National Human Services Data Consortium

2019 Spring Conference

Nashville, TN

April 15-17, 2019

Coordinated Entry System Pathways

A probabilistic graphical modeling approach to racial equity analysis

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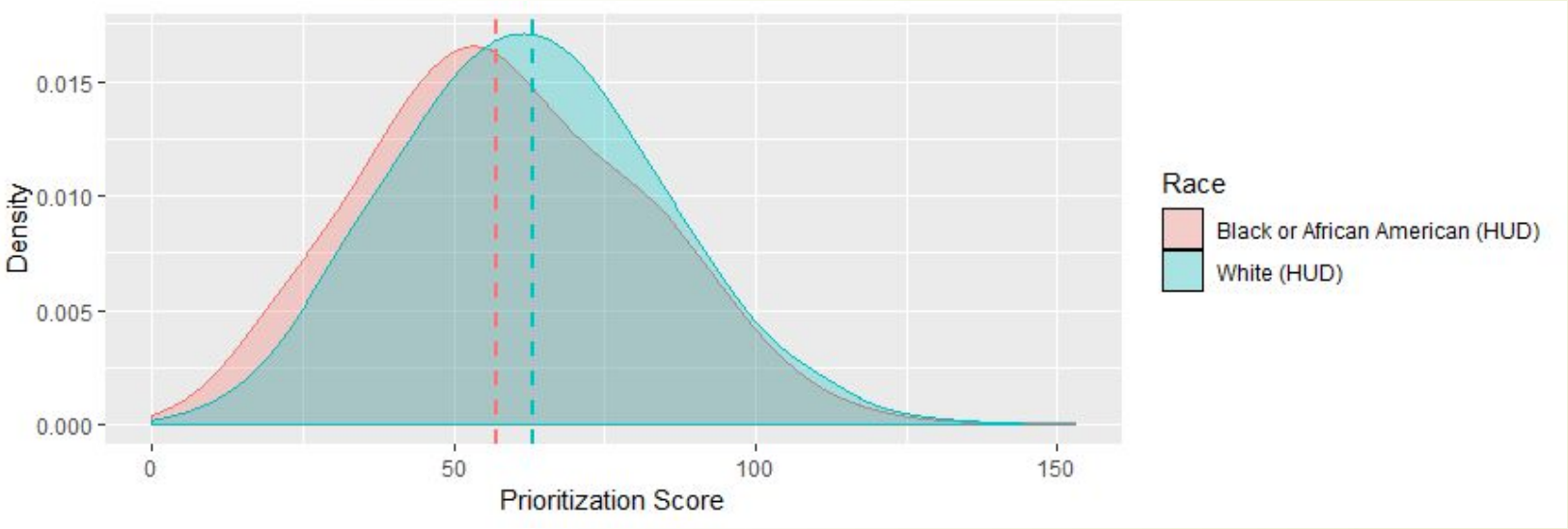
Increasing Capacity &
Building Connections:
Bridging to the Future

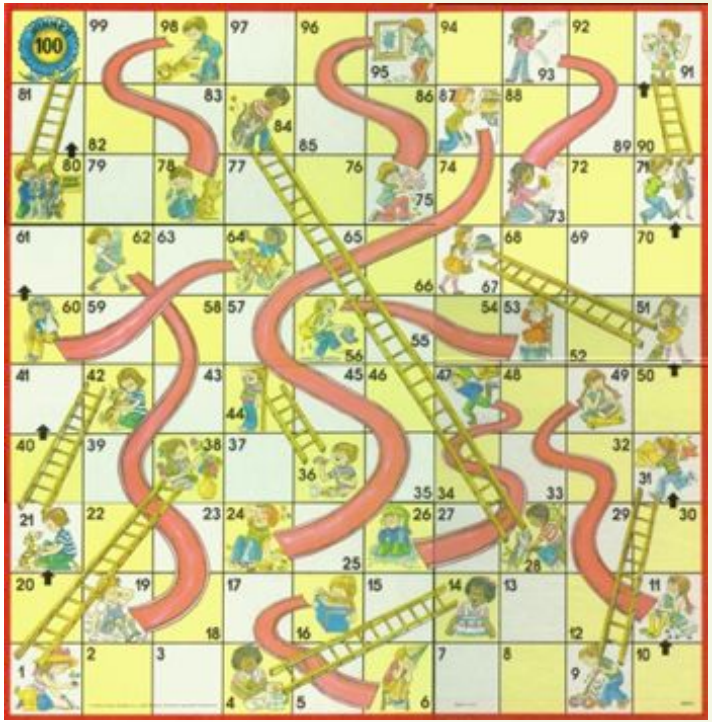

0.015
0.010
0.005
0.000
Density
0
50
100
150
Prioritization Score
Race
Black or African American (HUD)
White (HUD)

Motivating question

How does a difference in median prioritization scores act on the trajectories of Black/African American and White families through a homeless crisis-response system?

More generally...

How might we measure the diversity of experiences by which one interacts with a crisis-response system?


100
99
98
97
96
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90
80
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17
16
15
14
13
12
11
1
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6
7
8
9
10

What *is* a pathway?

We define a pathway as a client's *temporal sequence of interactions and outcomes* with a system

$$\{X_n : n \geq 0\}$$

$$P\{X_0 = i_0, \ldots, X_n = i_n\}, \quad i_0, \ldots, i_n \in S, n \geq 0.$$

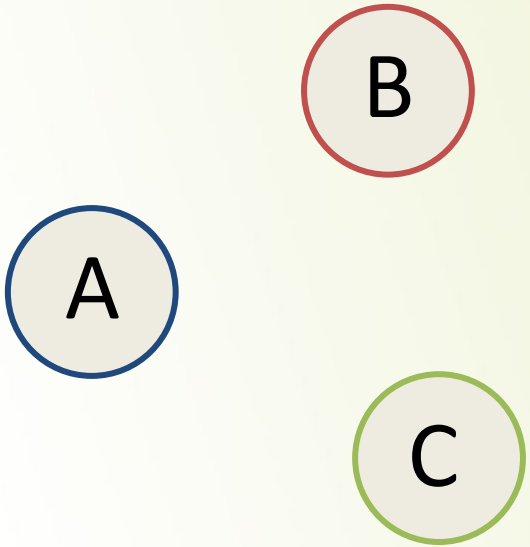
Probabilistic representation: stochastic process

$$P\{X_{n+1} = j \mid X_0, \ldots, X_n\} = P\{X_{n+1} = j \mid X_n\}$$

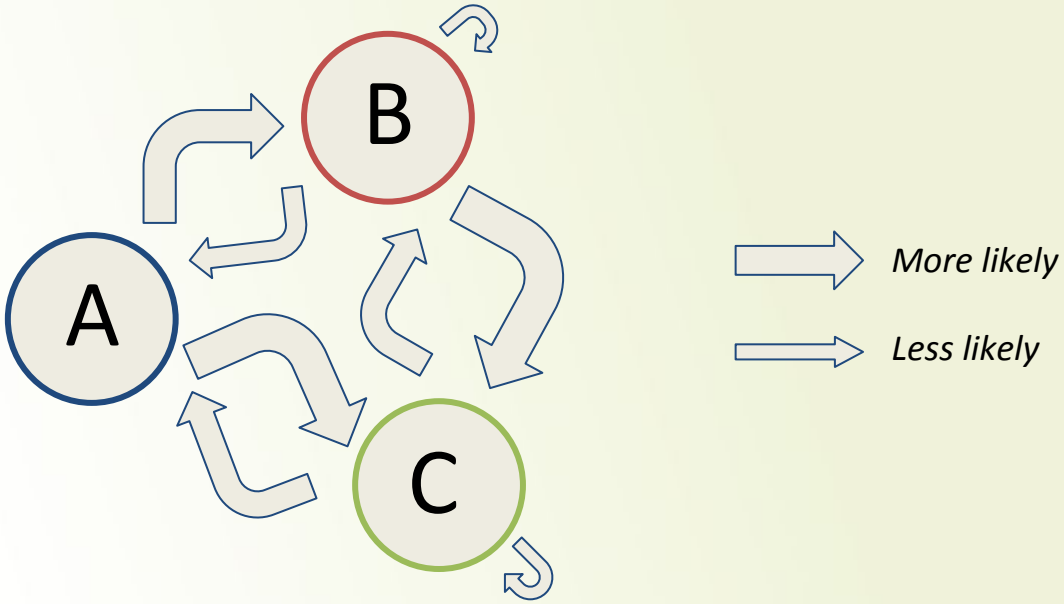
$$P\{X_{n+1} = j \mid X_n = i\} = p_{ij}$$

$$\mathbf{A} = (p_{ij})$$

Probabilistic representation: Markov chain



Graphical representation



Graphical representation (probabilistic graphical model)

Personal ID	Enrollment	Start Date	End Date	Outcome
1	Assessment	1/2/2017	1/3/2017	Temporary
1	Diversion	1/3/2017	1/14/2017	Permanent
2	Assessment	1/6/2017	1/7/2017	Temporary
2	Priority Pool	1/7/2017	2/20/2017	Temporary
2	Rapid Rehousing	2/21/2017	7/18/2017	Permanent

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2	Rapid Rehousing	2/21/2017	7/18/2017	Permanent

Personal ID	Status	Start Date	End Date
1	Assessment	1/2/2017	1/3/2017
1	Diversion	1/3/2017	1/14/2017
1	Permanent	1/14/2017	NULL
2	Assessment	1/6/2017	1/7/2017
2	Priority Pool	1/7/2017	2/20/2017
2	Rapid Rehousing	2/21/2017	7/18/2017
2	Permanent	7/18/2017	NULL

Personal ID	Status	Start Date	End Date
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2	Priority Pool	1/7/2017	2/20/2017
2	Rapid Rehousing	2/21/2017	7/18/2017
2	Permanent	7/18/2017	NULL*

**Or until a client returns...*

[ID] Sequence (status, days)-(status, days)...

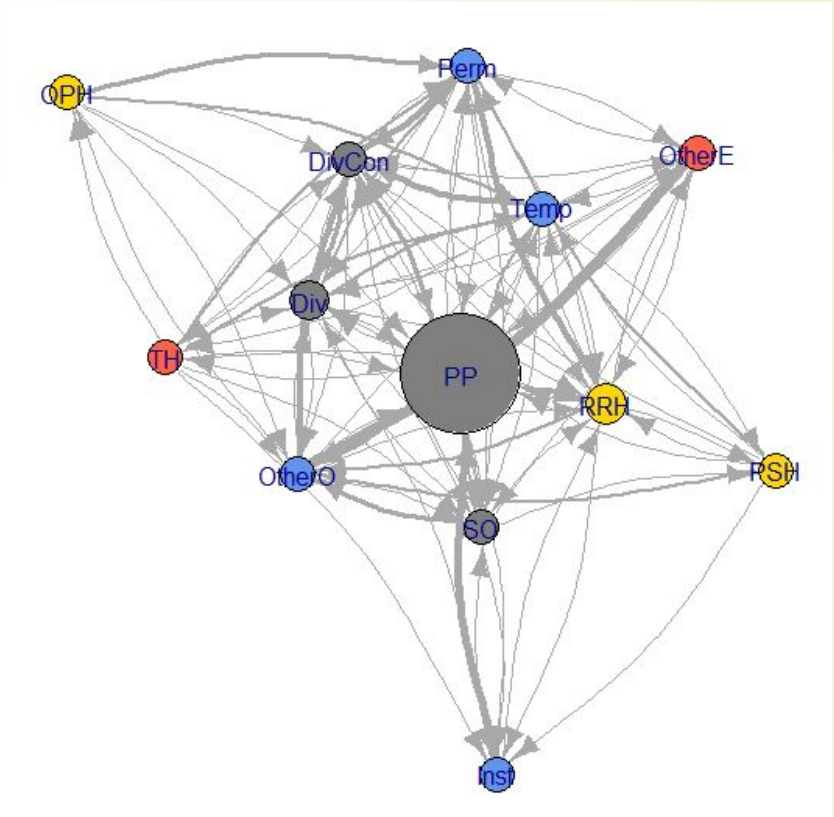
[1] (DivCon,1)-(PP,93)-(Temp,1)
[5] (DivCon,32)-(Div,7)-(Perm,1)
[6] (PP,72)-(RRH,401)-(Perm,1)
[7] (DivCon,1)-(PP,91)-(Temp,203)-(DivCon,1)-(Div,31)-(DivCon,1)-(Div,1)-(Perm,1)
[9] (SO,1)-(DivCon,1)-(PP,93)-(Temp,1)
[11] (PP,6)-(Div,23)-(Perm,504)-(DivCon,1)-(Div,30)-(DivCon,1)-(PP,90)-(Div,32)-(Temp,1)
[14] (DivCon,1)-(Div,5)-(Perm,1)
[15] (DivCon,1)-(PP,93)-(Temp,1)
[16] (DivCon,1)-(Div,14)-(Perm,1)

$$P\{X_{n+1} = j \mid X_0, \ldots, X_n\} = P\{X_{n+1} = j \mid X_n\}$$

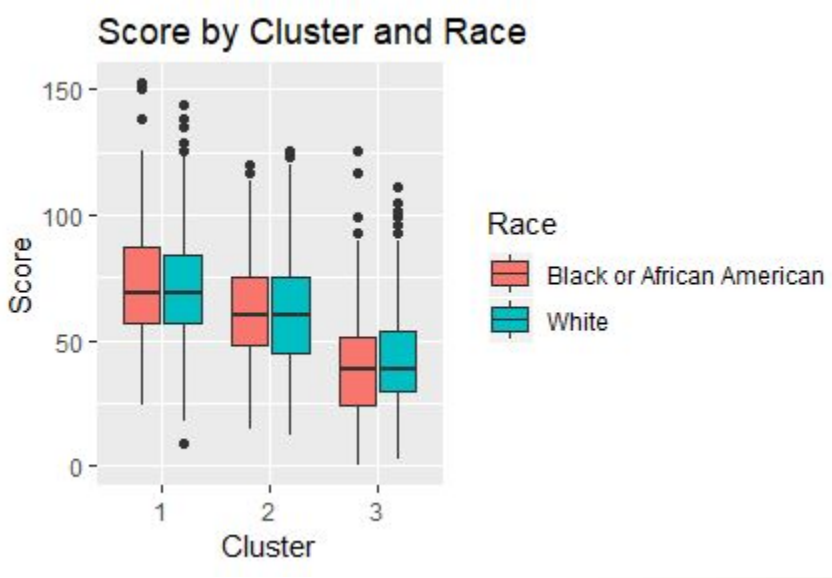
$$P\{X_{n+1} = j \mid X_n = i\} = p_{ij}$$

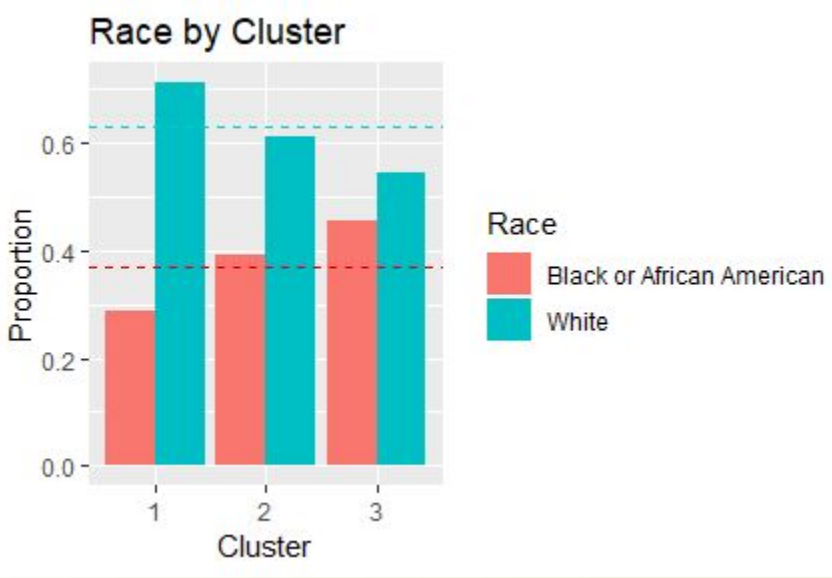
$$\mathbf{A} = (p_{ij})$$

Probabilistic representation: Markov chain

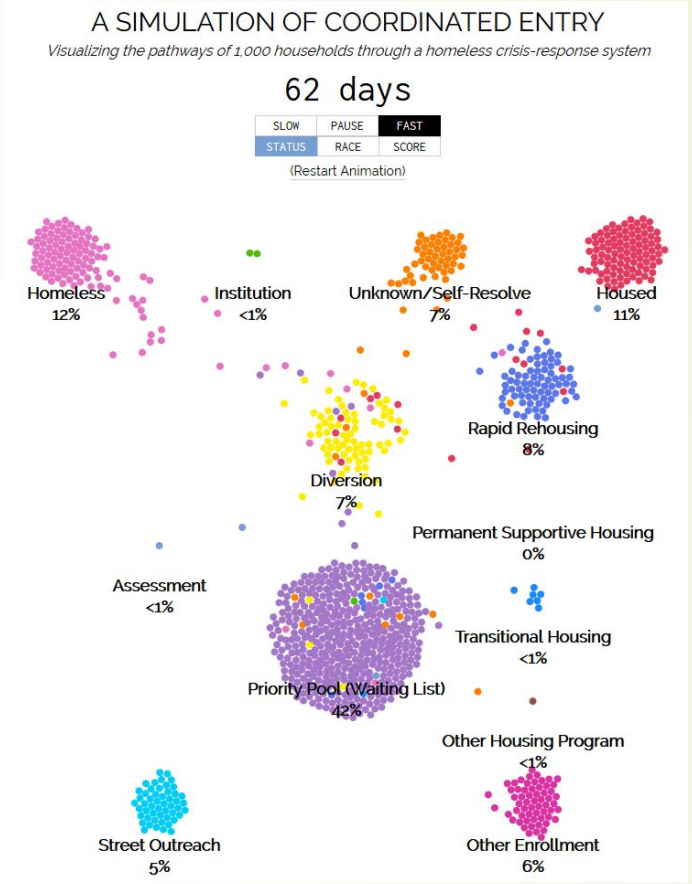

Perm
OPH
DivCon
OtherE
Temp
Div
TH
PP
RRH
OtherO
RSH
SO
Inst

Why should you care?


Score by Cluster and Race
Score
150
100
50
0
1
2
3
Cluster
Race
Black or African American
White

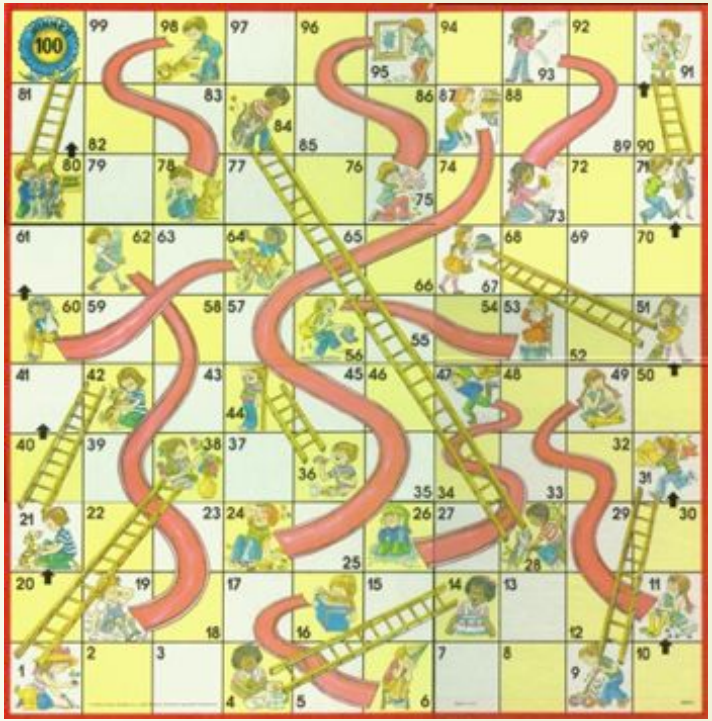

Race by Cluster
Proportion
0.6
0.4
0.2
0.0
1
2
3
Cluster
Race
Black or African American
White

[Animated demonstration]

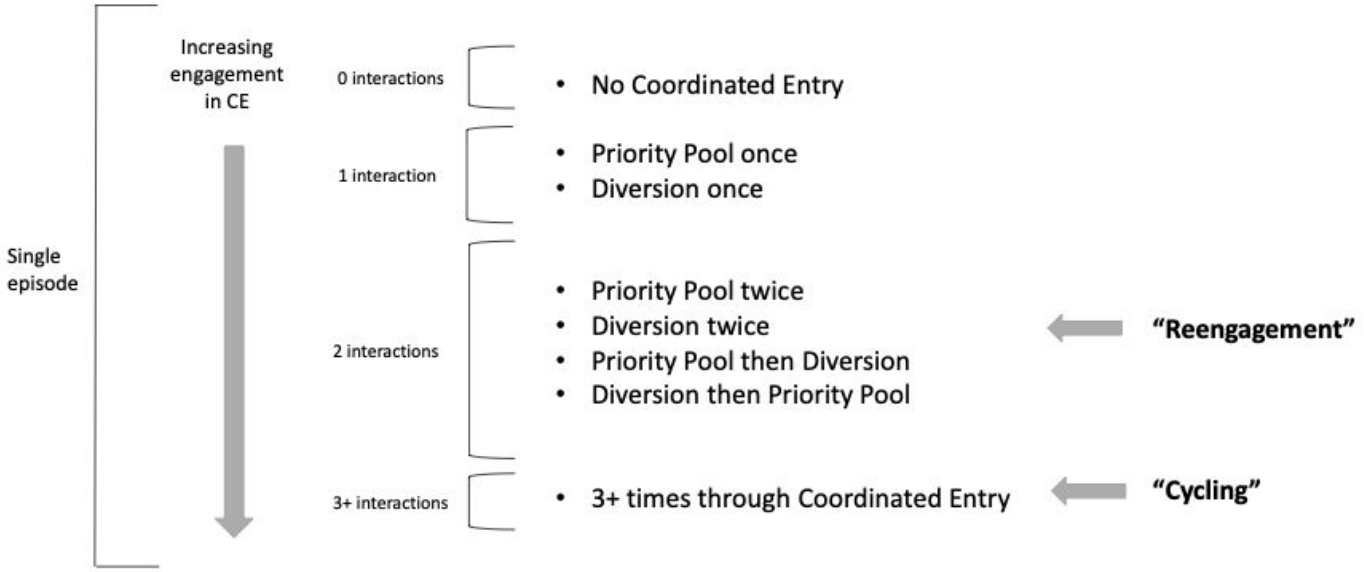

A SIMULATION OF COORDINATED ENTRY
Visualizing the pathways of 1,000 households through a homeless crisis-response system
62 days
SLOW
PAUSE
FAST
STATUS
RACE
SCORE
(Restart Animation)
Homeless
12%
Institution
<1%
Unknown/Self-Resolve
7%
Housed
11%
Rapid Rehousing
8%
Diversion
7%
Permanent Supportive Housing
0%
Assessment
<1%
Transitional Housing
<1%
Priority Pool (Waiting List)
42%
Other Housing Program
<1%
Street Outreach
5%
Other Enrollment
6%

Bounding the analysis

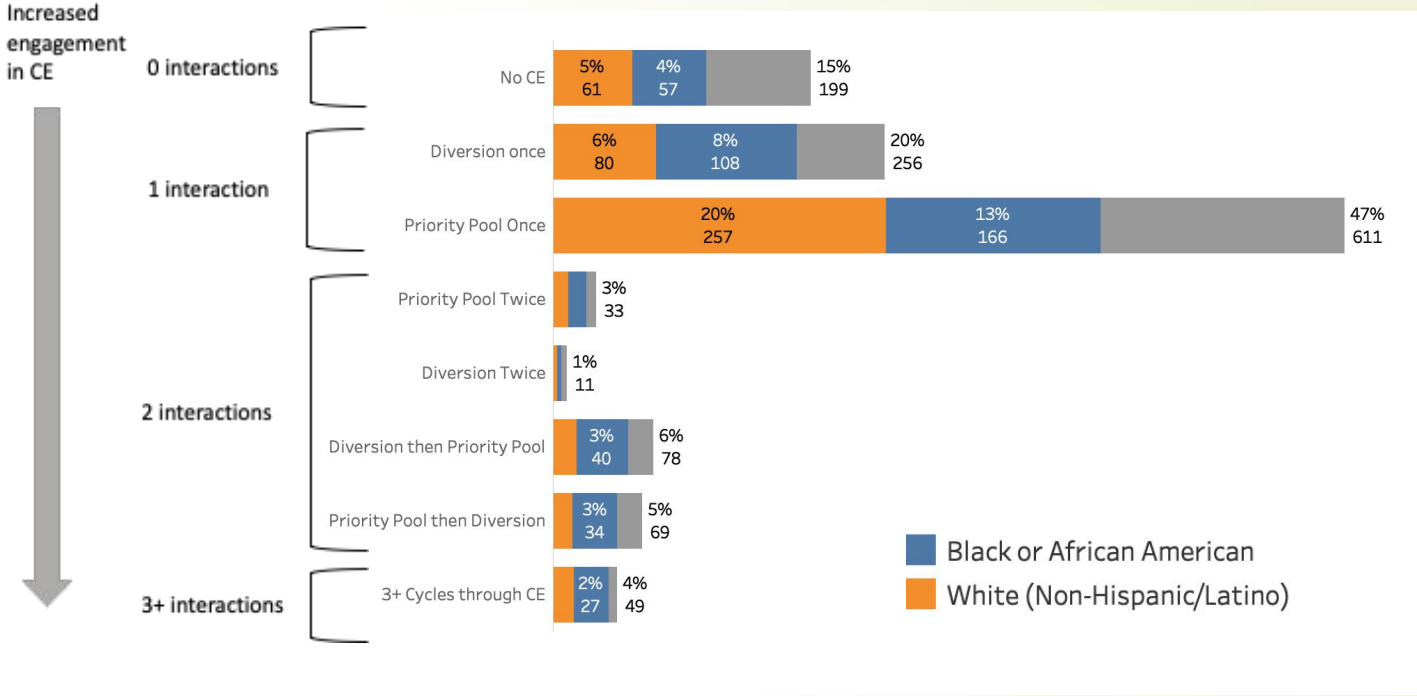
How do pathways of Black/African-American families differ from those of White families in moving through a homeless crisis-response system?



Eight Stylized Pathways Through Pierce County Homelessness Crisis Response System

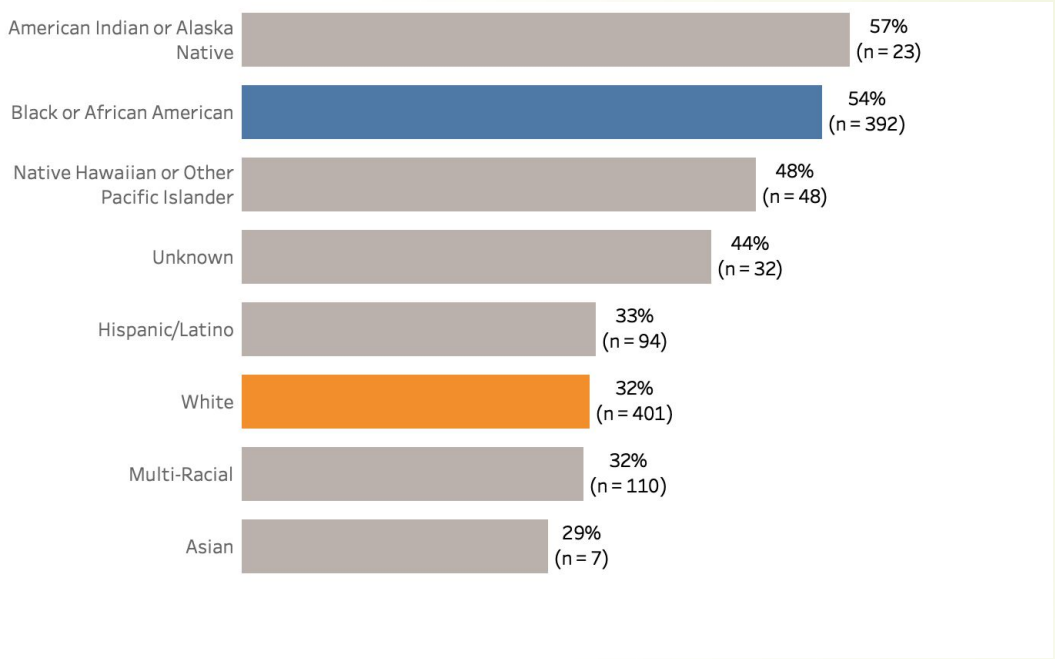


Likelihood of pathway



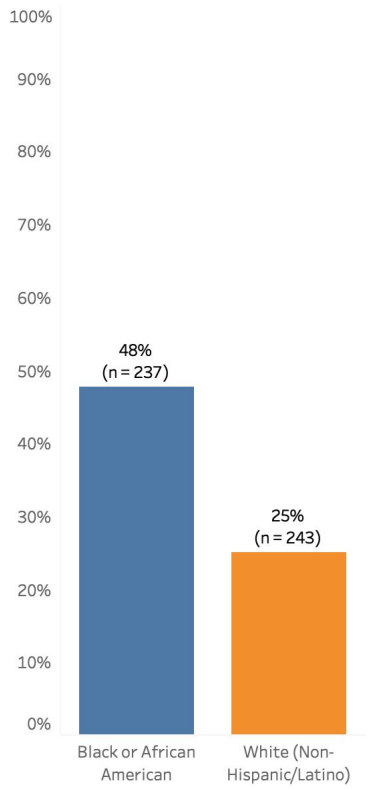
Dataset includes **1,306** families with an episode of homelessness starting in 2017

Diversion uptake



What percent of families by race/ethnicity group enter CE *and* take up diversion at some point along their pathway?

Black/African-American families are more likely to pursue Diversion than White families ($p < .001$)

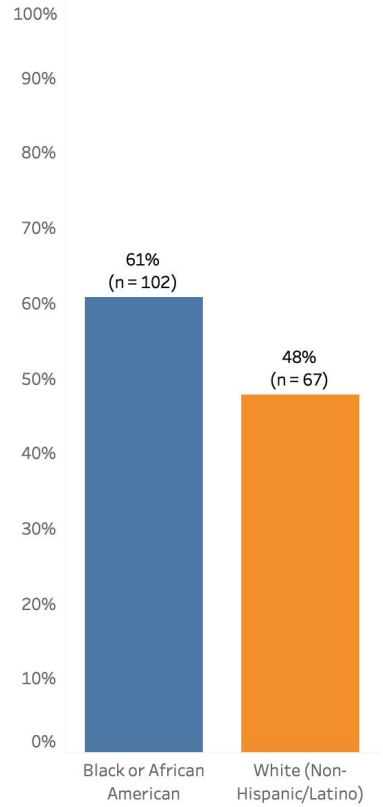


Re-engagement

Proportion of Black/African-American and White families who re-engage after an unsuccessful first attempt through **CE**

Black/African-American families are more likely to re-engage in system than White families after unsuccessful first attempt through CE ($P < .001$)

- 48% of Black or African-Americans families who were unsuccessfully housed re-engage with Coordinated Entry
- 25% of White families who were unsuccessfully housed re-engage with Coordinated Entry

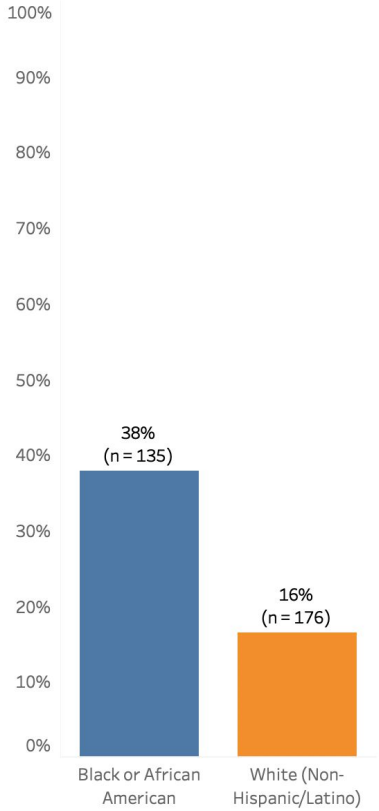


Re-engagement

Proportion of Black/African-American and White families who re-engage after an unsuccessful first attempt through **Diversion**

Black/African-American families are more likely to re-engage in system than White families after unsuccessful first pursuit of **diversion** ($p < .001$)

- 61% of Black or African-Americans families who were unsuccessfully housed via **diversion** re-engage with Coordinated Entry
- 48% of White families who were unsuccessfully housed via **diversion** re-engage with Coordinated Entry



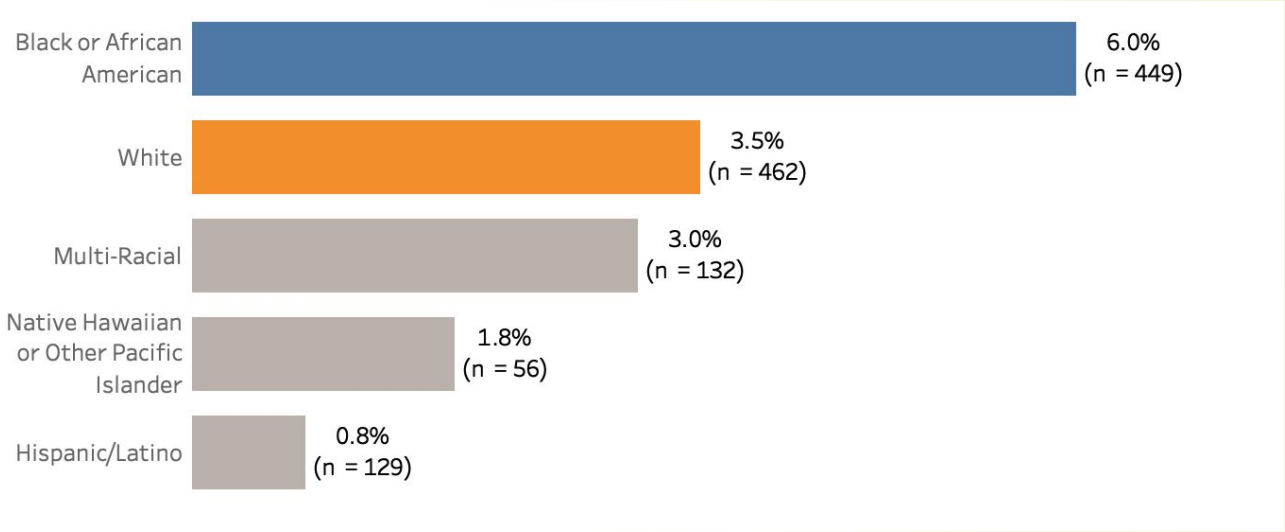
Re-engagement

Proportion of Black/African-American and White families who re-engage after an unsuccessful first attempt through **Priority Pool**

Black/African-American families are more likely to re-engage in system than white families after unsuccessful first enrollment in **priority pool** ($p < .05$)

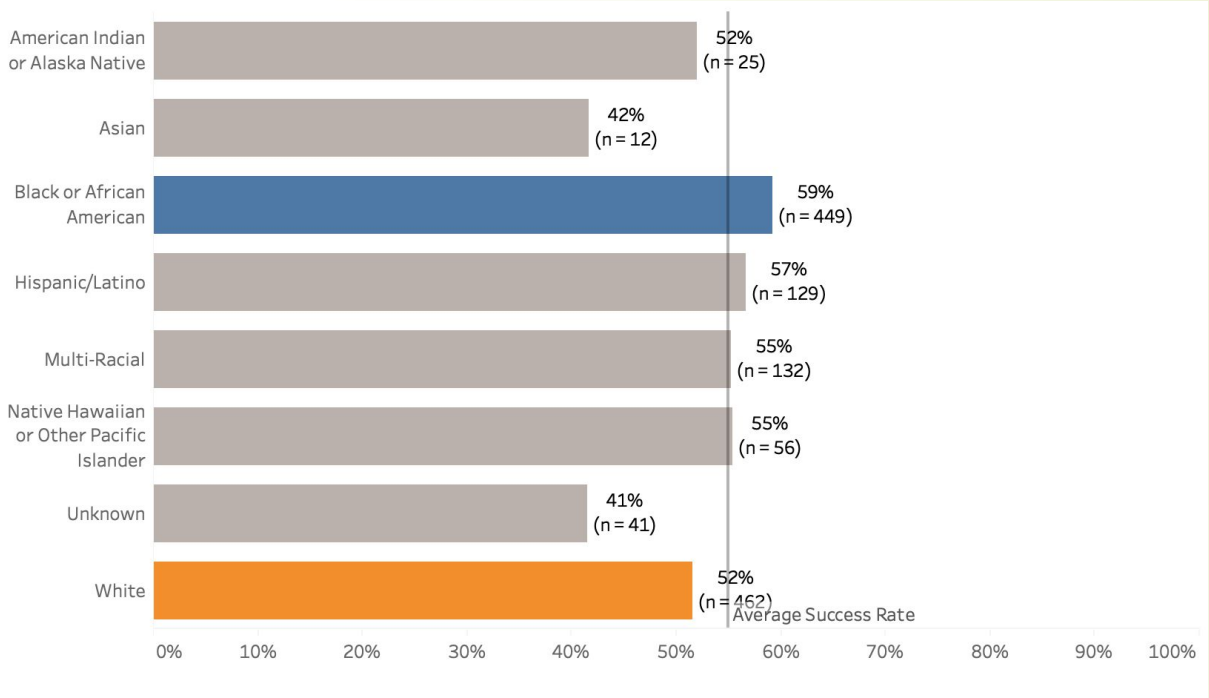
- 38% of Black or African-Americans families who were unsuccessfully housed through the **priority pool** re-engage with Coordinated Entry
- 16% of White families who were unsuccessfully housed via **priority pool** re-engage with Coordinated Entry

Cycling



Black/African-American families are more likely to cycle through Coordinated Entry 3+ times, relative to White families ($p < .05$)

Outcomes



Outcomes are largely equitable across race: White families have a slightly lower likelihood of successful housing outcome, relative to Black/African-American families ($p < .05$)

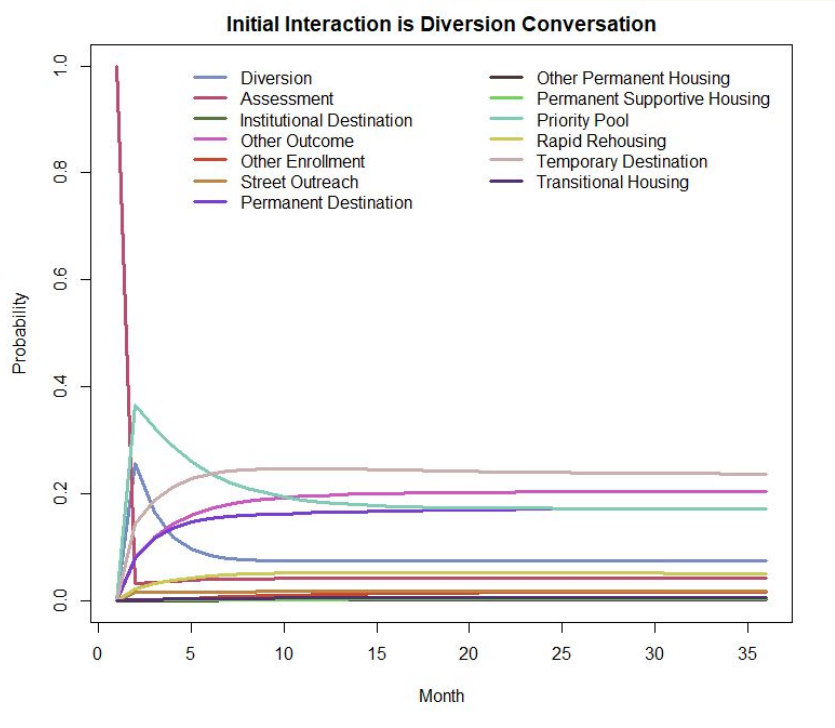
Case findings and implications

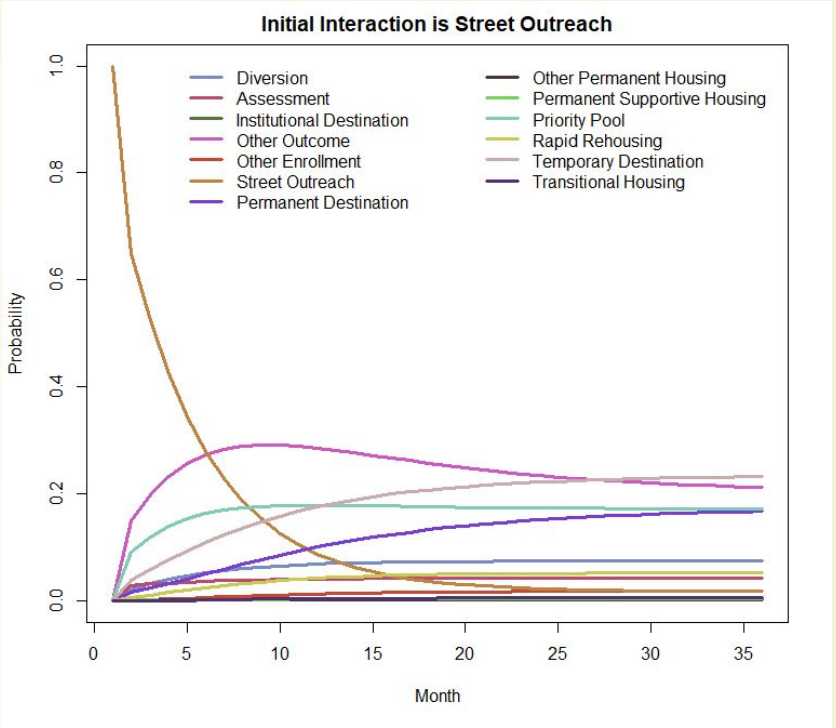
- While outcomes (i.e. PH referrals or diversion success) do not vary substantially by race/ethnicity, Black/African-American families navigate and experience Coordinated Entry differently, relative to White families
    - Black/African-American families are more likely to pursue a Diversion solution, relative to White families
    - Black/African-American families are more likely than White families to re-engage and cycle through Coordinated Entry multiple times if they do not initially obtain permanent housing

Discussion: What might this mean for assessment, program design, and service delivery?

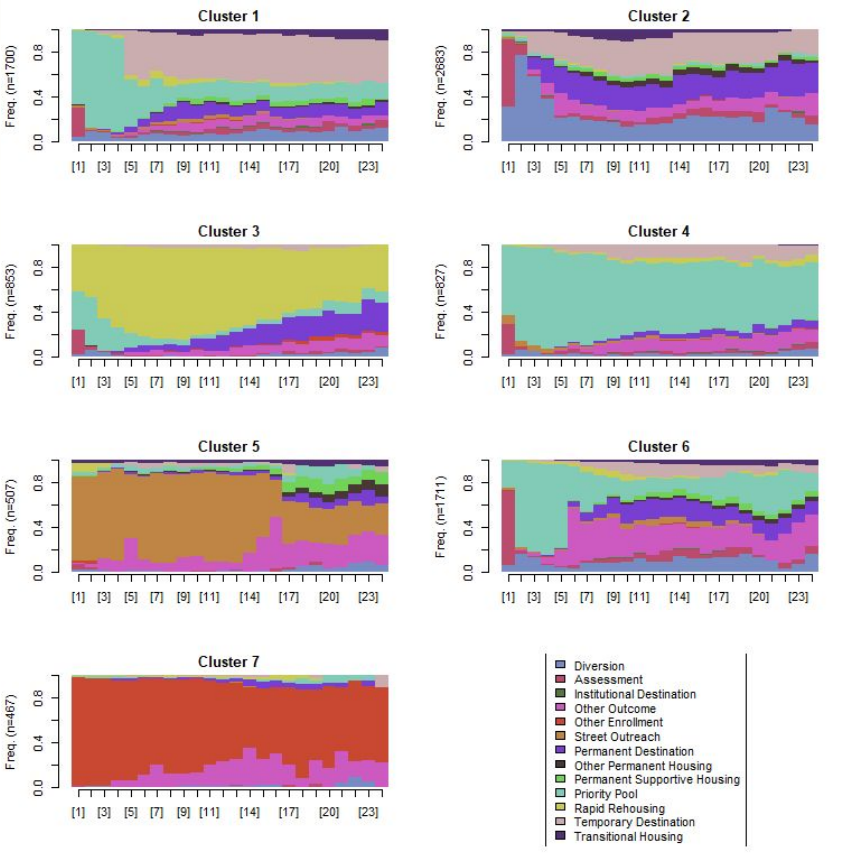
What's next?

Projection!


Initial Interaction is Diversion Conversation
Diversion
Assessment
Institutional Destination
Other Outcome
Other Enrollment
Street Outreach
Permanent Destination
Other Permanent Housing
Permanent Supportive Housing
Priority Pool
Rapid Rehousing
Temporary Destination
Transitional Housing
Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
5
10
15
20
25
30
35
Month


Initial Interaction is Street Outreach
Diversion
Assessment
Institutional Destination
Other Outcome
Other Enrollment
Street Outreach
Permanent Destination
Other Permanent Housing
Permanent Supportive Housing
Priority Pool
Rapid Rehousing
Temporary Destination
Transitional Housing
Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
5
10
15
20
25
30
35
Month

Clustering!


Cluster 1
Freq. (n=1700)
Cluster 2
Freq. (n=2683)
Cluster 3
Freq. (n=853)
Cluster 4
Freq. (n=827)
Cluster 5
Freq. (n=507)
Cluster 6
Freq. (n=1711)
Cluster 7
Freq. (n=467)
0.0
0.4
0.8
[1] [3] [5] [7] [9] [11] [14] [17] [20] [23]
Diversion
Assessment
Institutional Destination
Other Outcome
Other Enrollment
Street Outreach
Permanent Destination
Other Permanent Housing
Permanent Supportive Housing
Priority Pool
Rapid Rehousing
Temporary Destination
Transitional Housing

And…

- Dynamic (as opposed to static) models
  - e.g. non-homogeneous Markov models, mixture Markov models
- Whole systems modeling and forecasting
  - i.e. including housing/rental market data, income/wage data, and intervention supply/budget data

Resources

- R programming language
  - packages: TraMineR, seqHMM, igraph/qgraph
  - *R for Data Science* (Grolemund and Wickham)
- *Probabilistic Graphical Models: Principles and Techniques* (Koller and Friedman)
- JavaScript library D3.js (https://d3js.org)
  - https://bl.ocks.org/mbostock
  - https://flowingdata.com

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Thank you!