Fairness in Decision Making

Is Linear Regression Fair?

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Joint work with

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(Google Research)

Claire Mathieu
(CNRS, Université de Paris)

Namrata
(University of Warwick)

PART I

An Oversimplfied Overview

A Hypothetical Situation

Alice

Bob

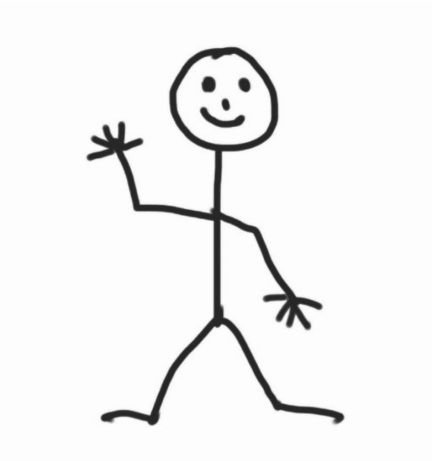
A Hypothetical Situation

Alice

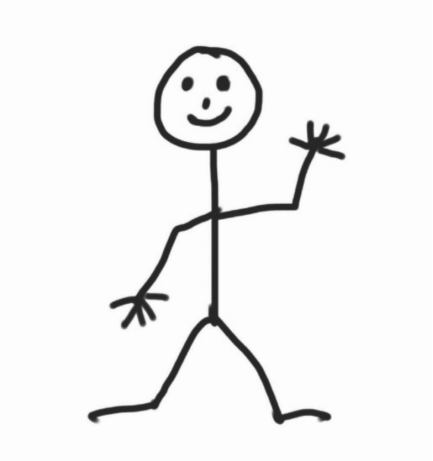
Bob

A Hypothetical Situation

Alice



Bob



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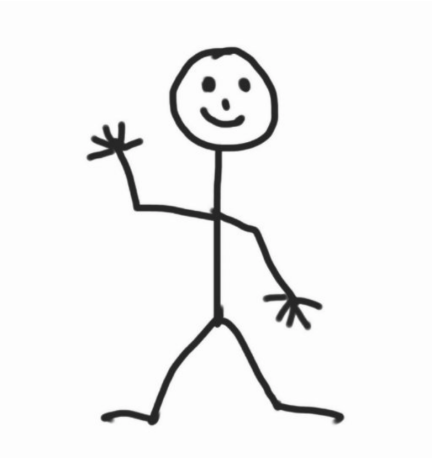

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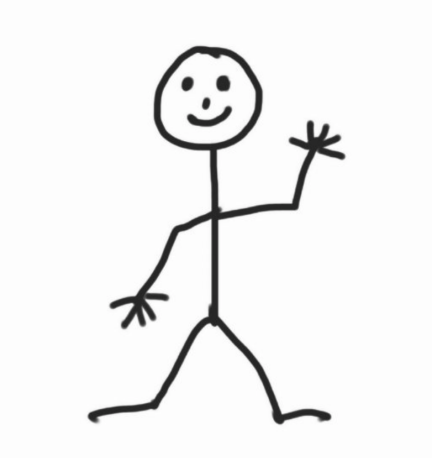

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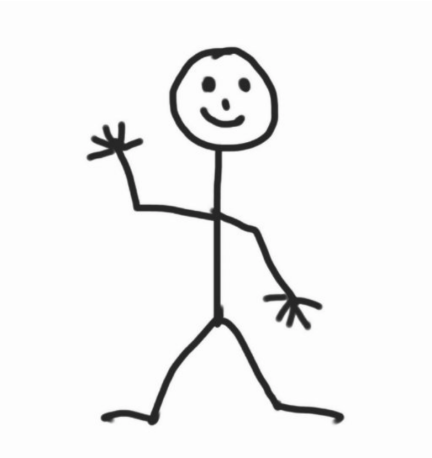

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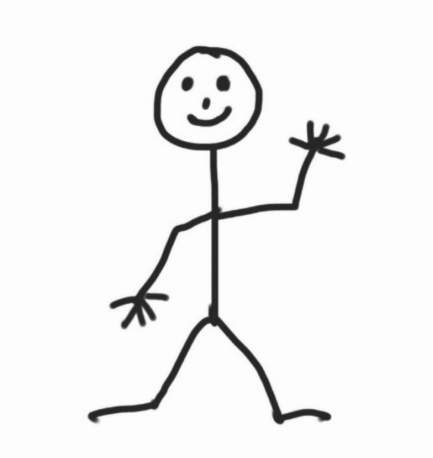

Math

Science

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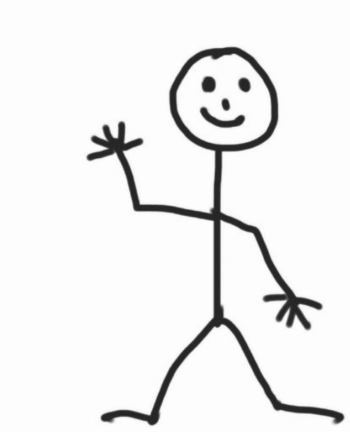		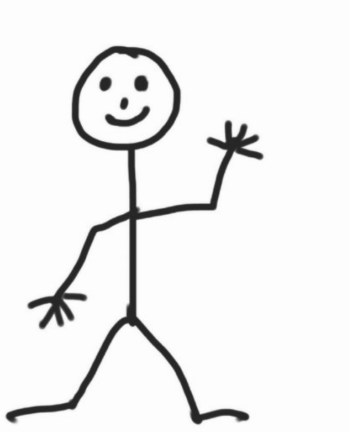
9	Math	10
9	Science	7

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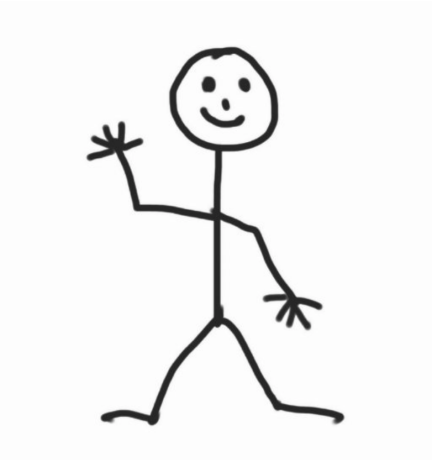		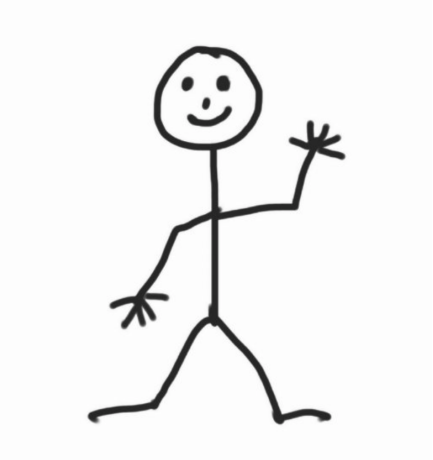
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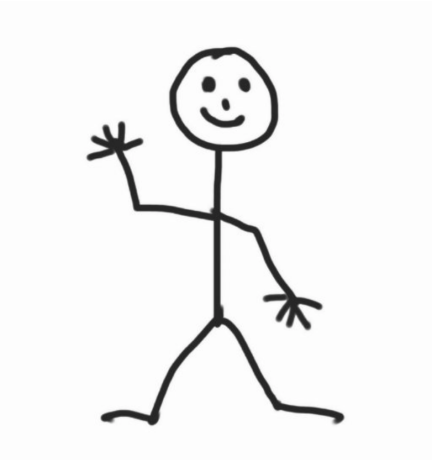		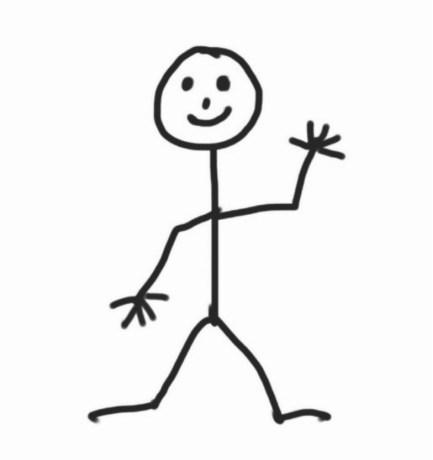
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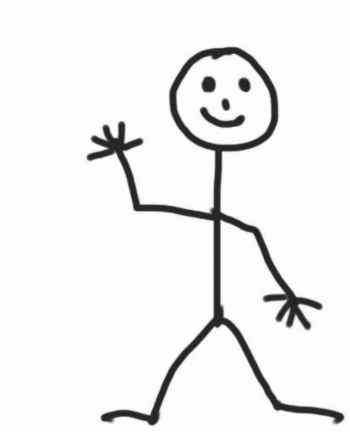		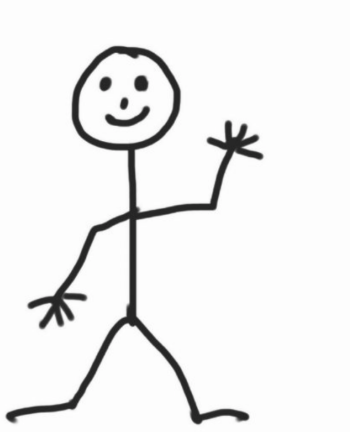
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A Hypothetical Situation

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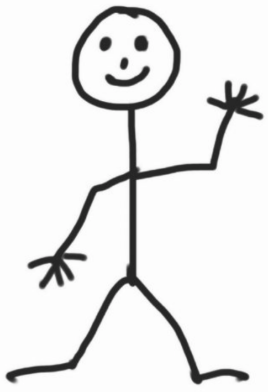
	*Caucasian*	
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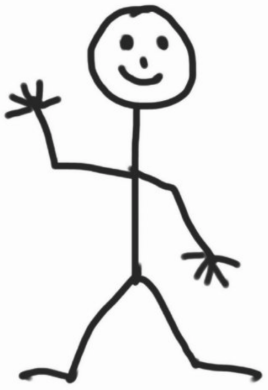	*African American*	
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Max: 9

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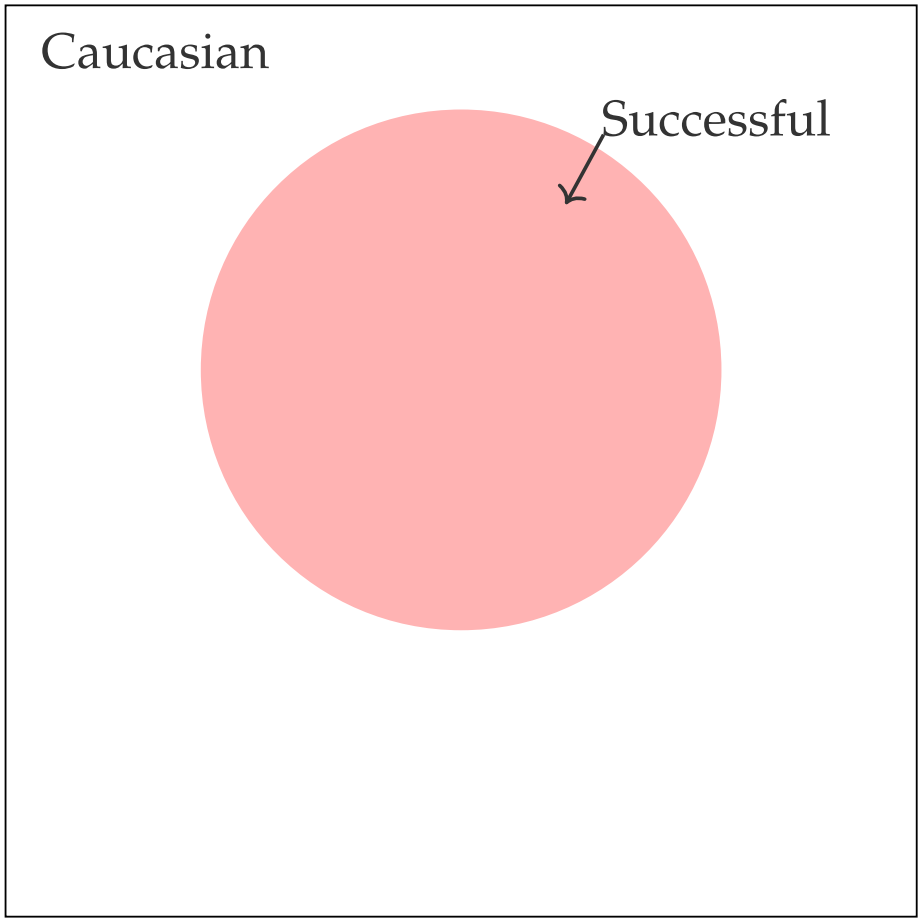
A Hypothetical Situation: Extrapolation



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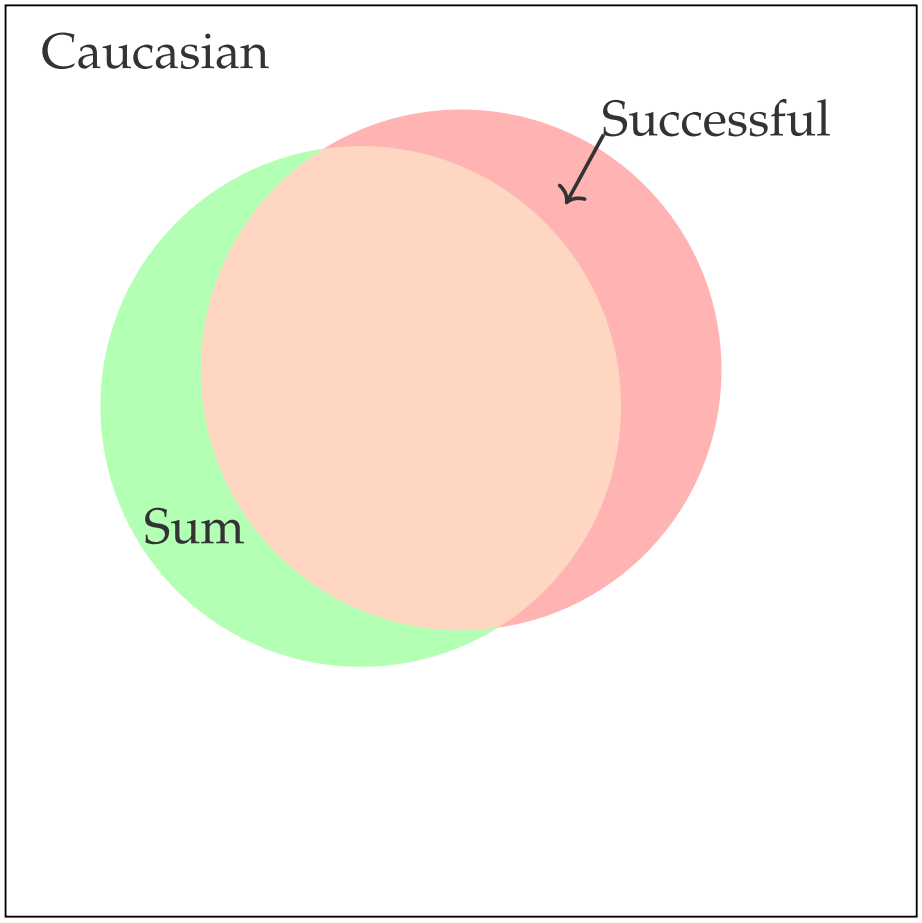

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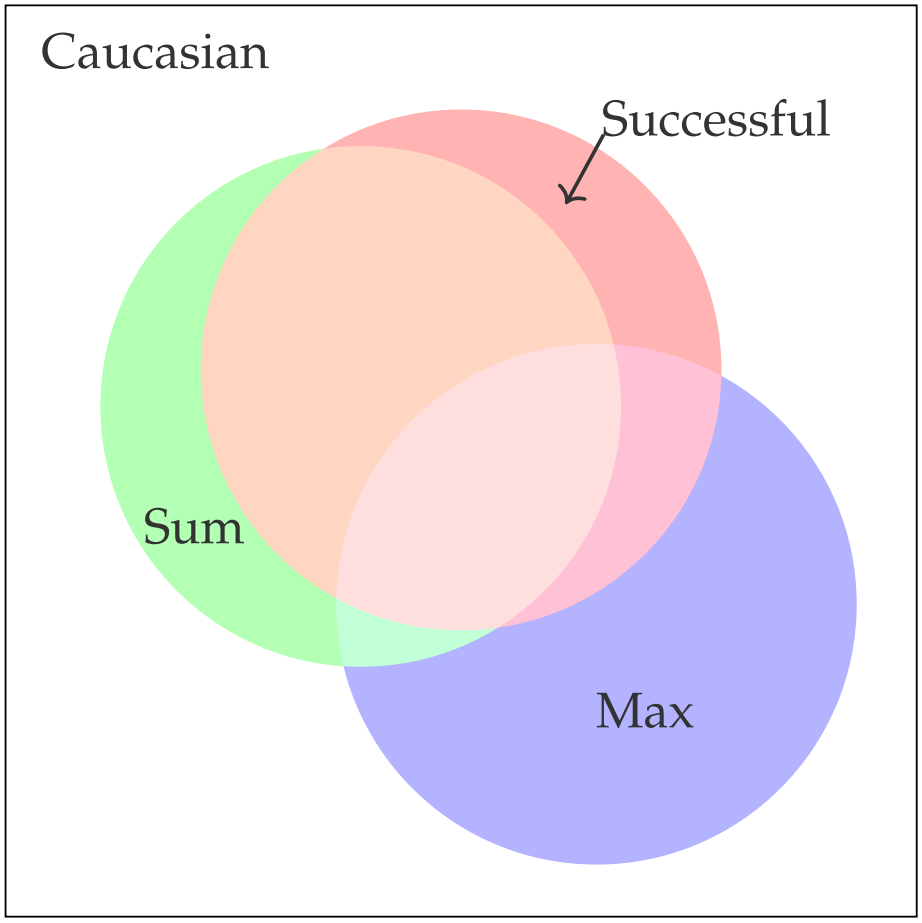

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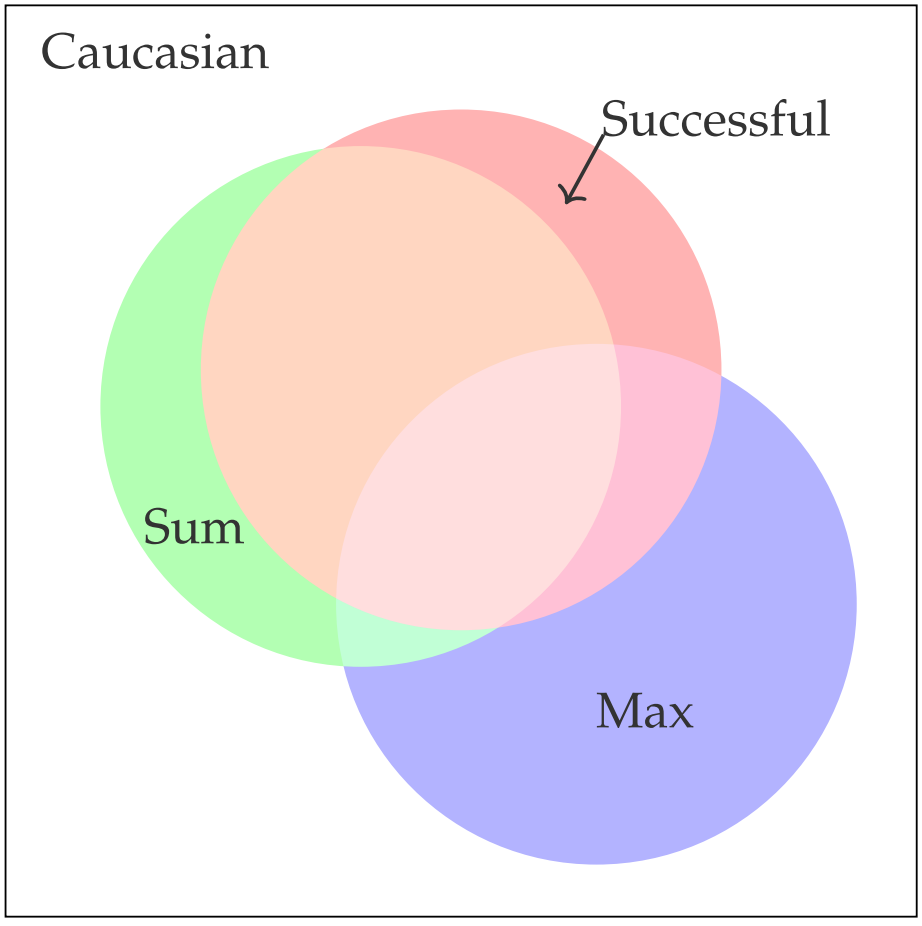

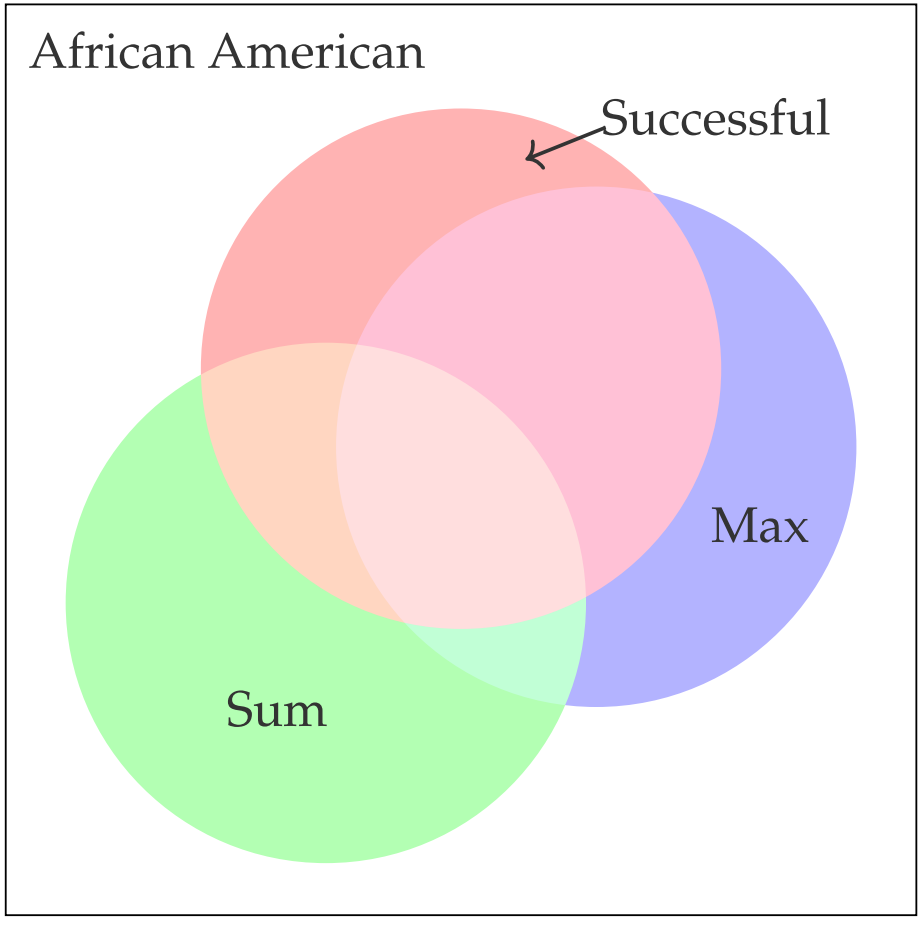

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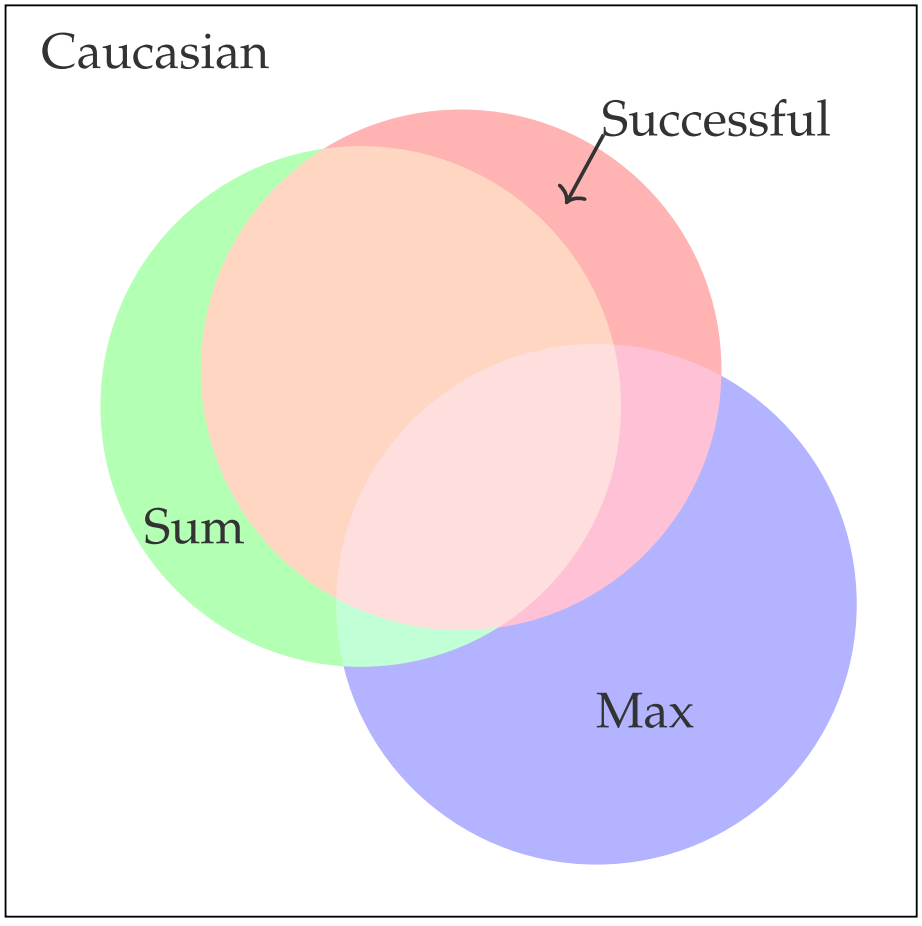

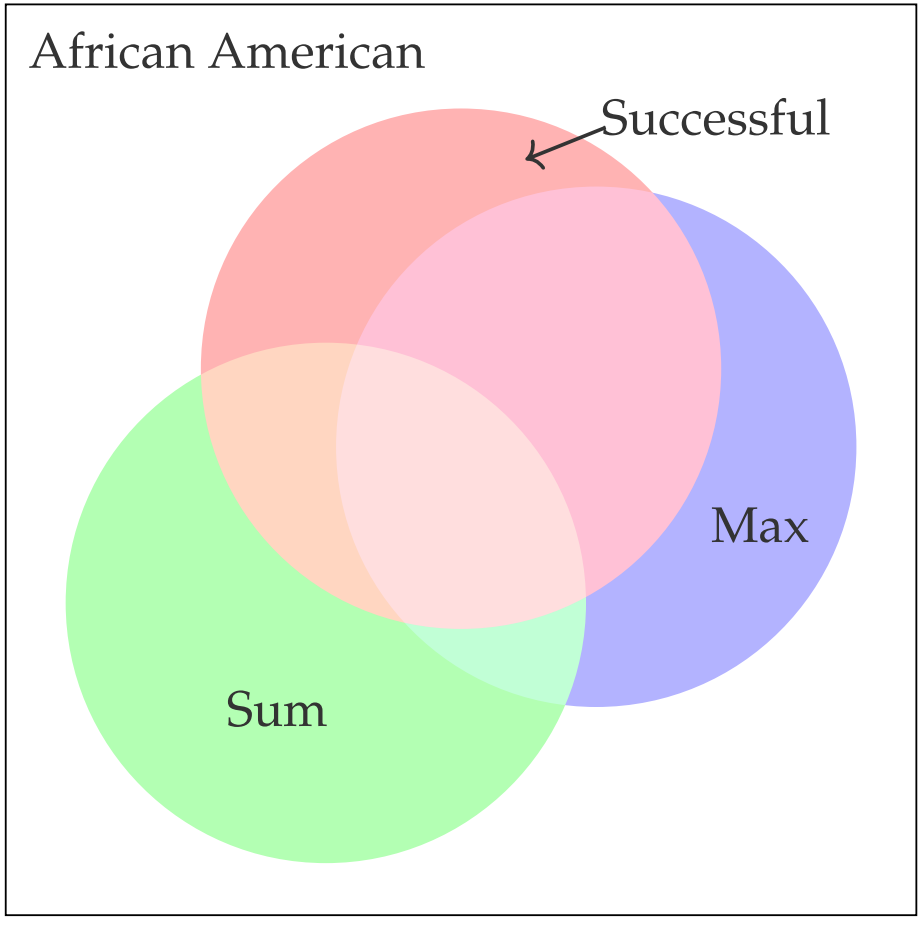

Decision Making System using Sum formula:
Reinforces Bias against African Americans

PART II

The Real Deal

Setting: Decision Making

Applications

Setting: Decision Making

Applications

Admission Committee

Setting: Decision Making

Applications

Admission Committee

Historical Data

But what is Linear Regression !?

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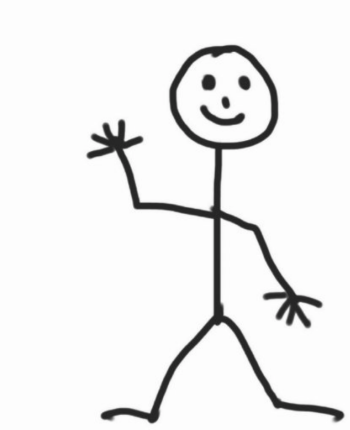		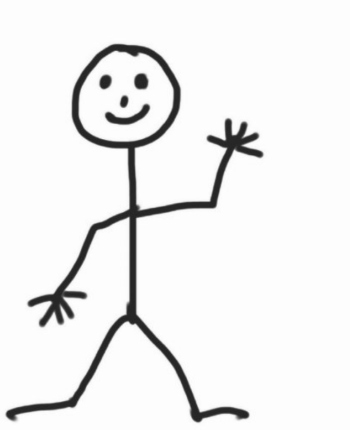
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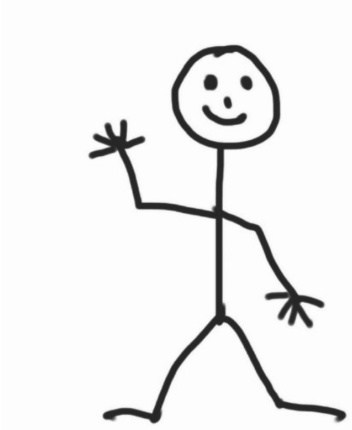		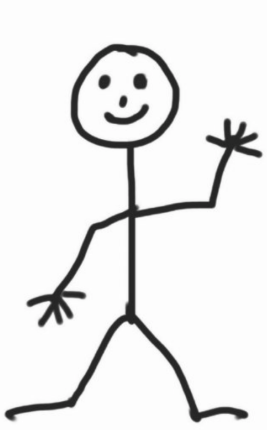
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$$3 \times \text{Math} + \text{Science}$$

Linear Regression

Learn Best Weighted Sum Formula

Data

- National Education Longitudinal Study of 1988

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- Follow up in 1990, 1992, 1994, 2000

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Affirmative Action is practiced in College Admission in the US since 1970s

Fitting to a Line

$\rightarrow$ 9^{th} grade Math vs. College success

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→ *"You are good at math You will do well"*

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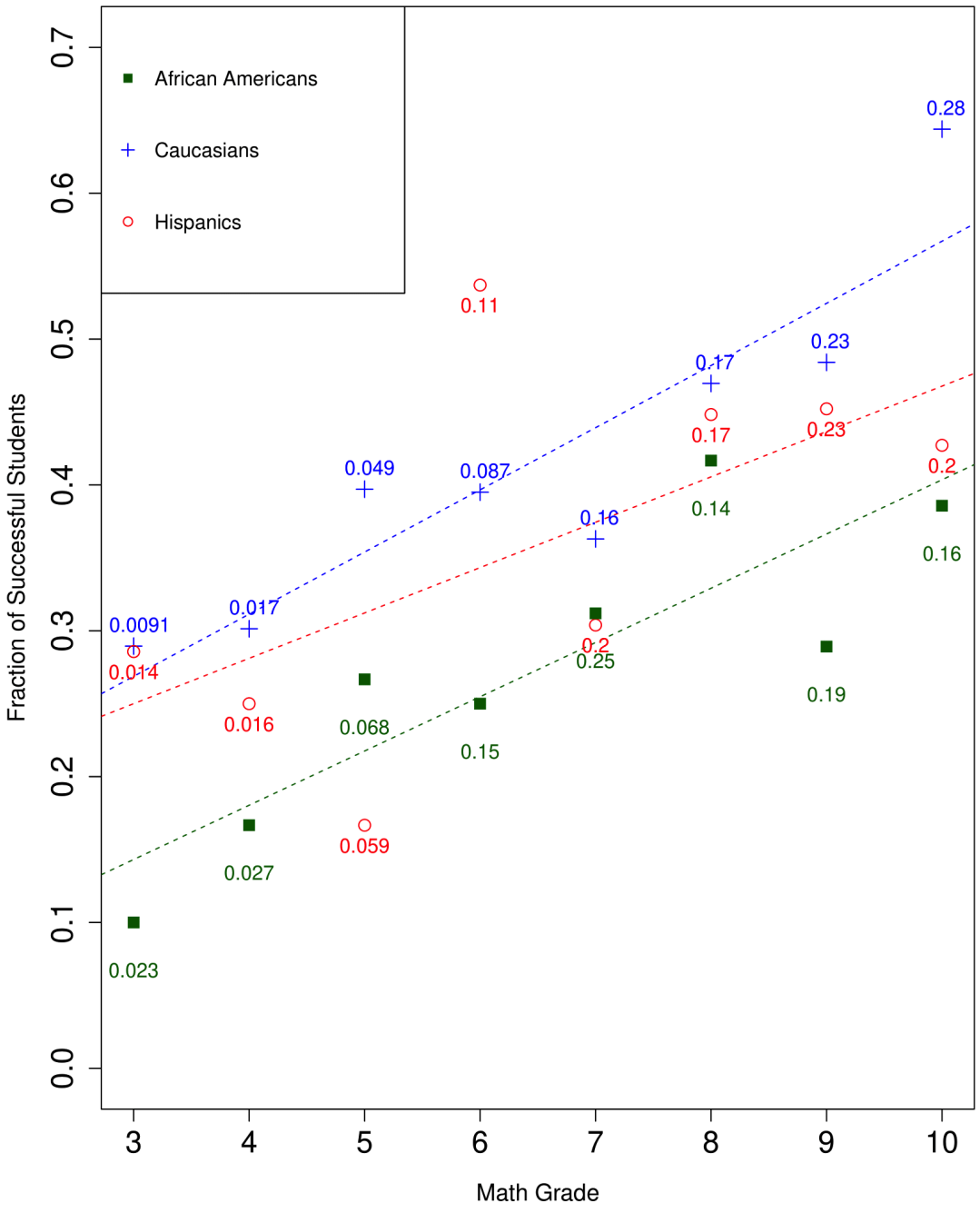

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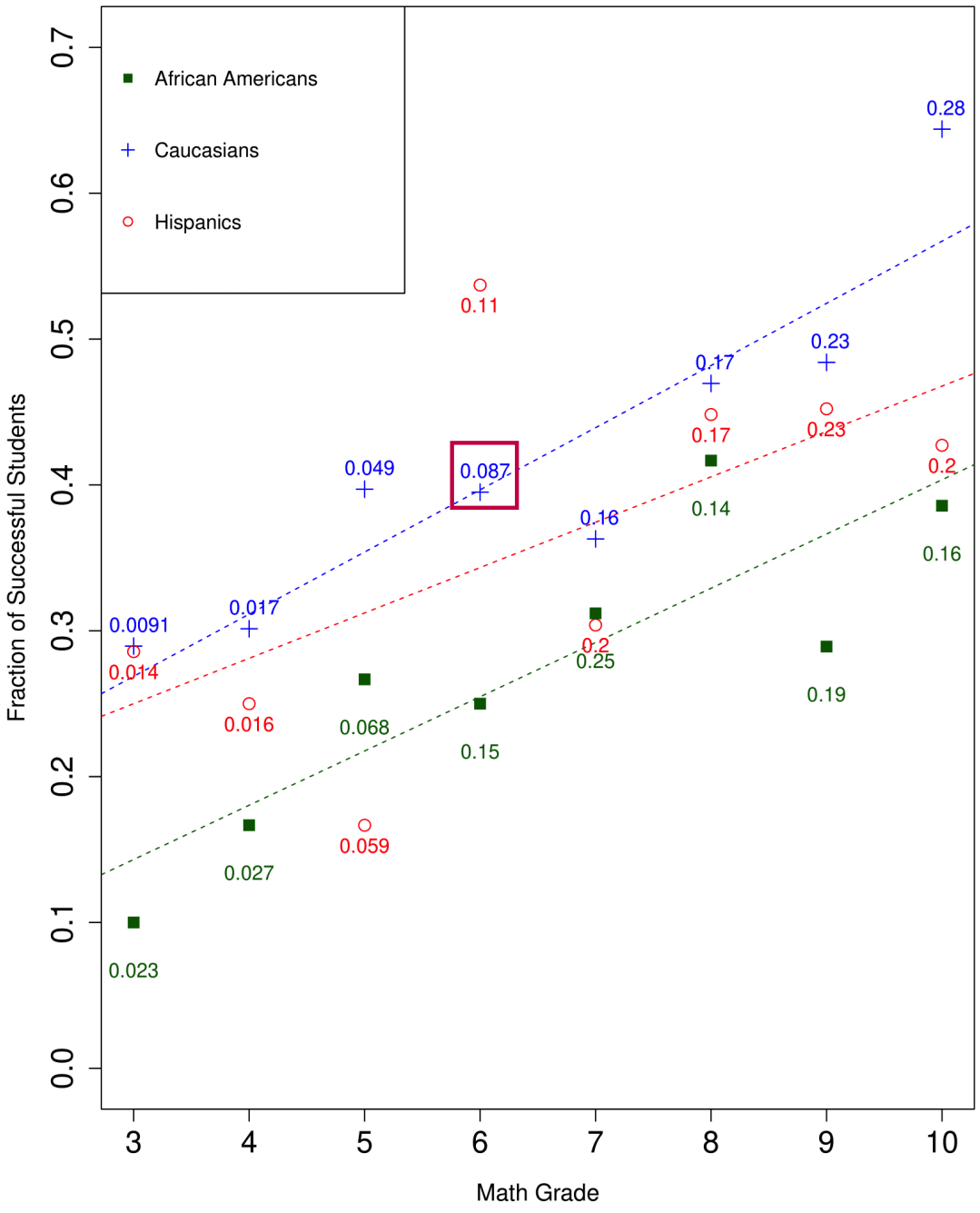

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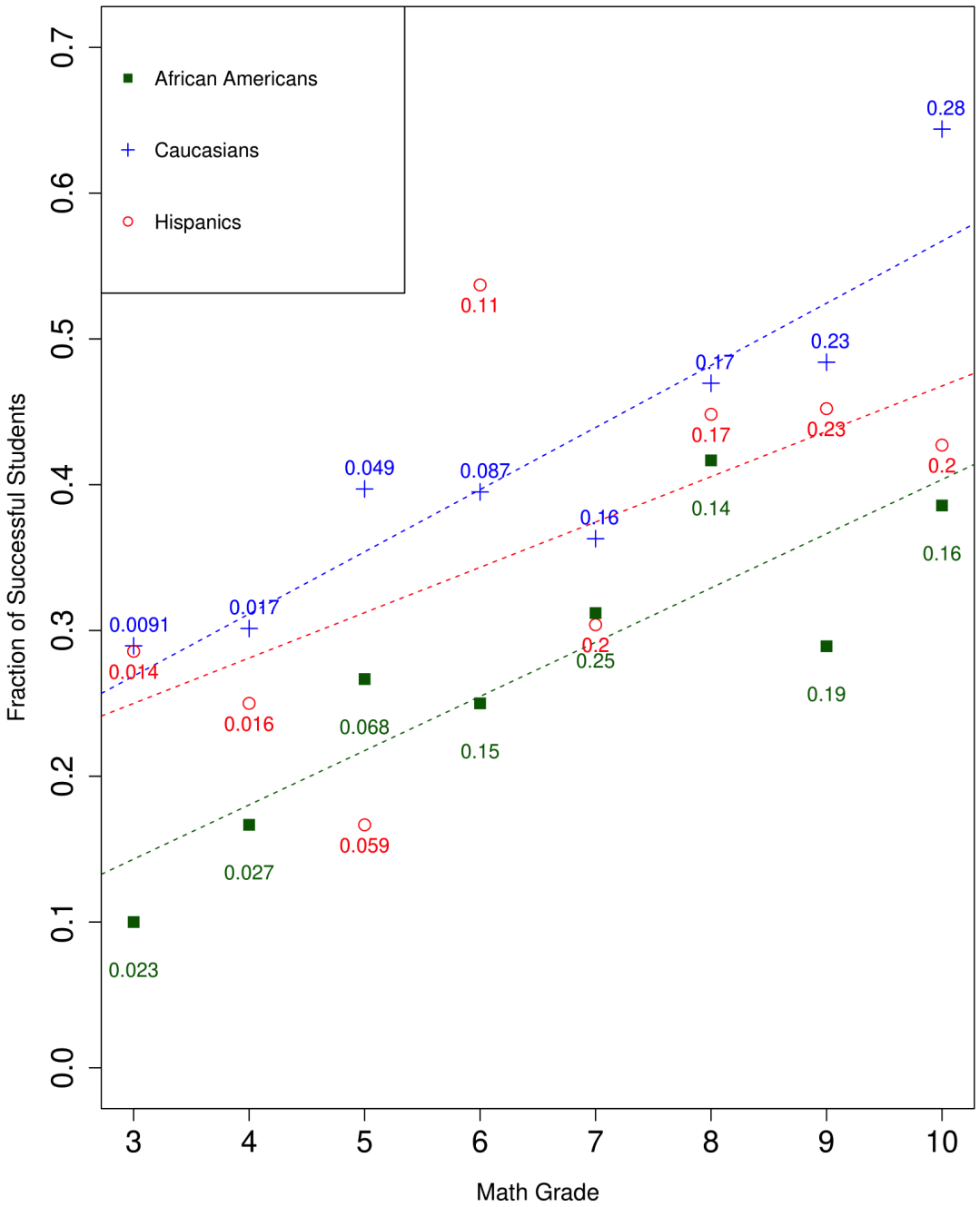

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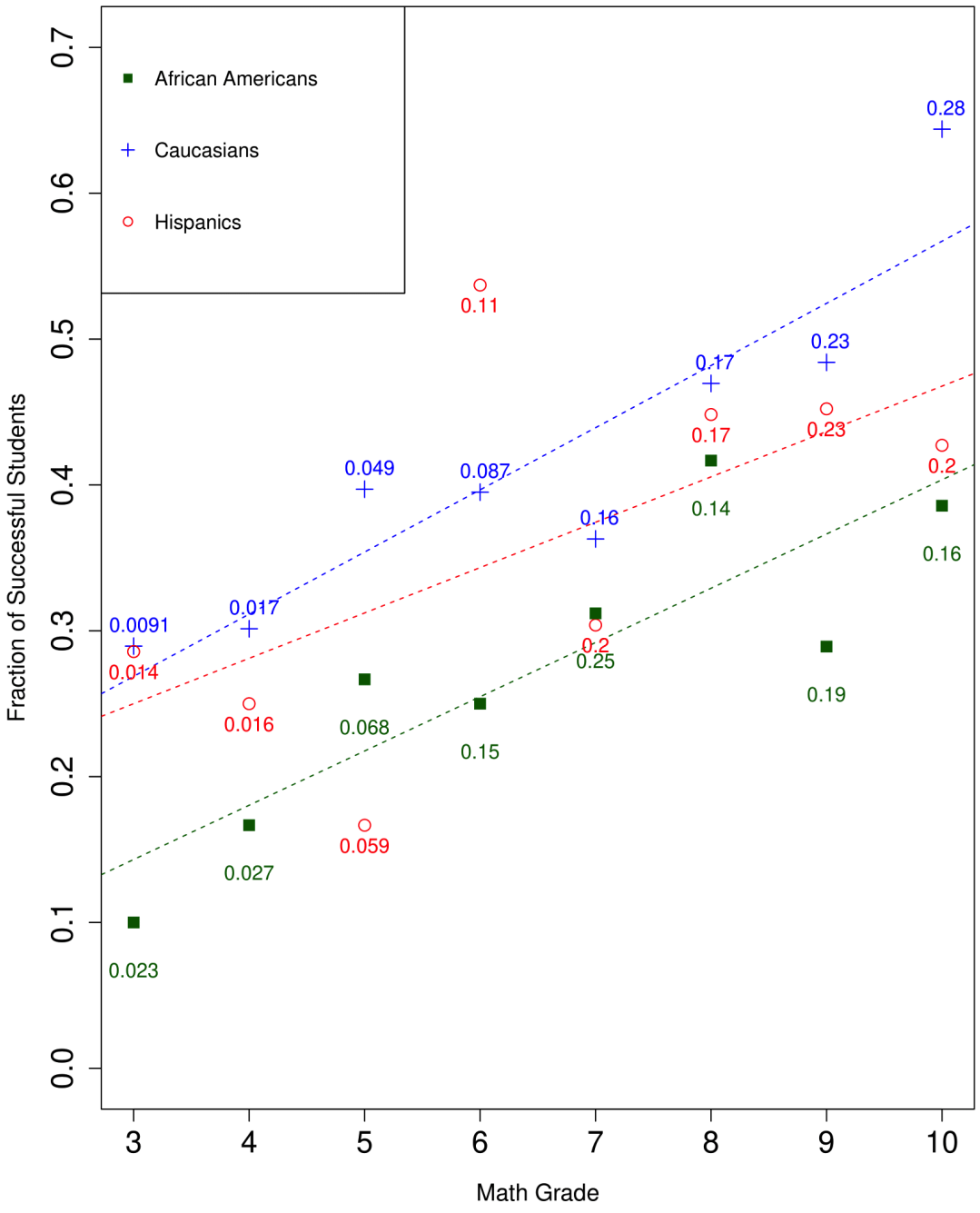

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→ Error is **not** Uniform Across Race groups

Number of Influential Features

$\rightarrow$ 9^{th} and 11^{th} grades,
Standardized tests,
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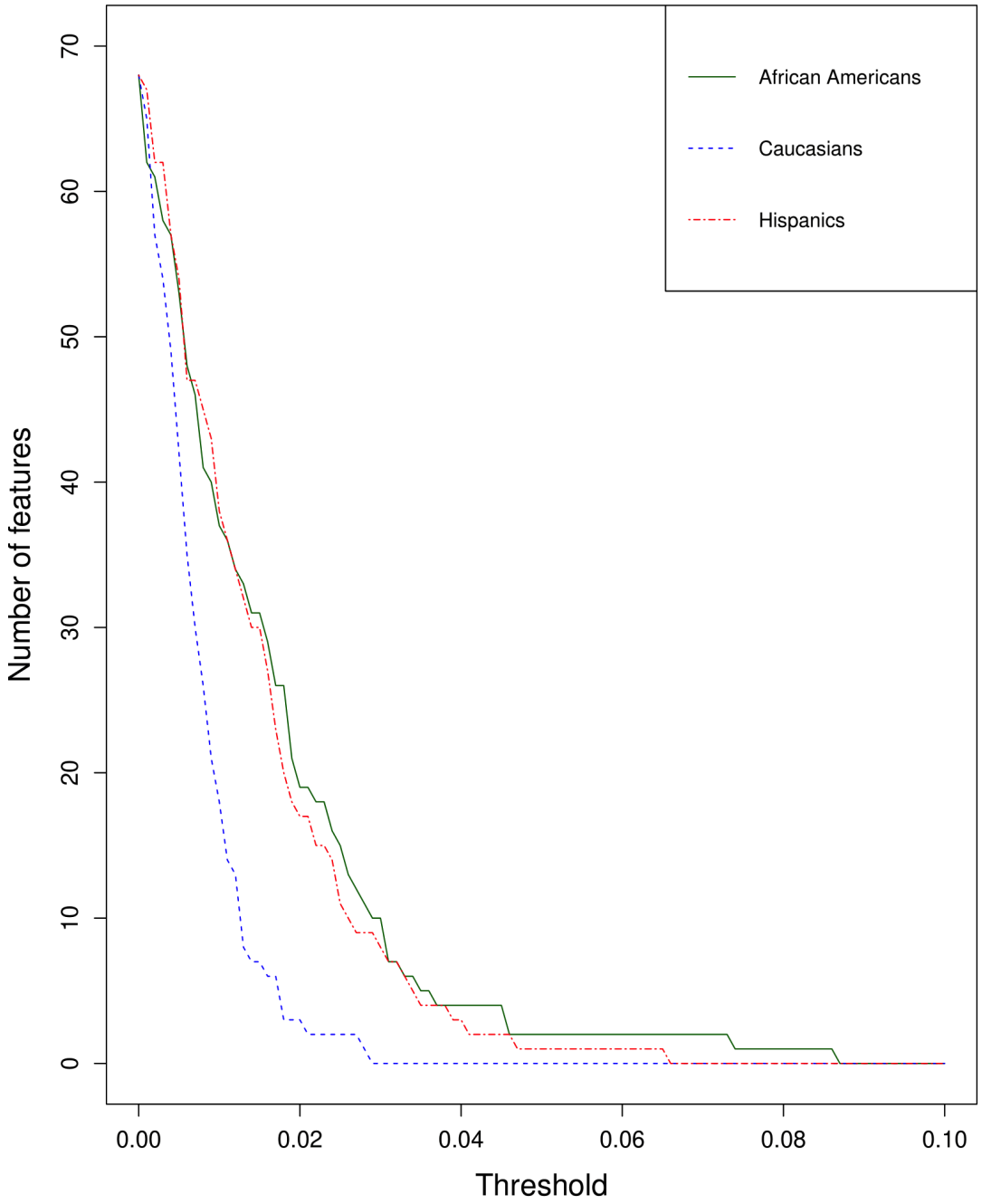

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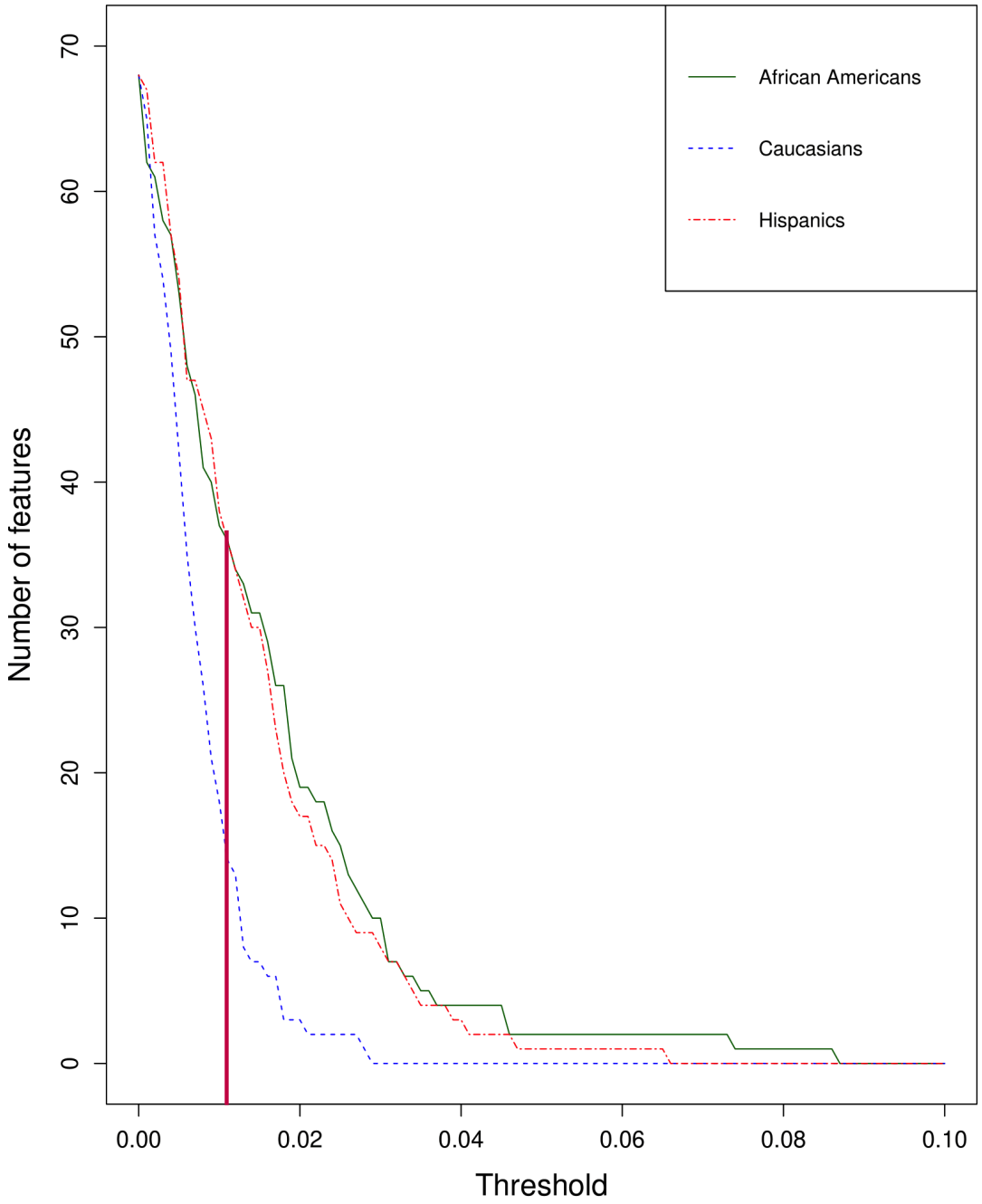

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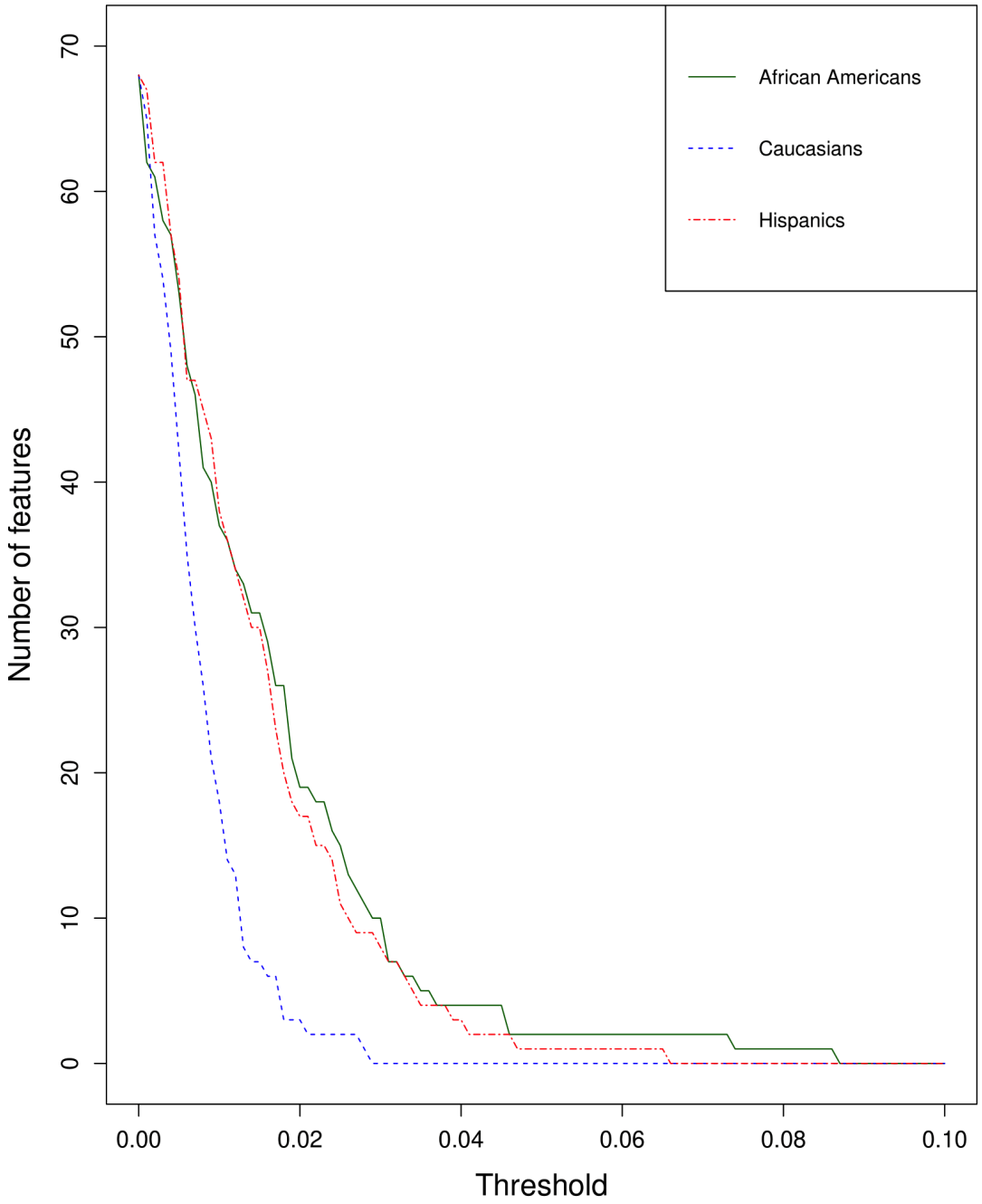

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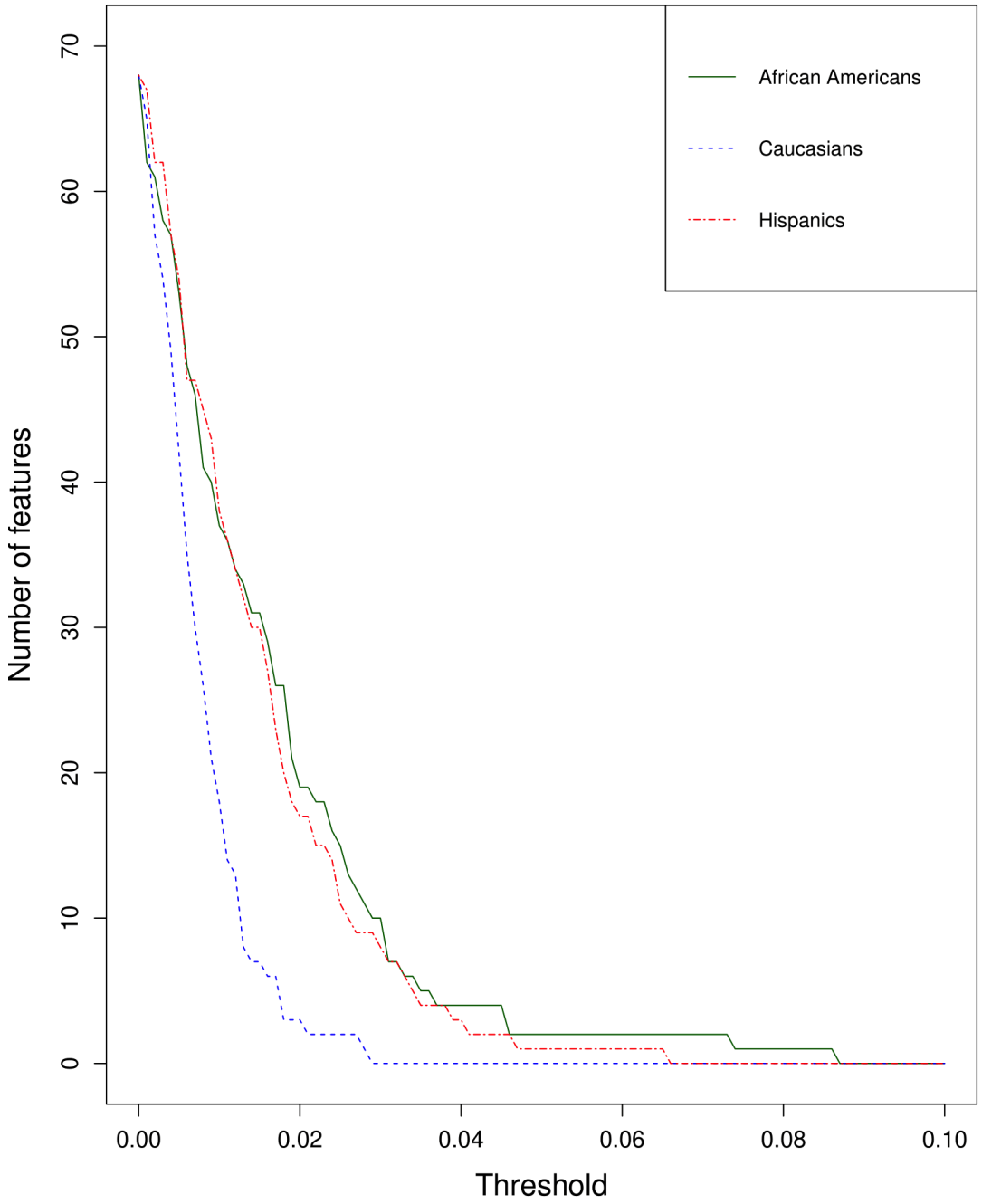

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→ The regressor formula of minority groups is complex

ℓ_p-norm Rankings

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p^{th} norm of (x, y) is

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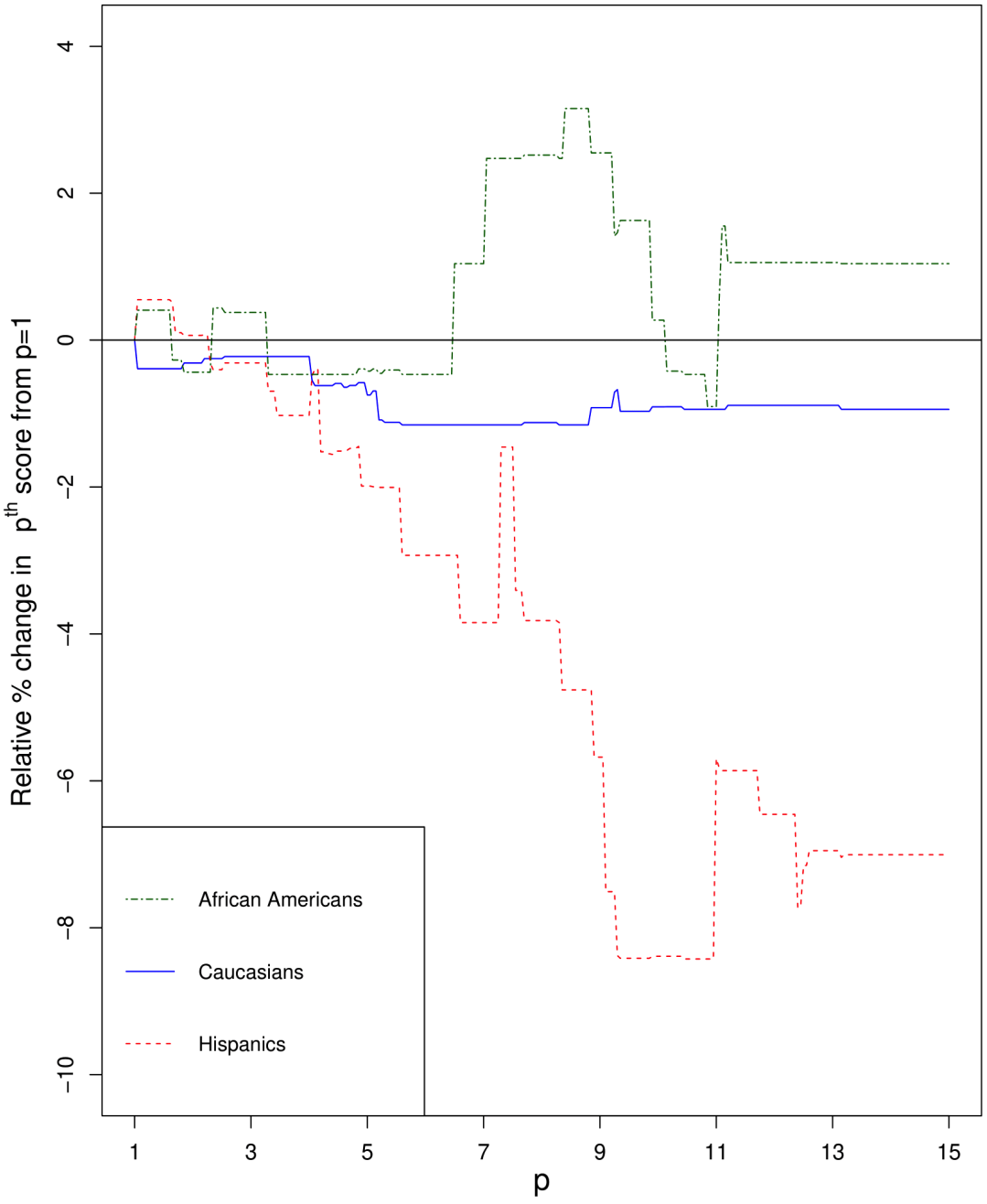

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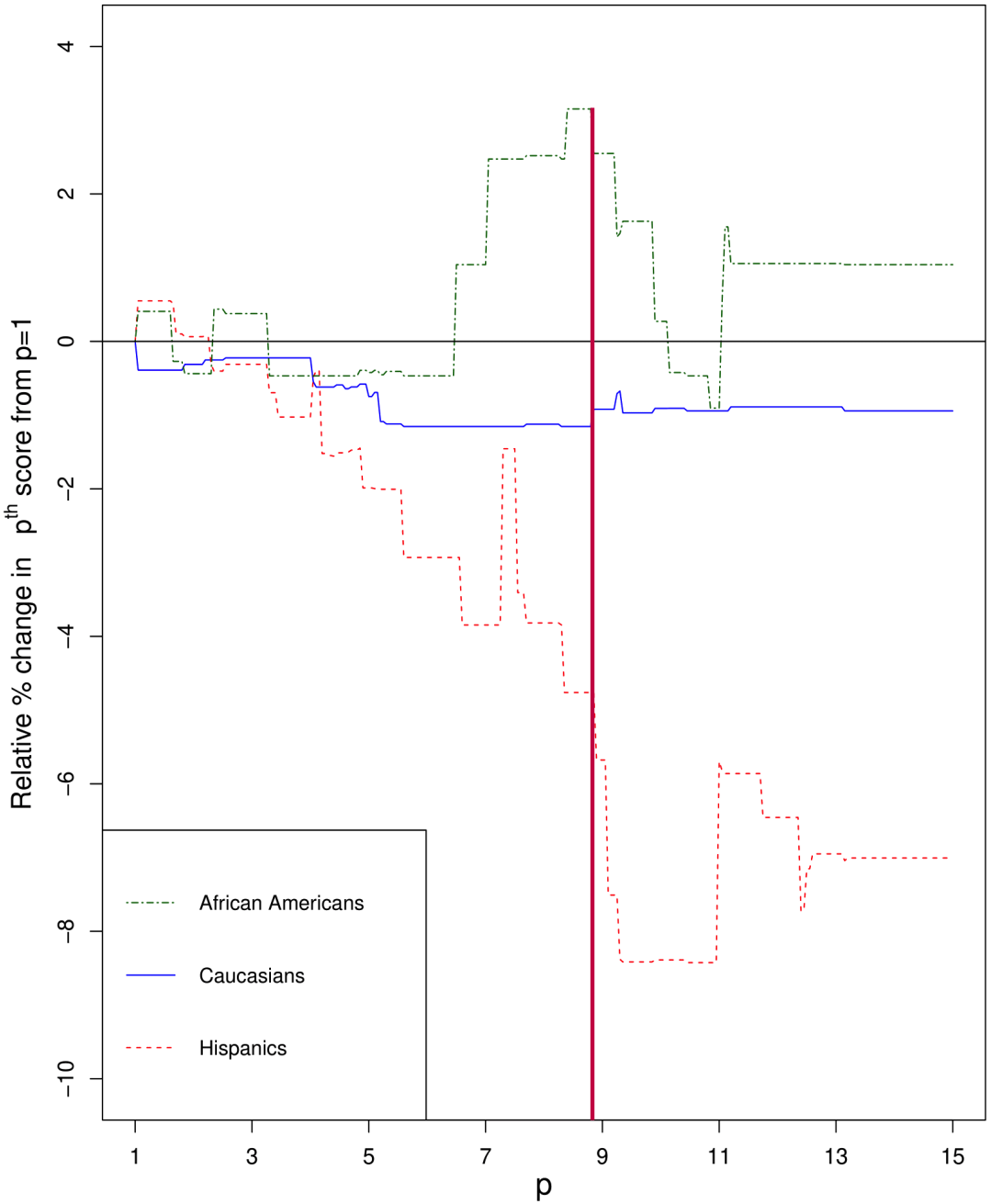

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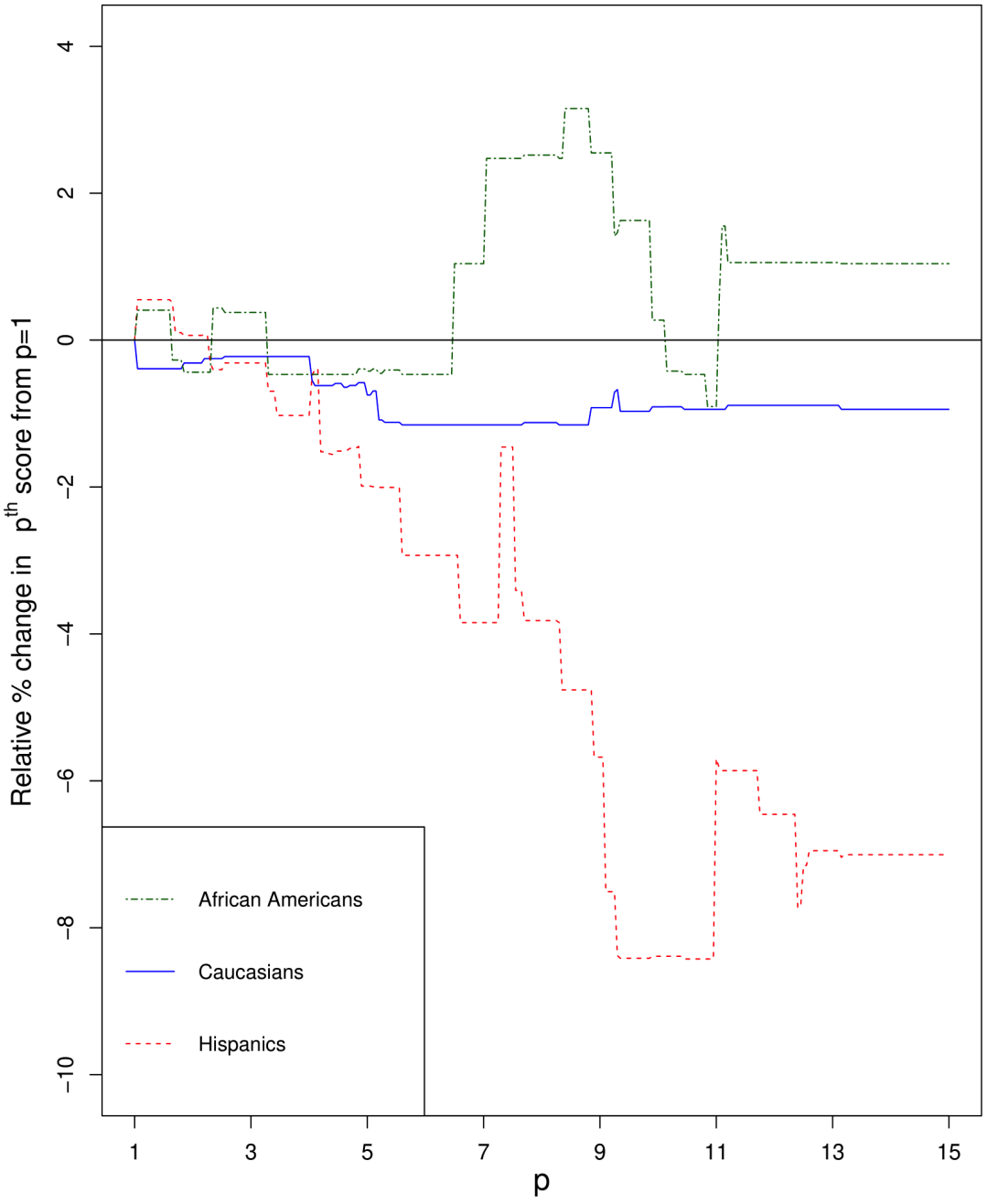

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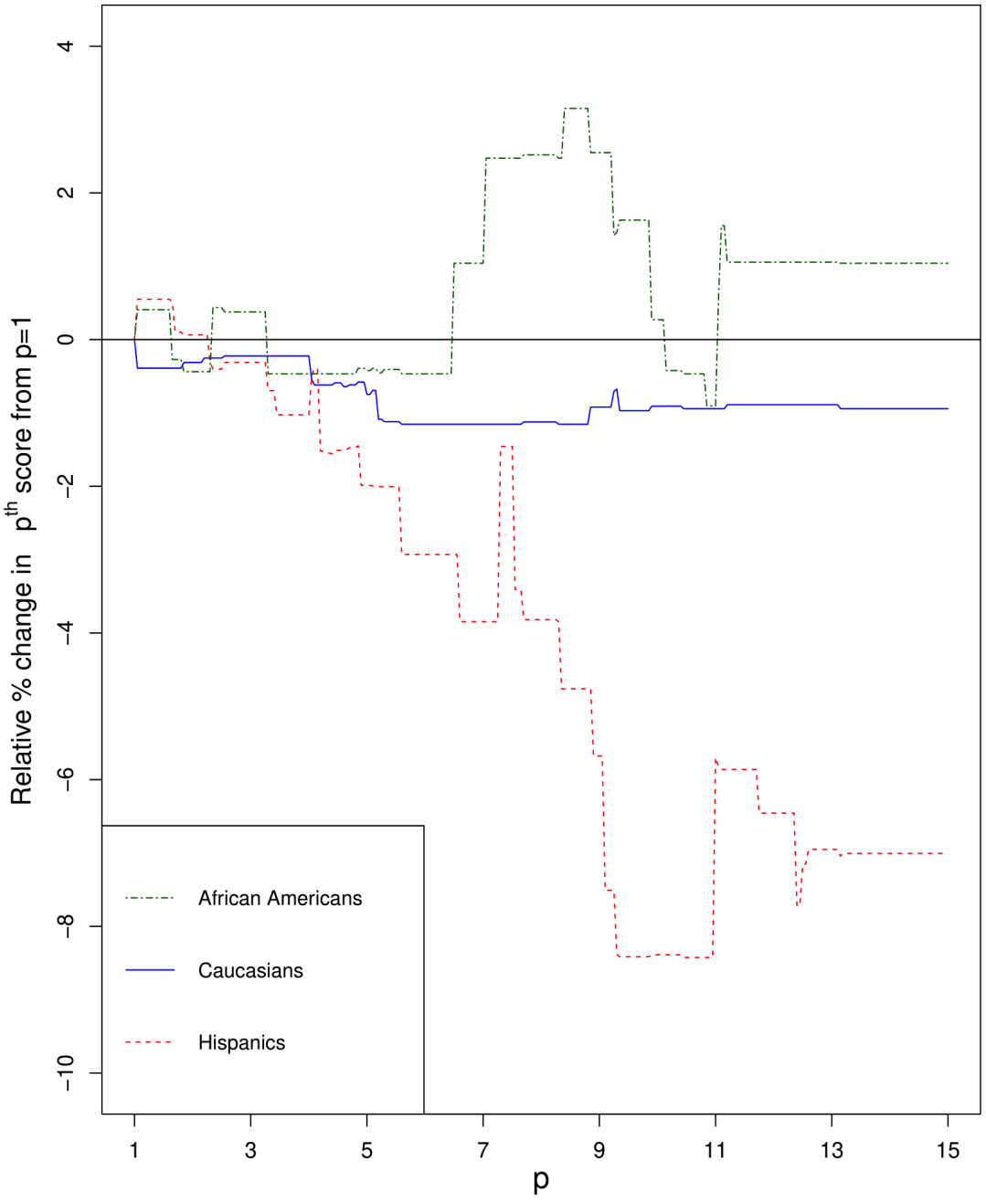

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→ Hispanics "prefer" 1-norm

Polynomial Regression

→ From Geometric Insights to Algebraic Tools

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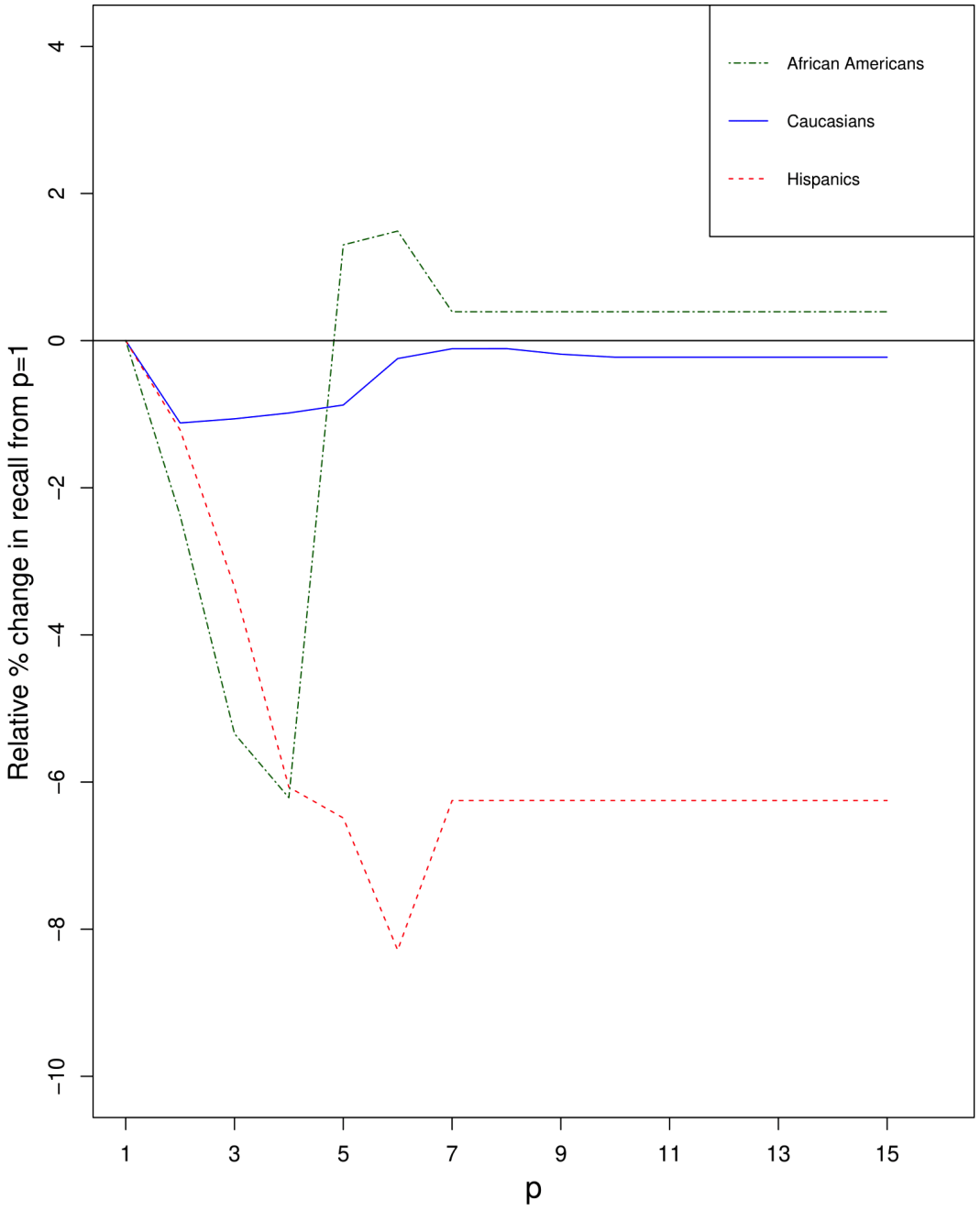
→ Training/Test : 50/50

Polynomial Regression



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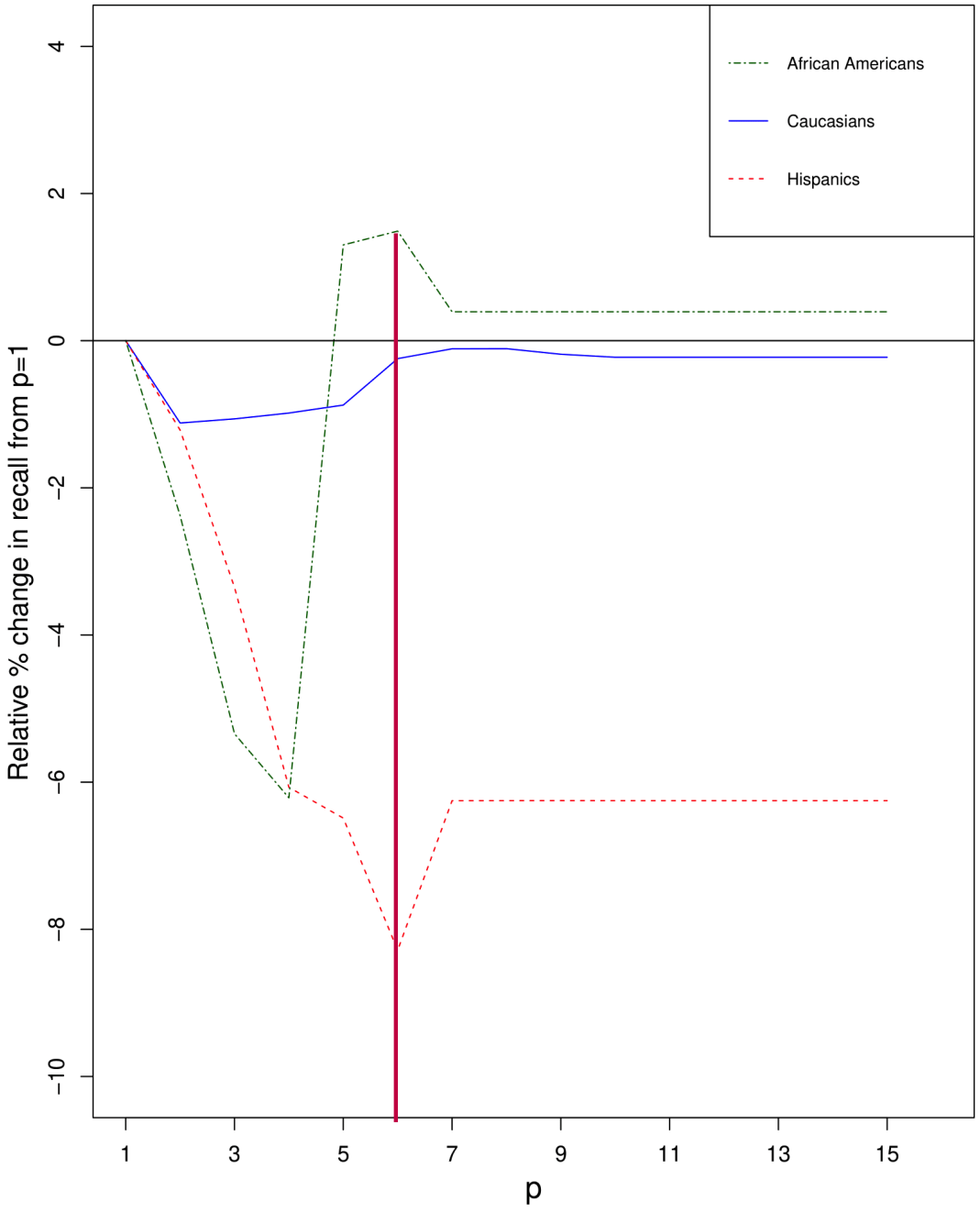

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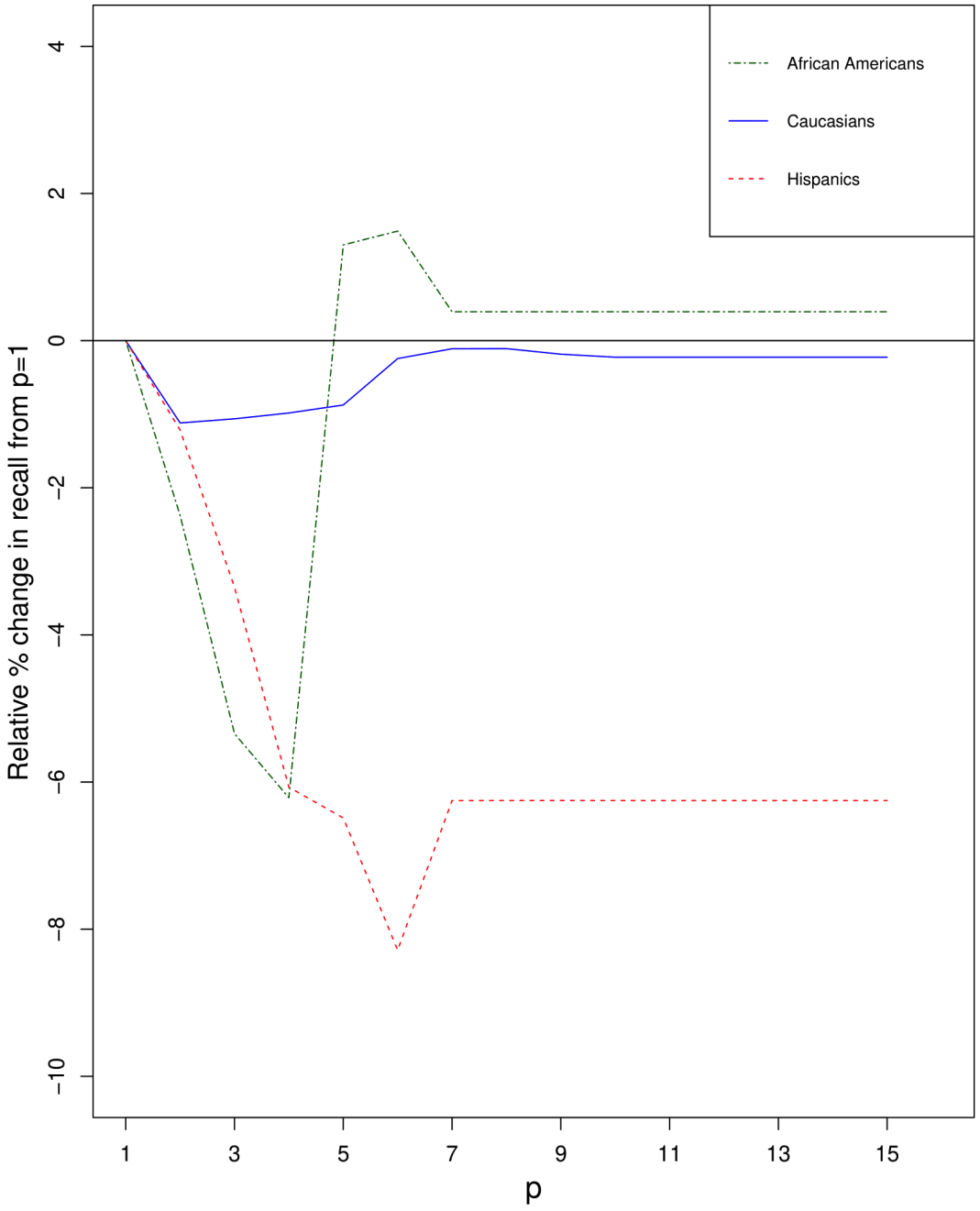

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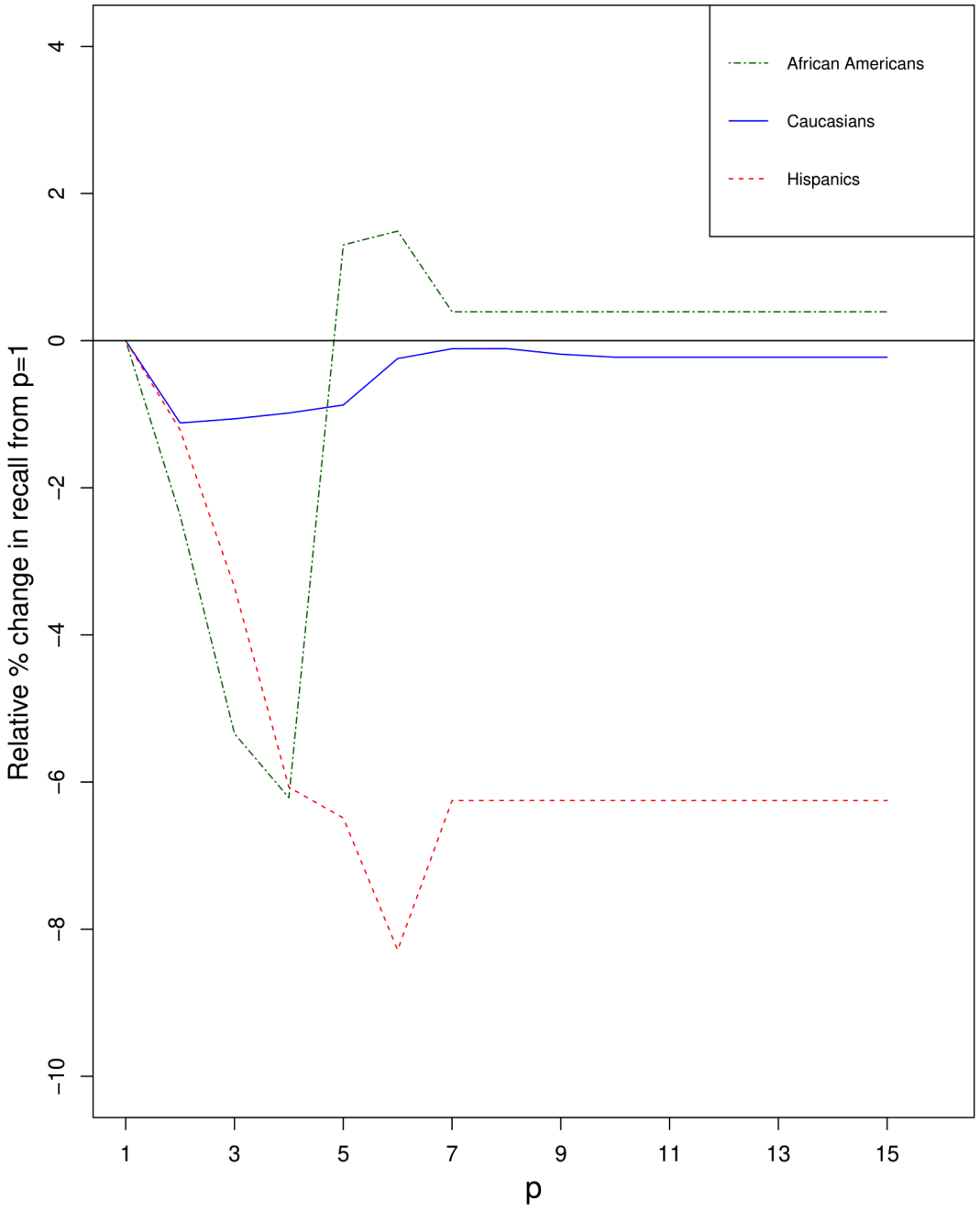

→ From Geometric Insights to Algebraic Tools

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→ A proof of concept
Not a solution

Putting things Together

Each minority group must have its own predictor

(formalized in Kleinberg-Ludwig-Mullainathan-Rambachan '18)

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Predictor must be sensitive to the geometry of its group

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Predictor must be sensitive to the geometry of its group

Linear Regression cannot capture
the complexity of minority group data

THANK YOU!