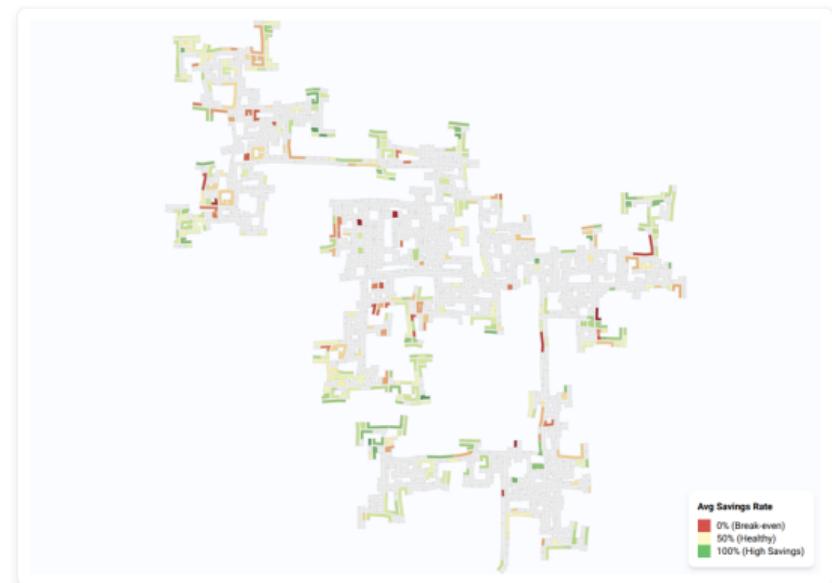
Question 2: Resident Financial Health

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

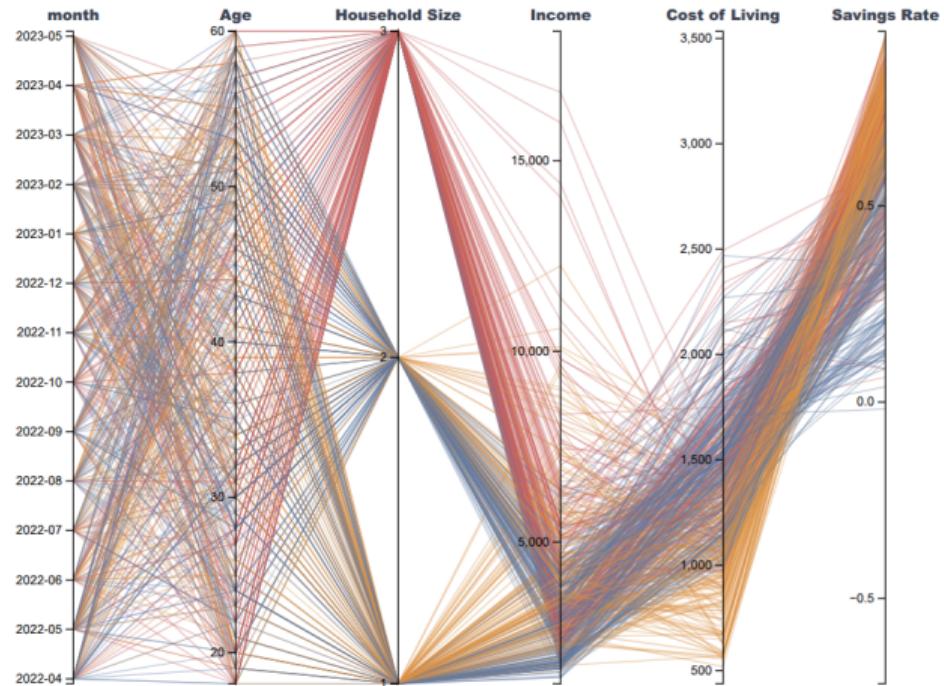
- High incomes, controlled costs

Stretched Households

- Lower income, little room to save

Lean Savers

- Singles, average income, low costs



Savings Drivers: Household Size vs. Education

Question 2: Resident Financial Health

Household Size

Savings Rate by Household Size

1-person household **53.9%**

Income \$3,247 Living Cost \$1,155

2-person household **54.3%**

Income \$4,176 Living Cost \$1,607

3-person household **53.9%**

Income \$4,609 Living Cost \$1,620

0% 50% 100%

Education Level

Savings Rate by Education

Graduate **67.5%**

Bachelors **62.6%**

High School **45.4%**

Low **42.1%**

0% 50% 100%

- Household size shows only minor differences in savings behavior.
- Education level shows a clearer pattern: higher education is associated with higher savings and greater financial resilience.

Inequalities Over Time

Question 2: Resident Financial Health

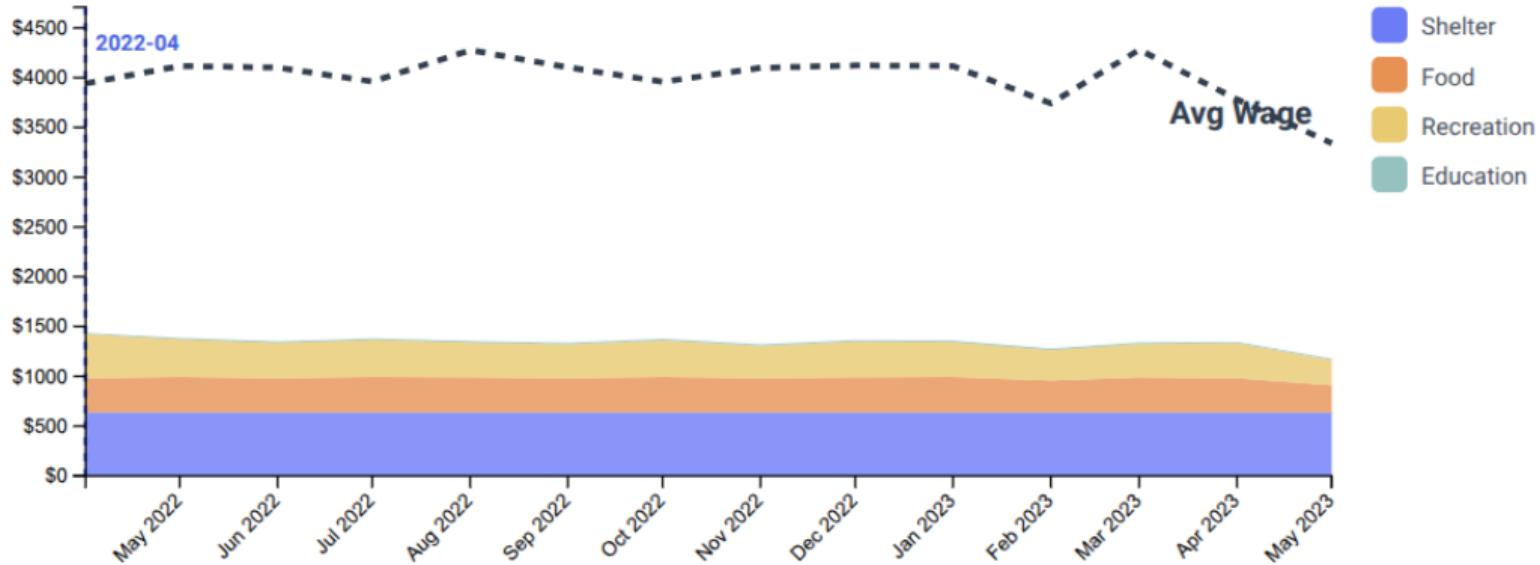


Inequality Trends

- 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

teammate

High Turnover Areas

To be filled by teammate

Design Decisions

Tech Stack

Design Decisions

Frontend

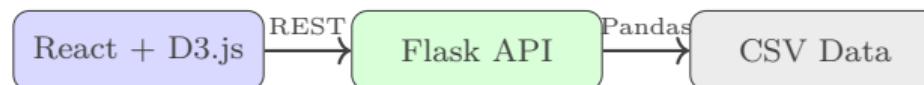
- **React 18** – Component architecture
- **D3.js v7** – Visualization rendering
- **TailwindCSS** – Styling
- **Axios** – API communication

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



Key Design Decisions

Design Decisions

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

Thomas Q1: Business Prosperity

Michal Q3: Employer Health

Jan Q2: Resident Financial Health

Shared Components

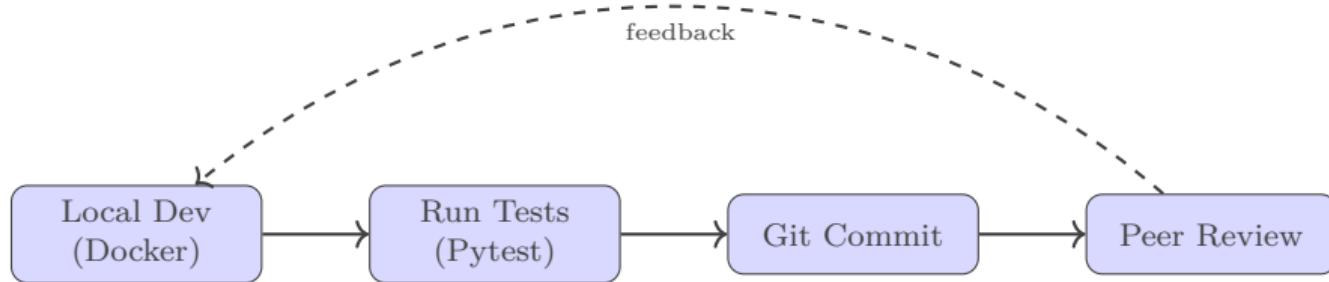
- Docker infrastructure
- API structure
- Test framework

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

Lessons Learned

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