Understanding Childhood Vulnerability in the City of Surrey

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Overview

- Introduction
- Datasets
- Top-Down: Understanding Trends of Neighborhoods
- Bottom-Up: Understanding City Program Reach
- Web Application
- Conclusion and Future work
Introduction

Understanding the community conditions that best support universal access and improved childhood outcomes allows ultimately to improve decision making in the areas of planning, and investing across the early and middle years of childhood development.

How do we measure this?
Early Development Instrument (EDI)

Ex. Questions for Preschool (Age 4-5) Teachers:

- Is a child *too tired or sick* to do school work?
- Would you say this child *demonstrates respect for other children*?

Approximately the bottom 10% of the first B.C. scores set the vulnerability cut-off. The top approximately 90% of scores are said to be *not vulnerable*.

Source: Vulnerability of the EDI, The Human Early Learning Partnership

<table>
<thead>
<tr>
<th>Language</th>
<th>Social</th>
<th>Emotional</th>
<th>Physical</th>
<th>Communication</th>
</tr>
</thead>
</table>
Two Approaches: Top-Down and Bottom-Up

**Top-Down**: Holistic Measures of Neighborhood Success in Childhood Development

- **Motivated** to understand factors that might correlate with EDI Scores across neighborhoods (and therefore childhood vulnerability)
- Do neighborhoods that have similar EDI Scores across years (waves) behave the same?

**Bottom-Up**: Granular analysis of City-wide Program Usage and Registration Data

- **Motivated** to utilize city-wide data that might better represent lived-experiences of children living in Surrey
- Can program/resource utilization trends by families be used as an indicator for childhood vulnerability?
Datasets used

Open Source Datasets

- Early Development Instrument (EDI) provided by UBC’s Human Early Learning Partnership (HELP) for the City of Surrey
- Statistics Canada 2016 Census Data (retrieved through cansim R Package)

Private Dataset from Surrey

- CLASS Dataset (160Gb)
  Private Dataset - Provided by City of Surrey’s Community and Recreation Services (CRS) division
Clustering Neighborhoods based on EDI Scores
Single Wave Clusters (t-SNE) for Wave 6

Key Takeaway: t-SNE Approach shows good separation amongst all three clusters for every scale of EDI
Single-Wave Cluster Analysis

- **Want**: Similarities between neighborhoods for each wave
- **What Worked**: t-SNE
- **What Didn’t**: PCA, KPCA, Hierarchical clustering

Clusters:
- **S0** - low vulnerability (Good)
- **S1** - medium vulnerability (Meh)
- **S2** - high vulnerability (BAD)
Clustering Over All Waves (t-SNE)

Key Takeaway:

t-SNE Approach incorporating all Waves of the EDI show six distinct Clusters.
All-Wave Cluster Analysis (t-SNE)

6 groups instead of 3:
A0 - Stable and low vulnerability (Good)
A1 - Unstable and low vulnerability (OK)
A2 - Unstable and medium vulnerability (?)
A3 - Most unstable (?)
A4 - Unstable and high vulnerability (?)
A5 - Stable and high vulnerability (BAD)
Neighborhood change each wave in relation to Single Wave Clustering
Validating Clustering results with UMAP

UMAP Clustering (Right) shows four distinct clusters on all-waves.

Hopkins Statistic (Below) to reject the null hypothesis that these clusters reasonably random.

<table>
<thead>
<tr>
<th>Cluster</th>
<th>t-SNE A-clusters</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>$H$</td>
<td>0.4563</td>
<td>0.5478</td>
<td><strong>0.5706</strong></td>
<td>0.4166</td>
<td>0.6080</td>
<td><strong>0.4311</strong></td>
</tr>
</tbody>
</table>

Table 2: Hopkins statistic over the t-SNE all-wave clusters.

| Cluster | UMAP UA-clusters | | |
|---------|------------------|---|
|         | 0    | 1    | 2    | 3    |
| $H$     | **0.5706** | 0.5023 | 0.5308 | **0.4311** |

Table 3: Hopkins statistic over the UMAP all-wave clusters.
What keeps these Clusters together? Using Census Data to describe Cluster Identity

<table>
<thead>
<tr>
<th>A-cluster significant census variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Income of Households in 2015</strong></td>
</tr>
<tr>
<td>(Median)</td>
</tr>
<tr>
<td>Employment that use Transit</td>
</tr>
<tr>
<td>Native Tongue – Hindi</td>
</tr>
<tr>
<td>People of European Origins</td>
</tr>
<tr>
<td><strong>Male Unemployment Rate</strong></td>
</tr>
<tr>
<td>Production Occupations</td>
</tr>
<tr>
<td>Immigrants from Oceania and Other</td>
</tr>
<tr>
<td>Lone Parent (%)</td>
</tr>
</tbody>
</table>

Table 5: An assortment of significant census variables for the 6 A-clusters.

<table>
<thead>
<tr>
<th>UA-cluster significant census variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Income of Households in 2015</strong></td>
</tr>
<tr>
<td>(Median)</td>
</tr>
<tr>
<td>Employment that Commutes for over 60 Minutes</td>
</tr>
<tr>
<td>Native Tongue – Punjabi</td>
</tr>
<tr>
<td>People of South Asian Origins</td>
</tr>
<tr>
<td><strong>Female Unemployment Rate</strong></td>
</tr>
<tr>
<td>Art / Sport Occupations</td>
</tr>
<tr>
<td>Immigrants</td>
</tr>
<tr>
<td>Married (%)</td>
</tr>
</tbody>
</table>

Table 6: An assortment of significant census variables for the 4 UA-clusters.
Analysis of the CLASS Dataset
(Program registration for the City of Surrey)
Representation of Neighborhoods in CLASS Dataset

Key Takeaway:

4 Neighborhoods (Surrey City Centre, South Surrey West, Newton East, Cloverdale South) represent approx. 50% of all Data points.
Extracting Child Registration Data from CLASS

- **PostgreSQL Search Terms:**
  - Accounts with registered Birth Dates greater or equal to 01/01/2000
  - Course with a Max Registration count >= 1
  - Course must have been completed (no Withdrawals)

- **High-Level Classification of Courses offered and visible in CLASS:**
  - Aquatics
  - Arena and Skating
  - Arts and Crafts
  - Day Camps
  - General Activities
  - Music, Dance and Theatre
  - Parent Participation and Family
  - Sports, Fitness and Wellness

**General Activities:** *(e.g Arts and General - Children Computer, Arts and General - Children Personal Development, Youth Outdoor Recreation, Youth Personal Development)*

**Parent Participation and Family:** *(e.g Arts and General - Parent Participation Performing Arts-Arts Centre, Family Environment and Parks)*
Distribution of Children’s Age at time of First and Last Registration

Key Takeaway:

Critical Age of Retention seems to be around 7-8 Years.
Age of First Registration for Male and Female Children
Number of Children Registering for Programs by Season

- **Fall Registration Session**
- **Spring Registration Session**
- **Summer Registration Session**
- **Winter Registration Session**

**Count**

**Entering Age**

**Entering Program**
- Aquatics
- Arenas and Skating
- Arts and Crafts
- Day Camps
- General Activities
- Music, Dance, and Theatre
- Parent Participation and Family
- Sports, Fitness and Wellness
Key Takeaway:

Programs that are classified as ‘General Activities’ present anomalous bimodal distribution of Children exiting, suggesting greater retention rates.
Key Takeaway:

Programs that are classified as ‘General Activities’ present the largest proportion of Children having spent 8 or more years within the Program Pipeline when they leave.
Putting it all Together:
A Web Dashboard Application
Visualizing EDI Scores by Neighborhood
Visualizing Cluster Analysis Results

Choose the EDI Wave
- Wave 3: 2007-2009
- Wave 4: 2009-2011
- Wave 5: 2011-2013
- Wave 6: 2013-2016
- All Waves

Choose the clustering method
- tSNE
- UMAP

Census Groups:
- Geography
- Ethnic Origins

Disclaimer
Data is from the 2016 Canadian Census. This specific module is intended to understand factors that can explain cluster separation, and is not intended to model causation.

You can read the full academic report using this cluster analysis here.
You can also view additional instructions on using this analysis tab here.

Distribution of Neighborhoods among Clusters

Number of Neighborhoods
0.0 2.5 5.0 7.5 10.0
Using Census Data to describe Cluster Variation

Recommendation
Consider looking at Income of Couple Economic Families with Children (Median)

Census Variables

Anova Test
Total Income of Households in 2015 (Median)
A one-way anova test at the 0.05 significant level shows these clusters are statistically different
Clusters 1-0 are different
Visualizing a Child’s First and Last Registered Program

Disclaimer

The data currently loaded is an example data set. To view your data, click the Browse button and upload your CSV file.
You can view additional instructions on using this analysis tab here.

Entry and Exit Directions

[Graph showing entry and exit directions]
Conclusions

Results from Clustering with t-SNE and UMAP suggests that **Clusters are real**, and may provide useful in understanding underlying factors that drive Childhood Vulnerability rates (i.e EDI Scores)

Ethnicity and SES Census variables emerging as significant discriminants between clusters suggests **different groups access programs differently**

CLASS Analysis suggests that **certain Programs and their enrollment can influence retention of Children**, allowing for greater engagement of Children within the community and City
Challenges and Future Work

When is Machine Learning “appropriate”

- In the case of CLASS Dataset, modeling “Exit-Age” to build a predictor makes little sense since the data does not accurately reflect this.
- Combining the Top-Down and Bottom-Up approaches in a unifying model led to no statistically significant results (Connecting EDI to CLASS).

Future Work can include

- Analyzing Sub-Scale Data for EDI, utilization of MDI as well as future Census Data, and City of Surrey COSMOS Data (e.g. Greenspace)
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