

Using Predictive Analytics to Inform Child Welfare Preventive Services in New York City

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Part One:

Foundations, Goals, Methods, and Applications

What is Predictive Analytics?

- *Predictive analytics* (PA) is the practice of extracting information from existing data sets in order to identify patterns and predict the likelihood of future outcomes.
- *Predictive Risk Modeling* (PRM) is an approach to predictive analytics that uses routinely collected administrative data to identify individuals at risk of an adverse event or to inform prevention efforts.

Key Questions

- **Outcome:** What decision do you hope to inform?
- **Predictors:** What associations do you seek to detect?
- **Application:** What problem do you hope to solve?
- **Administrative data:** What are existing data sources?

Application: Goals for Predictive Analytics at NYC-ACS

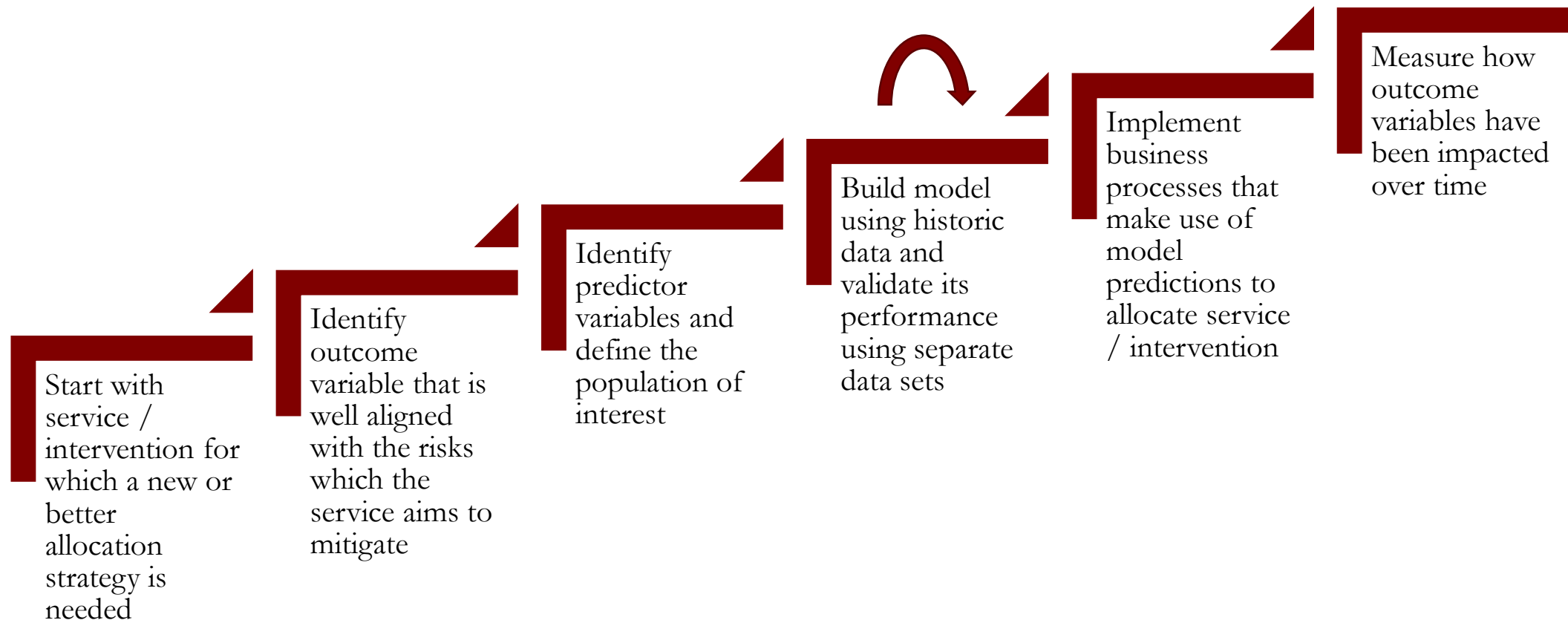
Overall: Apply administrative data to understanding the level of care, attention, and service a target population may need.

- Assist decision-making by providing more information to supervisors and additional resources to front-line staff
- Adjust Quality Assurance reviews to account for the distribution of challenging/high-need cases
- Identify appropriate services that may mitigate propensity for negative outcomes and strengthen protective factors

Requirements

- Clearly defined outcomes
- Available data
 - Depth
 - Breadth
 - Quality
- Teaming/Governance
 - Oversight group
 - Technical group
 - Stakeholder engagement
- Methodological expertise
 - Machine learning
 - Regression modeling

Building Blocks for a Collaborative and Iterative Approach



Defining Outcomes: Frequently Encountered Families



- Families that are the subject of several child protective investigations where safety and risk remain a concern
 - Families with two or more reports within the prior six months, or four or more within the prior two years
- Families that have been receiving multiple preventive spells for years without achieving their goals
 - Families involved with Preventive Services who are experiencing elevated risk factors.
 - Families involved with Preventive Services with long length of services, as measured by 18 months.
- Children who are in and out of foster care and have yet to achieve permanency
 - Children who achieve permanency and later re-enter into placement
 - Children who experience foster care placement and later are involved in a case as a case parent

Predictive Analytic Methods

Empirically predict/estimate the likelihood/probability of an event/outcome of interest



- Prediction \neq Causality
- Prediction \neq Crystal ball
- Prediction \neq Absolute truth
- Prediction \neq Error free



Predictive Analytics: Methodological Approaches

- **Regression**

- Estimates relationship among selected variables
- Can describe the strength (“weight”) of a predictor’s relationship with an outcome
- “Best fit” line formula minimizes differences between “predicted” and “observed” outcomes

- **Machine Learning**

- Searches for patterns in mass data
- Modeled on artificial intelligence (i.e., “learning”)
 - Decision tree learning (e.g. random forest)
 - Deep learning (e.g. neural network)
- Formula yields a probability of prediction

Both approaches yield algorithms for prediction

Training & Test Samples

To ensure that model holds under similar, but not identical, conditions, we use two samples:

- “Training” dataset
 - To develop and fit the parameters that produce a predictive model
- “Testing” dataset
 - As similar to the “training” dataset as possible
 - To provide an unbiased evaluation of the final model from the “training” dataset

Key Concepts for Evaluating a Predictive Model

- Error rate

- True Positive
- True Negative
- False Negative (Error)
- False Positive (Error)

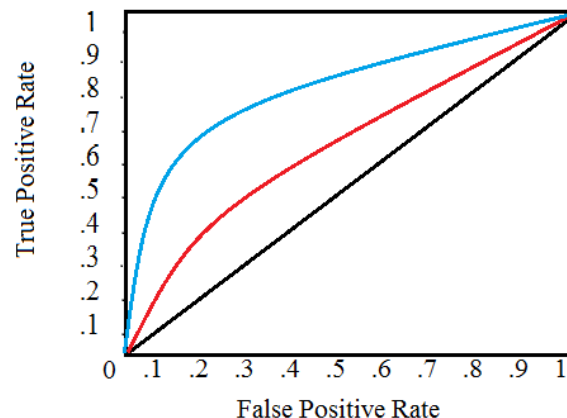
		Actual Outcome	
		Yes	No
Predicted Outcome	Yes	True Positive	False Positive
	No	False Negative	True Negative

- Threshold

- Turning continuous predicted “risk scores” into categorical prediction (e.g., yes/no)

- Receiving Operating Characteristics (ROCs) curve and the area under the ROC (AUC)

- Graphical representation of the tradeoff between True Positive Rate and False Positive Rate afforded by the full range of thresholds for a given model



ACS Predictive Model Example: Predicting “Severe Harm”



Outcome: Severe maltreatment, defined as one or more future Substantiated Severe Harm Allegations against the child and occurring within 2 years of investigation start date, 5.7% prevalence

Training and Test Samples: ~200K children in investigations ending between Jan. 1, 2013 and Dec. 31, 2014 (2 years)

Time of prediction: day 7 of investigation

Predictors: ~200, collected from data prior to time of prediction, including demographic data, past and current investigation data

Outcome: Severe Harm



Allegation	Include
Abandonment	If child is under 3
Burns/Scalding	Yes
Child Drugs/alcohol Use	No
Choking/Twisting/Shaking	Yes
Education Neglect	If child is under 3
Emotional Neglect	No
Excessive Corporal Punishment	If child is under 7
DOA/Fatality	Yes
Fractures	Yes
Inadequate Food/Clothing/ Shelter	No
Internal Injuries	Yes
Inappropriate Custodial Conduct	No
Inadequate Guardianship	If child is under 3
Inappropriate Isolation/Restraint	If child is under 7
Lacerations/Bruises/Welts	Yes
Lack of Medical Care	If child is under 7
Lack of Supervision	If child is under 3
Malnutrition/ Failure to Thrive	Yes
Parent Drug/ Alcohol Misuse	If child is under 3
Poisoning/ Noxious Substances	Yes
Swelling/ Dislocation/Sprains	Yes
Sexual Abuse	Yes
Other	No

Predictors



Current and past investigations

- Number of investigations
 - Total and indicated
 - Recent total and indicated
 - Child has role
 - Perpetrator (confirmed + non-confirmed)
- Time known to DCP
- 13 High Priority Codes
- 23 Allegation types
- 19 Safety Factors
- Risk Assessment Profile (RAP) scores

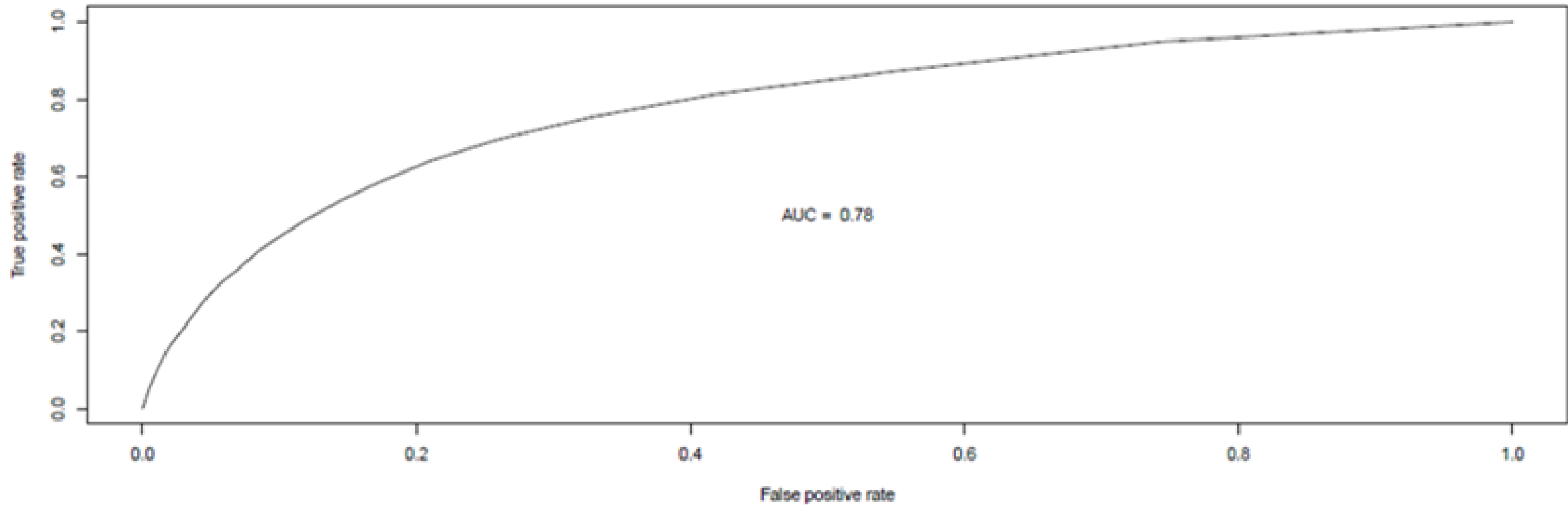
Demographics

- Ages of child and mother; sibling counts by age (e.g., 1 sibling between 11-18)
- Child's race ('Hispanic', 'Afr Am', 'White', 'Asian/Pacific Island', 'Other', 'Unknown')
- Child's gender
- Community district and county (from current stage)

Model Refinements

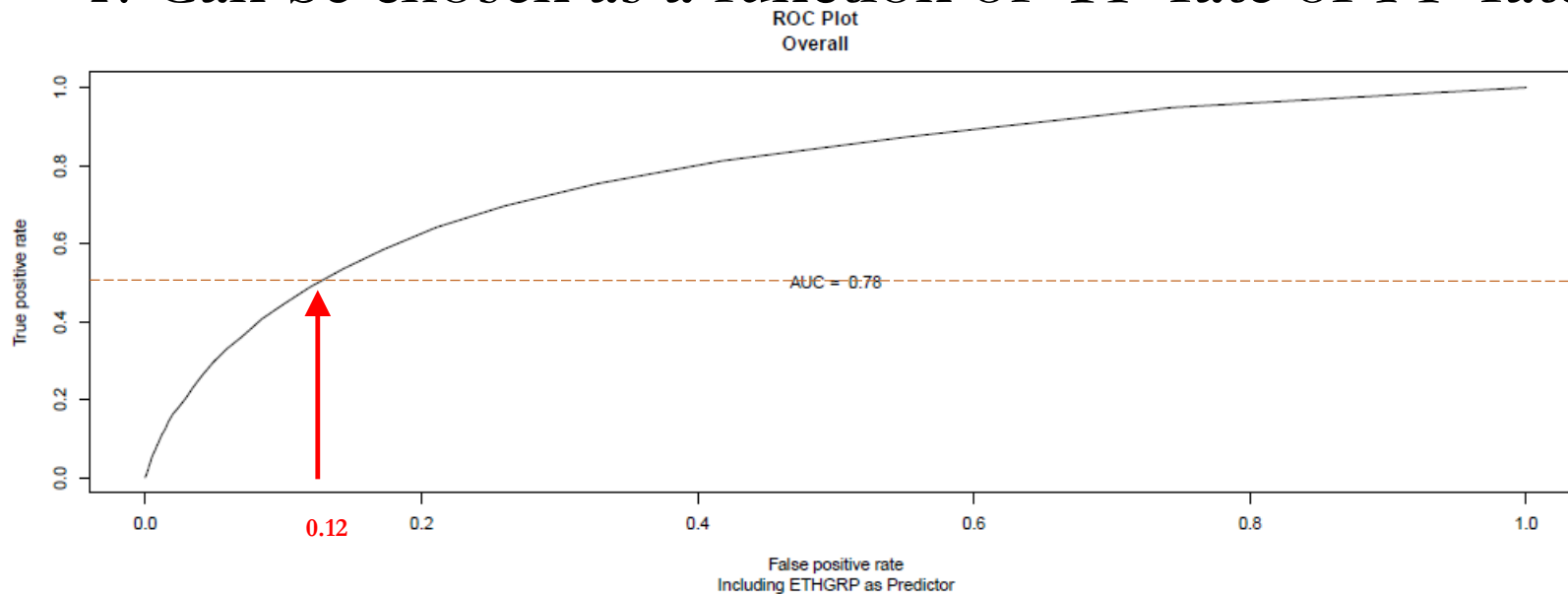
- FASP/RAP Questions
- Foster care history

ROC



Thresholds

1. Can be chosen as a function of TP-rate or FP-rate (not both)



TP rate of 0.5 corresponds here to a FP rate of 0.12

2. Can be chosen as a function of available resources

The above threshold makes positive predictions for the top 15% of children at risk (some of whom will be FPs)

Intended Areas of Application



Applications

- Use of “severe harm” predictive model in
 - Risk adjustment of preventive provider scorecard
 - QA reviews and coaching of high-risk investigations
 - Prioritizing Family Team meetings and closing conferences that are facilitated by ACS



Part Two:

Challenges, Stakeholder Engagement, and Ethical Protections

Timeline



- **2015-2016:** FEF workgroup operationalize and finalize outcomes
- **2016-2017:** Inventory data and developed initial predictive analytic models
- **2017-2018:** Build internal capacity to refine and prioritize predictive analytic models; develop ethical governing bodies; identified applications of predictive analytic models
- **2018-Present:** design and implement applications, test model equity, refine models, meet with stakeholder, advocacy, and ethical oversight groups

Operational/Implementation Challenges

- When is the predictive model run?
- Who sees the predictive model score?
- How does the predictive model score change casework behavior?
- How to refine the predictive model?

Challenges

- Stakeholder engagement
- Data operationalization and availability
- Ethics and equity
- Operational/implementation

Developing Inter-Agency Collaboration: Inclusive Process

Internal Stakeholders (ACS)

- Child Welfare Programs
- Division of Child Protection
- Division of Preventive Services
- Family Permanency Services
- Division of Policy, Planning, and Measurement

External Stakeholders

- Chapin Hall at the University of Chicago
- City University of New York
- New York University
- Contracted Provider Agencies Quality Assurance
- Casey Family Programs

Bridging Practice & Data

Practice

- What outcomes do we wish to affect?
 - How can we use data to help you meet your goals?
- What are some potential predictive variables?
- What is the application?
 - What processes do we want to put into place to increase positive outcomes?

Data

- What data are available?
 - Enough quantity?
 - Enough quality?
- What analytic approach do we wish to use?
 - Exploratory?
 - Machine Learning?
- Internal or external?
 - Internal capacity building?
 - Contracted partners?

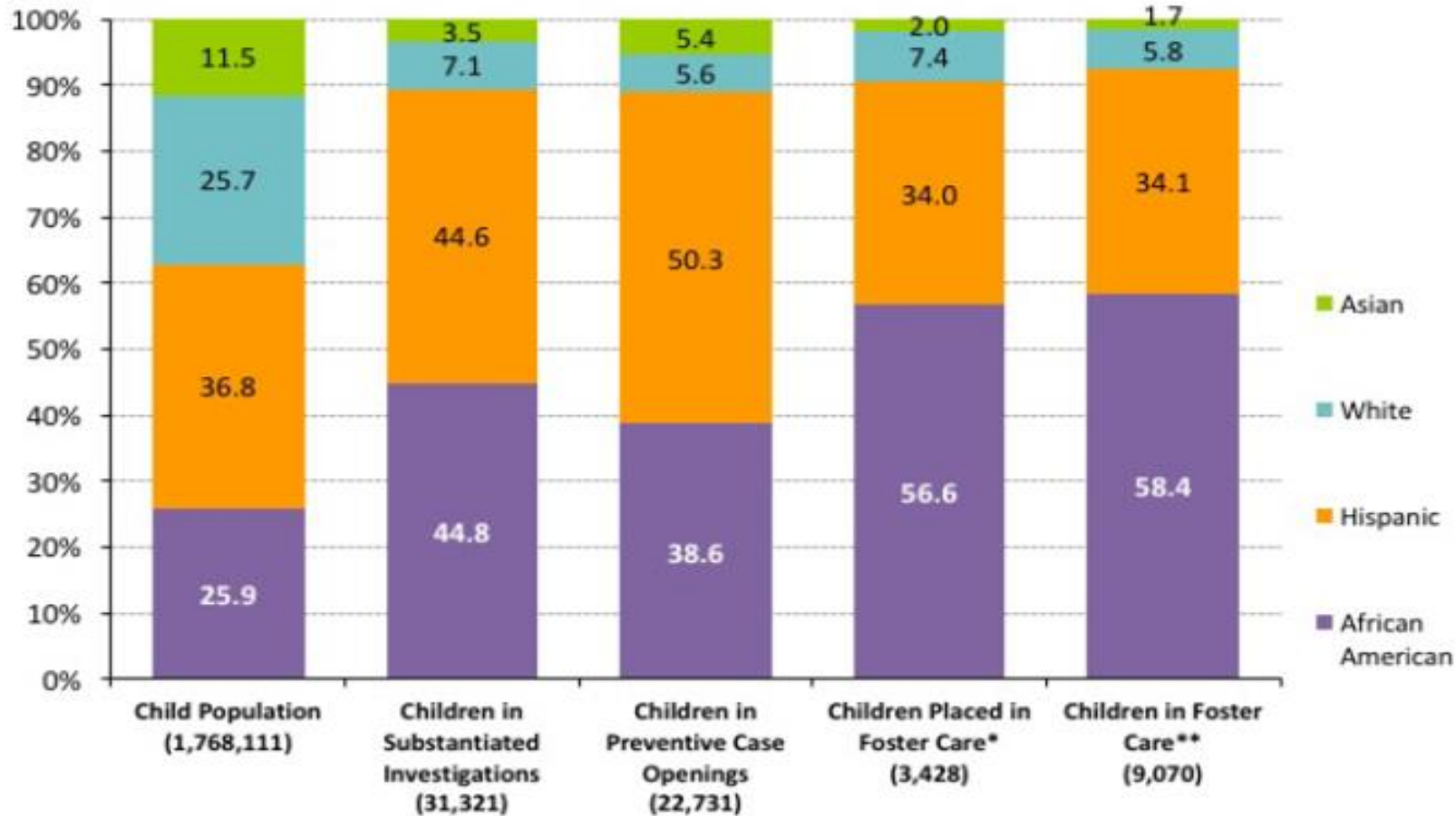
Methods and Ethics

- Stewardship of administrative data
- Repercussion of prediction quality on target populations (positive vs. negative reinforcement)
- Fairness/Unfairness of prediction
- Transparency of prediction
- Resource allocation (e.g., benefit the mass vs. prioritize the most needy?)

Nutrition Facts	
8 servings per container	
Serving size	2/3 cup (55g)
Amount per 2/3 cup	
Calories	230
% DV*	
12%	Total Fat 8g
5%	Saturated Fat 1g
	<i>Trans Fat</i> 0g
0%	Cholesterol 0mg
7%	Sodium 160mg
12%	Total Carbs 37g
14%	Dietary Fiber 4g
	Sugars 1g
	Added Sugars 0g
	Protein 3g
10%	Vitamin D 2mcg
20%	Calcium 260mg
45%	Iron 8mg
5%	Potassium 235mg
* Footnote on Daily Values (DV) and calories reference to be inserted here.	

Methods and Ethics

Race/Ethnicity and Path through the Child Welfare System, 2016



Note: Missing values and other race are excluded from percent calculations.

*Excludes youth placed in Close to Home.

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Goals for Model Equity

- **Parity:** Impact the same for all groups
- **Prediction Quality:** Error rates are the same for all groups
 - Technically: Similar ROC/AUC across groups
 - Operationally: Equally risky cases are treated the same



Ethical Predictive Modeling

- **Predictive Analytic Advisory Committee (PAAC):** Reviews all proposals for advanced analytics models; commits to participate in associated workgroups, conference calls, and in-person meetings periodically; approves or rejects all advanced analytic models; and consults with the advisory group on an as needed basis.
- **Predictive Analytic Advisory Group (PAAG):** Consults with the approval committee on an as needed basis; reviews selected proposals to support compliance with ethical guidelines; interprets models so they are clear to the ACS community; recommends ethical development and application of models to guide ACS policy, program and practice; and identifies opportunities for stakeholder engagement.

ACS' Draft Predictive Analytics Guidelines

1. **Validity:** build, monitor and refine models to ensure good predictive power; perform sound technical analyses.
2. **Transparency:** create technical documents that are accessible to internal staff and external stakeholders, including access to the following information: model predictors and outcomes; model performance; intended applications.
3. **Equity:** employ safeguards during model development and implementation in order to counter systemic biases; ensure diverse representation in oversight groups; conduct impact analyses to ensure that new practices mitigate disproportionality.
4. **Relevance:** set analytic goals that can complement effective business practices and current agency priorities; predict outcomes related to actionable goals / applications
5. **Application:** employ model predictions in applications that have themselves been vetted for effectiveness and appropriateness; evaluate success over time; utilize model predictions only if they provide the best available decision making strategy

