

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

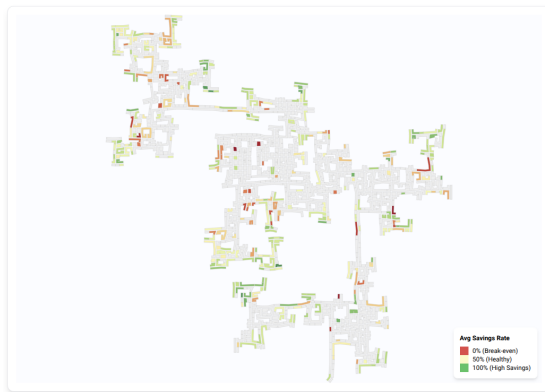
Question 2: Resident Financial Health

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



Resident Profiles: Three Demographic Groups

Question 2: Resident Financial Health

KMeans on demographics

Affluent Achievers

- High income
- Often graduate education

Stretched Households

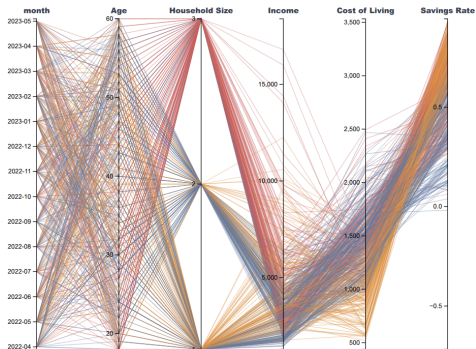
- Often with kids
- Larger households
- Low savings capacity

Lean Savers

- Typically without kids
- Smaller households
- Lower cost base

Top separators (η^2)

- Has kids 83.1% Graduate education 72.0%



Demographic Drivers (Ranked)

Question 2: Resident Financial Health

SavingsRate predictors (ΔR^2)

- | | |
|-------------------------|-------------------|
| 1. Cost of living 0.828 | 2. Income 0.408 |
| 3. Household size 0.376 | 4. Has kids 0.127 |

Cluster separators (η^2)

- | | |
|----------------------|--------------------------|
| Has kids 83.1% | Graduate education 72.0% |
| Household size 61.9% | Income 38.0% |

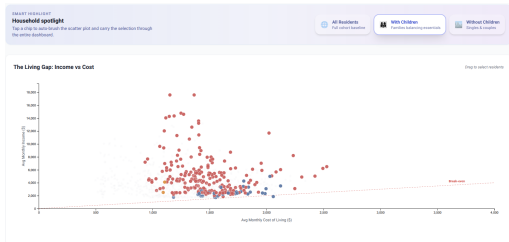
Story

- Costs dominate short-run savings rate
- Income raises buffer and resilience
- Kids and education define the main splits

The “Living Gap”: Kids Compress the Margin

Question 2: Resident Financial Health

With Children



Without Children

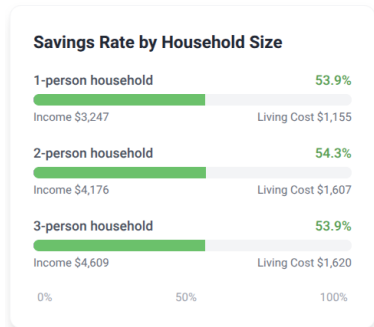


- Diagonal: break-even (income = cost)
- With kids: points concentrate near the diagonal
- Without kids: more margin above break-even

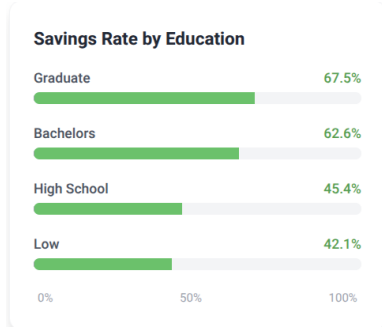
Savings Drivers: Household Size vs. Education

Question 2: Resident Financial Health

Household Size



Education Level



- Household size: weak pattern ($\approx 54\%$ for 1–3 persons)
- Education: strong gradient (Graduate > Bachelors \gg High School/Low)
- Interpretation: income + cost-of-living explain most variation; kids adds pressure

Inequalities Over Time

Question 2: Resident Financial Health

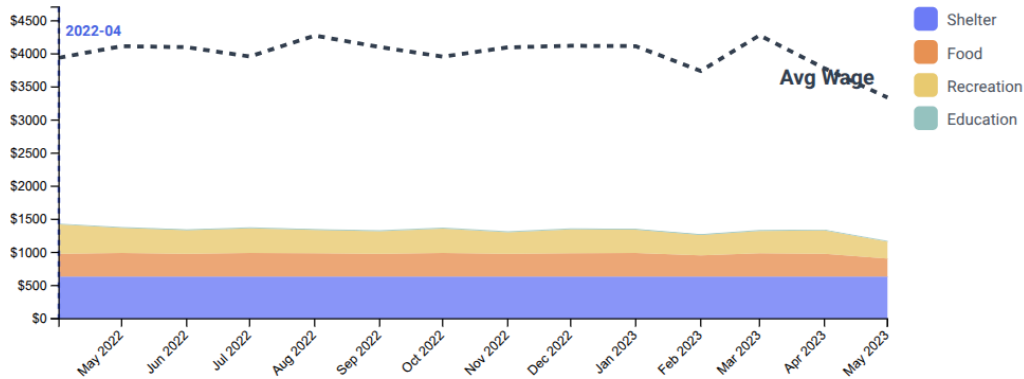


Inequality Trends

- 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

Thomas	Q1: Business Prosperity
Michal	Q3: Employer Health
Jan	Q2: Resident Financial Health

Shared Components

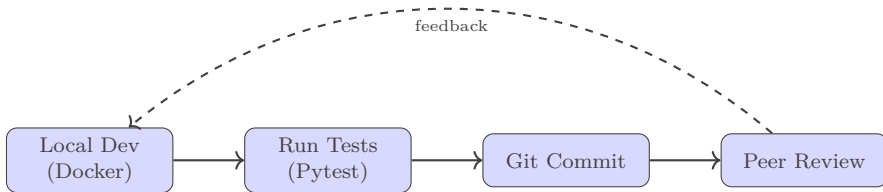
- Docker infrastructure
- API structure
- Test framework

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

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