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Predicting the Slide to Long-term Homelessness

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Agenda

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- **The Challenge of Homelessness**
  - Causes and Contributors to Homelessness
  - Chronic and Long-term Homelessness
- **Predicting the Slide to Long-term Homelessness**
  - Context and Data Sources
  - Exploratory data analysis
  - Developing a predictive model
  - Model validation
- **Application of the Predictive Model**
- **Limitations and Future Work**

The Challenge of Homelessness

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- Being homeless is not a condition, it is something people experience.
- **Defining Homeless**: "a person who lacks a fixed, regular, and an adequate nighttime residence"
- An ecosystem of care agencies (shelters, hospitals, correctional facilities) respond to the concerns of the homeless (CoC)

3

Contributors to Homelessness

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- **What causes homelessness**?
  - Lack of affordable housing
- What contributes to homelessness?
  - Unemployment, poverty, low wages, mental illness, substance abuse, and domestic violence (for women)
- What impacts the intensity of homelessness?
  - Gender, family support, veteran status, combat status and education level impact the intensity (e.g. frequency, duration)

4

Homelessness: Chronic

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- **Chronically homeless**: someone who is continuously homeless for a year or more or has 4 or more episodes of homelessness adding to a year or more in the previous three years (US HUD)
- Incidence: ~10% of the population
- Burden: ~50% of the bed space
- Problem: How to track individuals across the ecosystem (shelters, hospitals), as well as streets, prisons …

Why is this important?
- It drives policy
- It drives funding

5

Homelessness: Long-Term

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- **Long-term homelessness:** being homeless (during a continuous period of 365 days) for a significant fraction of time
- Operationalization**:** Fraction = at least one out of every three days
- **Purpose**:
  - Not merely meeting the US HUD definition (chronically homeless) for the purpose of counting
  - Instead, identifying the propensity for long-term homeless quickly, so that this can lead to more effective action at different points within the ecosystem of care.

6

Context of Our Work

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- **Context**: City of Boston, and Pine Street Inn (PSI), the largest homeless shelter in New England
- Homeless population in Massachusetts: 20,068 (in 2018)
- Homeless population in Boston: 6,144 (in 2018)
- Data source: what PSI and the City of Boston collect, primarily for reporting (e.g. US HUD)
- Coverage: About 4.5 years (early 2014 to May 2018)

7

Exploratory Analysis

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- **Data**: Entrances and Exits of 22,693 individuals recorded by Pine Street Inn
- Key Attributes: Enrollment Entry Date (the earliest entry date of all enrollments for an individual) and Enrollment Exit Date (the latest exit date of all enrollments for an individual)
- Exploring correlation with long term homelessness with no initial filtering of any of the characteristics

8

Exploratory Analysis

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- avg (length (homelessness$_k$)) = length (episode$_{ik}$) / {time-periods}

TABLE II. DIFFERENCES LONG- VS. SHORT-TERM GROUPS – A

Group	Variables (see Table I)						
	AI	AS	AF	PI	WH	HI	G
Short-term	0.011	0.016	0.397	0.013	0.536	0.207	0.750
Long-Term	0.013	0.014	0.485	0.009	0.468	0.205	0.738

TABLE III. DIFFERENCES LONG- VS. SHORT-TERM GROUPS - B

Group	Variables (see Table I)				
	V	Age	Dom	Inc	Sub
Short-term	0.063629	42.32759	0.17763	0.472659	0.61715
Long-term	0.053934	47.96416	0.184598	0.628301	0.773144

TABLE IV. DIFFERENCES LONG- VS. SHORT-TERM GROUPS - C

Group	Variables (see Table I)						
	Dis	DisT5	DisT6	DisT7	DisT8	DisT9	DisT10
Short-term	0.62	0.306	0.142	0.344	0.029	0.512	1.064
Long-term	0.77	0.443	0.200	0.481	0.032	0.623	1.230

Ethnicity

Background

Disability

TABLE I. POTENTIAL INDEPENDENT VARIABLES

Variables Description and Type
(AI) American Indian: Is the individual American Indian (native)? (*B*)
(AS) Asian: Is the individual Asian? (*B*)
(AF) African American: Is the individual Black /African American? (*B*)
(PI) Pacific Islander: Is the individual Native HI/ Pacific Islander? (*B*)
(WH) White: Is the individual White? (*B*)
(HI) Hispanic: Is the individual Hispanic? (*B*)
(G) Gender: What is the individual's gender? (Is it Male?) (*B*)
(V) Veteran: Is the individual a veteran? (*B*)
(Age) Date of Birth: What is your DOB? (to compute Age)
(Dom) Domestic Violence Victim: Is the individual a Victim? (*B*)
(Inc) Income: Does the individual have income? (*B*)
(Sub) Substance Abuse: Was there substance abuse? (converted to Ordinal)
(Dis) Disabled: Does the individual have a disability? (*B*)
(DisT)Disability Type: What is the disability type? (converted to *B* for each)

(*B*: Binary variable; *Gender:* Female, Male, Transfemale, Transmale, Does not identify as male, female or transgender; *Substance abuse:* No, Alcohol abuse, Drug abuse, Both alcohol and drug abuse; *Disability type:* Physical, Developmental, Chronic condition, HIV, Mental health)

Developing a Predictive Model

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Log-odds of the probability of the individual being in the Long-term Group

$$\ln (p/(1-p)) = a+\beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \cdots + \beta_n x_n$$

p = probability (of an individual being a long term homeless, <u>given</u> the status of the individual as a homeless individual.

```
Coefficients:
                        Estimate Std. Error z value Pr(>|z|)
(Intercept)           -3.494350   0.143685 -24.319  < 2e-16 ***
AmIndAkNative          0.382145   0.191528   1.995 0.046016 *
Asian                  0.366593   0.192214   1.907 0.056494 .
BlackAfAmerican        0.588332   0.112469   5.231 1.69e-07 ***
NativeHIOtherPacific   0.051600   0.225637   0.229 0.819113
White                  0.196495   0.113122   1.737 0.082385 .
Ethnicity              0.156061   0.051196   3.048 0.002302 **
Gender                -0.063623   0.050347  -1.264 0.206347
VeteranStatus         -0.487058   0.086876  -5.606 2.07e-08 ***
Age                    0.028034   0.001685  16.642  < 2e-16 ***
Disable                0.442712   0.054982   8.052 8.15e-16 ***
DisType5               0.072685   0.047277   1.537 0.124185
DisType6               0.156221   0.053764   2.906 0.003665 **
DisType7               0.120681   0.045989   2.624 0.008687 **
DisType8              -0.346114   0.113733  -3.043 0.002341 **
DisType9               0.144977   0.047272   3.067 0.002163 **
DisType10              0.059271   0.017908   3.310 0.000934 ***
DomesticViolenceVictim -0.086562   0.057125  -1.515 0.129693
Income1                0.282445   0.043293   6.524 6.84e-11 ***
```

Initial Model
No variables removed

Final Version of the Predictive Model

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```
Coefficients:
                 Estimate Std. Error z value Pr(>|z|)
(Intercept)     -3.298134   0.082580 -39.939  < 2e-16 ***
BlackAfAmerican  0.385994   0.039645   9.736  < 2e-16 ***
VeteranStatus   -0.512541   0.085794  -5.974 2.31e-09 ***
age              0.028818   0.001587  18.164  < 2e-16 ***
Disable          0.569002   0.049504  11.494  < 2e-16 ***
DisType10        0.055994   0.017491   3.201  0.00137 **
income1          0.333501   0.041762   7.986 1.40e-15 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Removing variables not considered significant. Being African American (AF), being a Veteran (V), being above a certain age (Age), having a disability (Dis), and reporting an income (Inc) significant (at 0.001), substance abuse disability (DisT10) is significant (at 0.01).

Model validation

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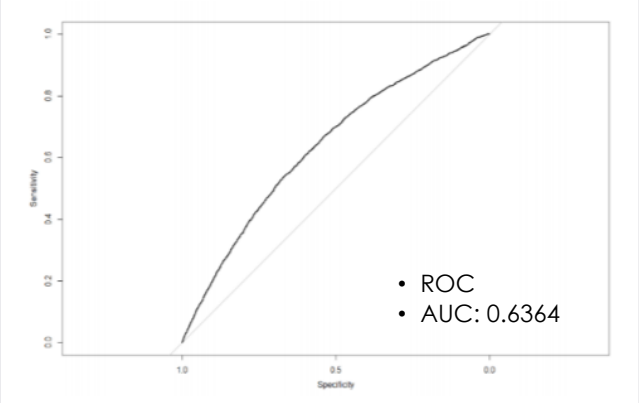

50% is Random Chance
Closer to 1 = Better

Jay presents himself at the shelter. What can we predict?

Emily presents herself at the shelter. What can we predict?

Application of the Model

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Jay presents himself at the shelter. Jay happens to be Black/African American, 60 years old, has a disability, reports having an income, and reports no substance abuse.

Assessing the probability that a guest will slide into long-term homelessness					
Factors to consider	**Enter Data**				
Age	60	Numner			
Race - Black	1	Yes/No		**Choices**	
Veteran Status	0	Yes/No		Yes	1
Disability Status	1	Yes/No		No	0
Disability Type - Substance Abuse	0	Yes/No			
Income	1	Yes/No			
Log Odds	-0.280357				
Computed initial probability	43.03%				
Interpretation:					
The initial probability that this individual will slide to long-term homelessness				43.03%	

Anticipatory identification of at-risk individuals, those with a greater propensity to slide into **Long-Term** homelessness.

13

Application of the Model

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Emily presents herself at the shelter. Emily happens to be Asian, 40 years old, does not have a disability, is a veteran, reports no income.

Assessing the probability that a guest will slide into long-term homelessness					
Factors to consider	**Enter Data**				
Age	40	Numner			
Race - Black	0	Yes/No		**Choices**	
Veteran Status	1	Yes/No		Yes	1
Disability Status	0	Yes/No		No	0
Disability Type - Substance Abuse	0	Yes/No			
Income	0	Yes/No			
Log Odds	-2.657955				
Computed initial probabilit	6.55%				
Interpretation:					
The initial probability that this individual will slide to long-term homelessness				6.55%	

Anticipatory identification of at-risk individuals, those with a greater propensity to slide into **Long-Term** homelessness.

14

Limitations, Ongoing Work

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- **Limitations**
  - A slice of time (four and a half years)
  - Tied to a single city
- **Ongoing Work**
  - Introducing the predictive model within the work practice
  - Developing meaningful variations of the predictive model

For more information and to reach the research team
http://homelessness.researchproject.us

15