The difference between knowing the path and walking the path: Predicting student persistence in science from community college to the university
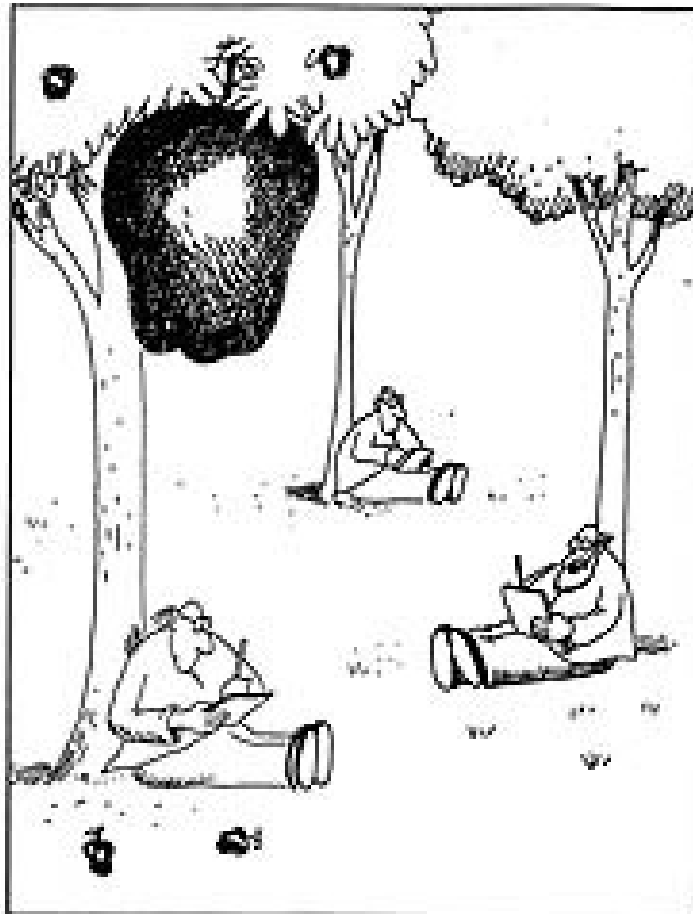
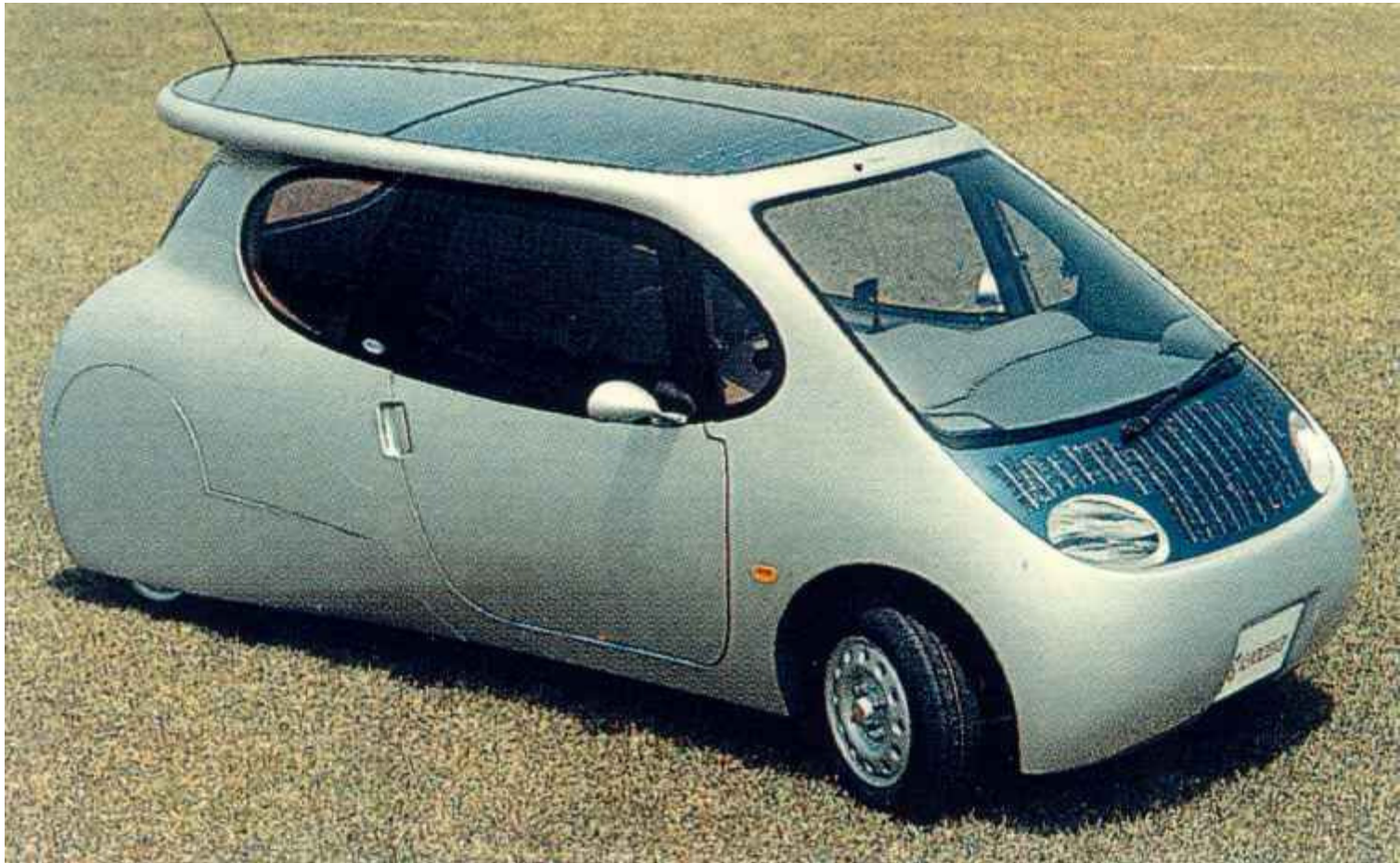Terrence Willett, Director of Research

Cal-PASS

Is Science, Technology, Engineering, Mathematics (STEM) education important?

"Nothing yet. ...How about you, Newton?"

J.Huart

Lick Observatory

Bovine Genome Project

UC Davis Experimental Rice Farm

Persistence in STEM Pathways

★ Using the National Education Longitudinal Study of 1988 (NELS:88) data set, about 75% of 8th graders with STEM career aspirations had switched to a non-STEM goal 6 years later (Mau, 2003).

★ STEM persisters tended to have higher self-efficacy in science and math and were more likely to be male (Mau, 2003; Burge, 2006).

★ Progression in science shows differences by gender and ethnicity at least as early as middle school with males and Asians and Whites showing higher levels of science achievement than other groups (Muller, Stage, & Kinzie, 2001).

★ Some of these differences may continue after high school with women and many ethnic minorities being more likely to switch out of a STEM degree pathway in college (Tan 2002).

Community College to University Transition

★ Question

   ★ For students completing university degrees, are certain demographic groups more likely to complete a STEM degree given they had started along the STEM pathway in community college?
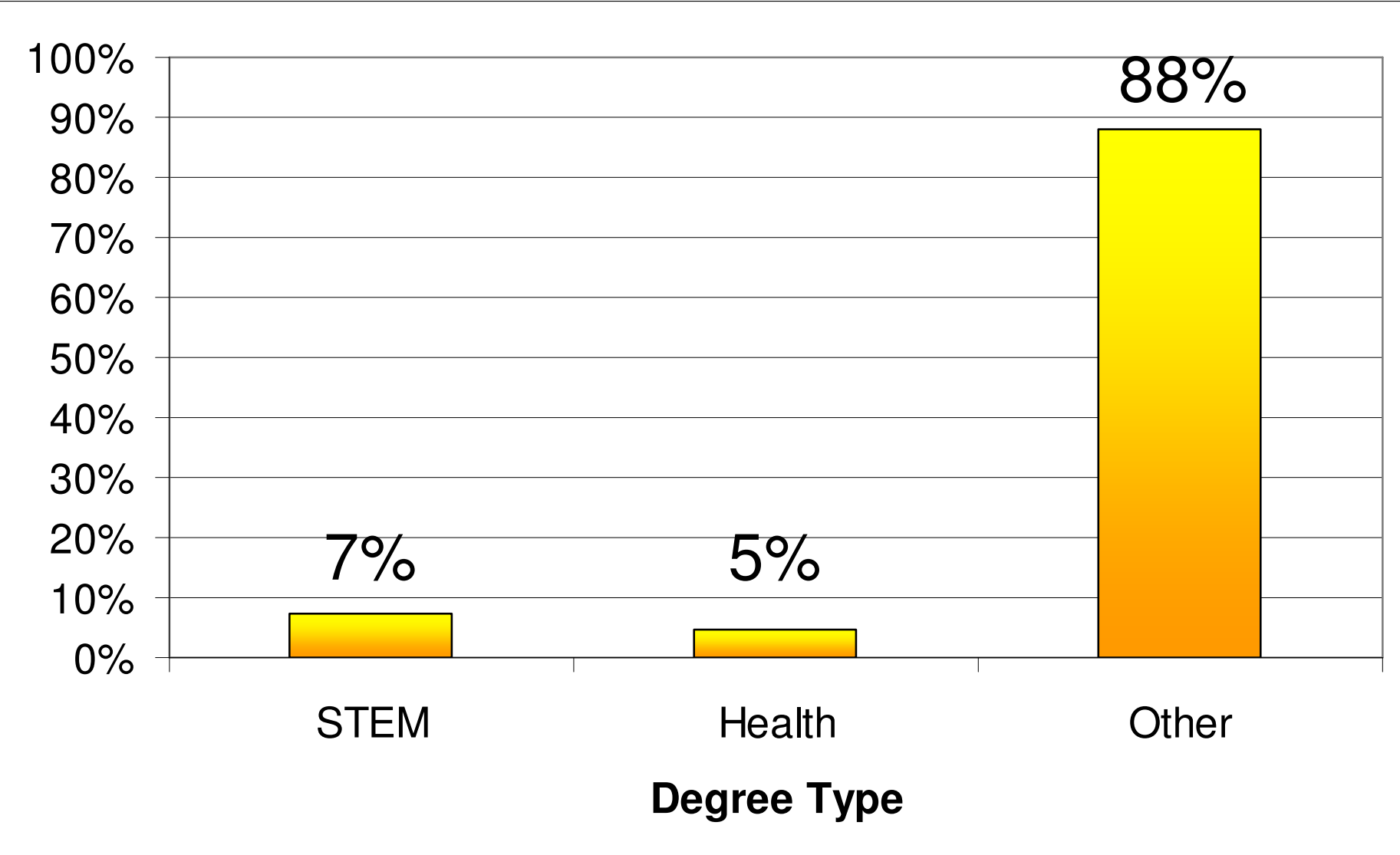
★ Corollary Question

   ★ Can we detect whether a student is on a university STEM degree pathway based upon community college records?
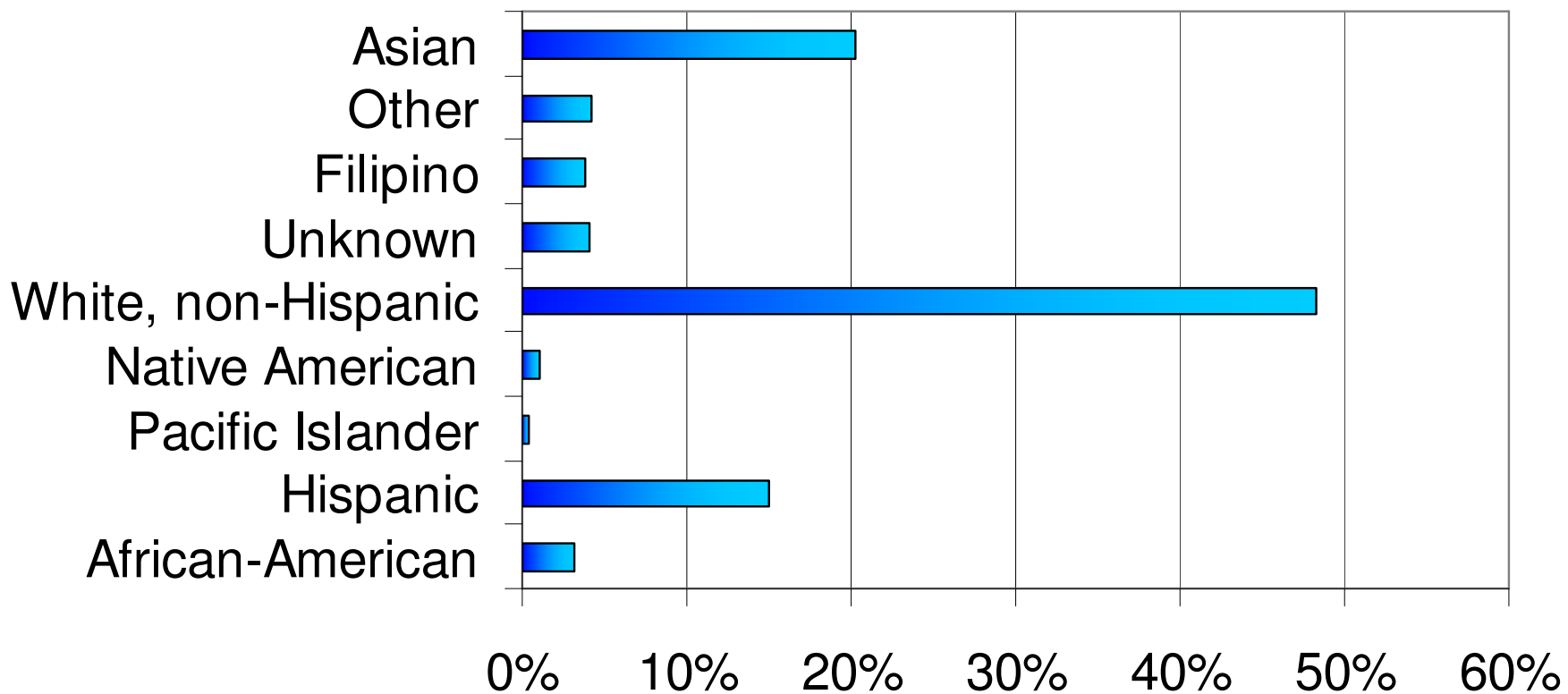
Defining the Sample

★ Community college students who earned at least 12 units and enrolled in and earned a B.A. from one of a set of Universities

  ★ 2 CSU's and 1 UC

★ n= 20,564

★ Data from 1996-2006 for most but not all institutions

STEM Degrees by Ethnicity

Asian	
Other	
Filipino	
Unknown	
White, non-Hispanic	
Native American	
Pacific Islander	
Hispanic	
African-American	

0.00   0.50   1.00   1.50   2.00

% STEM Degrees / % All Degrees
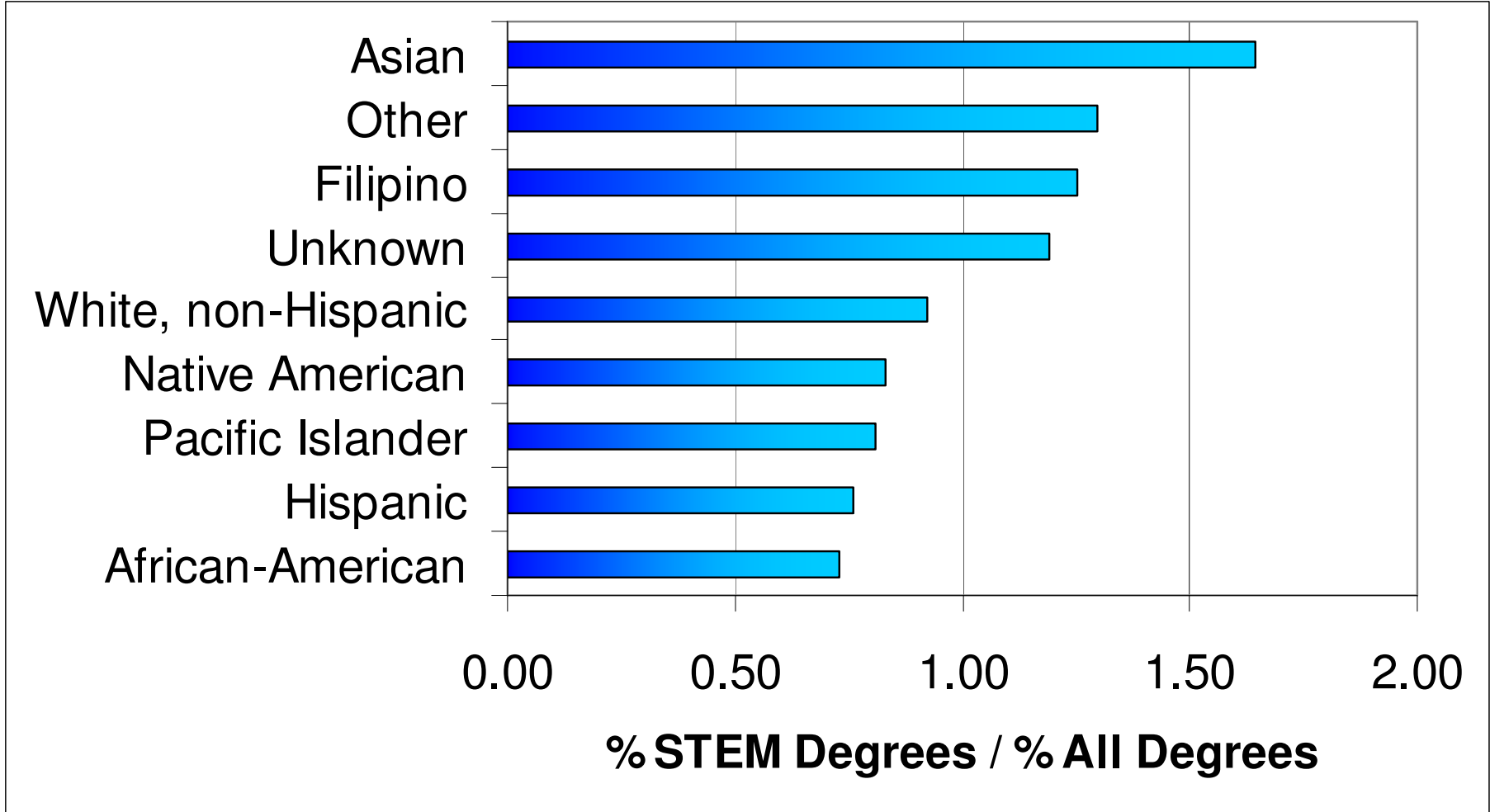
STEM Degrees by Gender
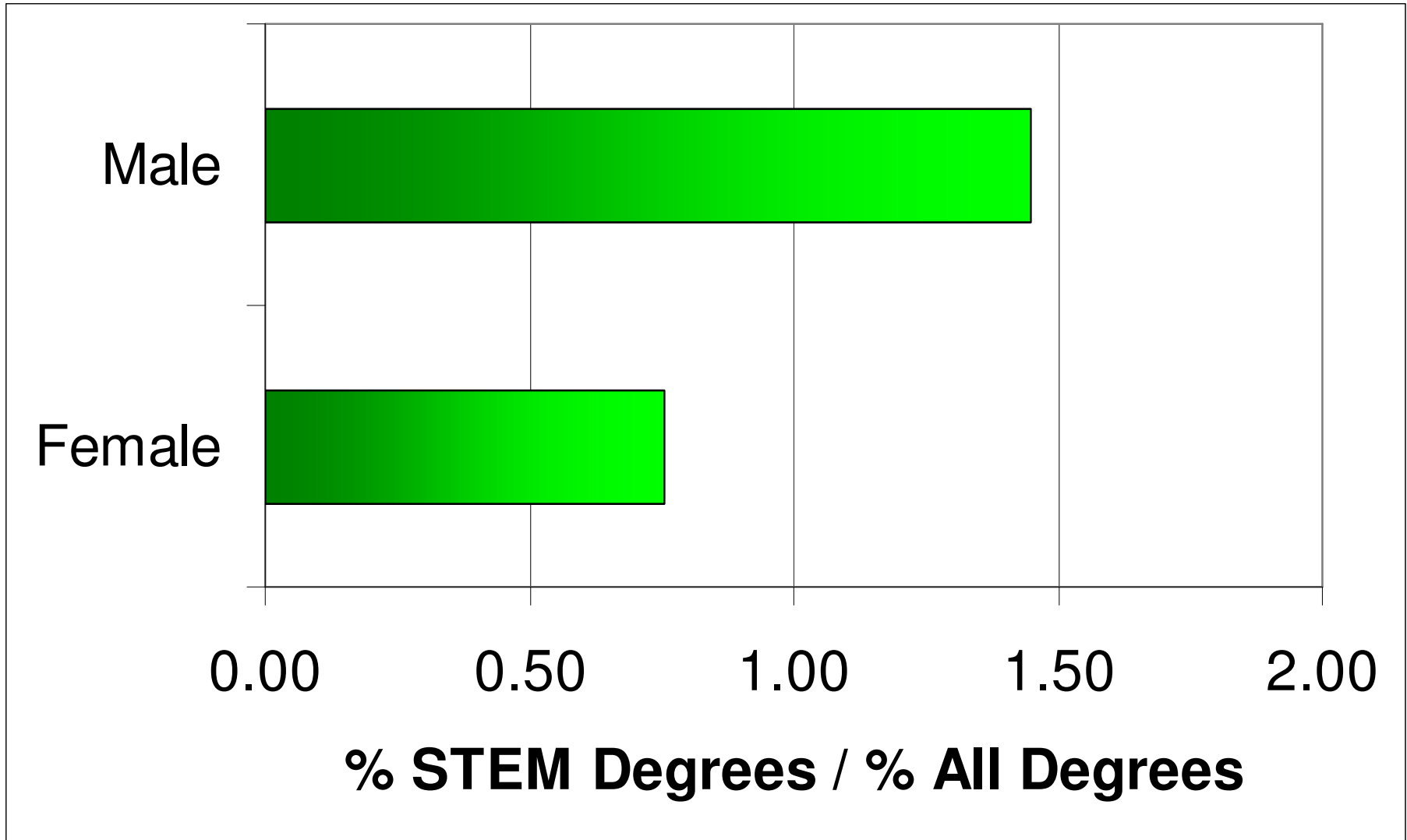
Method

- ★ Degrees grouped into 3 types:
  - ★ STEM, Health, Other
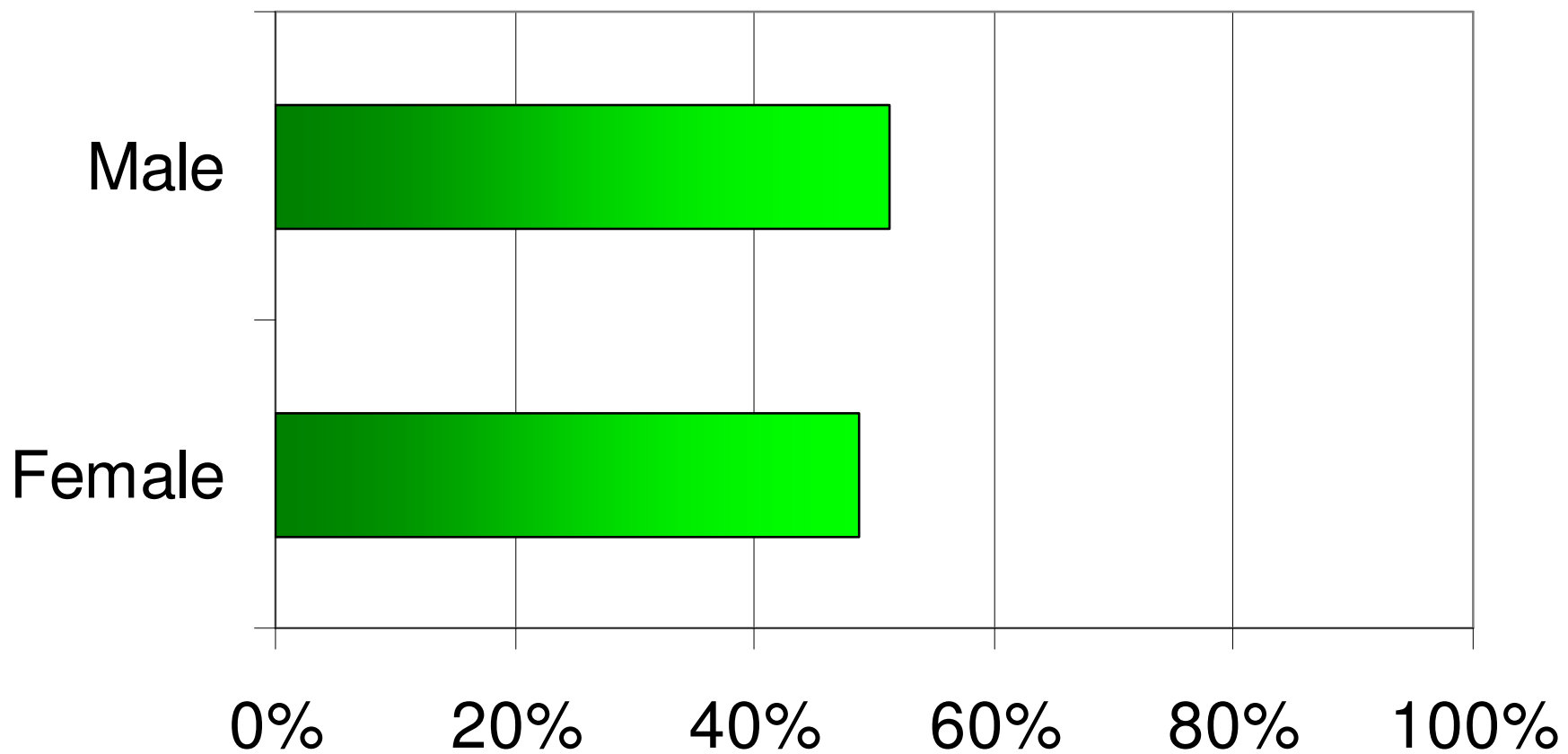- ★ Compare degree type with last math successfully completed at community college
- ★ Add ethnicity and gender
- ★ Add other demographics and courses for exploratory analysis

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Rank	Description
1	Basic Math
2	Pre-Algebra
3	Beginning Algebra
4	Geometry
5	Intermediate Algebra
6	Statistics/Finite/Discrete/Other Transferable Math
7	Advanced Algebra/College Algebra/Precalculus/Trigonometry
8	Calculus
9	Linear Algebra/Diff Eq/Other higher math
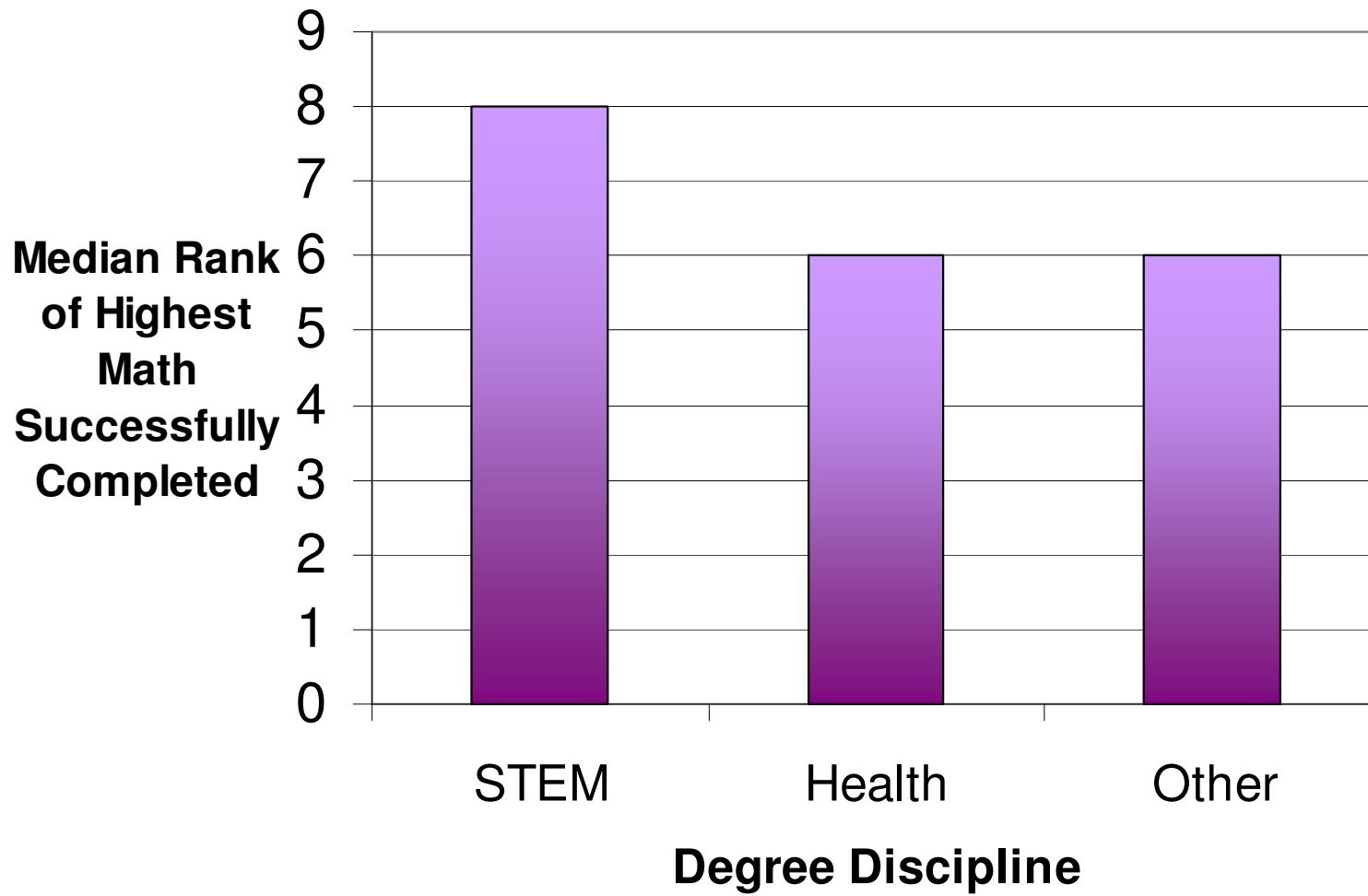
	Math Rank		Total	
	<= 6	>= 7	Percent	N
STEM	9%	91%	100%	1065
Health	77%	23%	100%	599
Other	75%	25%	100%	13517
Total	70%	30%	100%	15181

Chi-square (2) = 2100.607, $p < 0.0005$, Phi = 0.372

University degree by math path of last community college math class successfully completed by ethnicity

Green = stayed in path indicated by CC math

Blue = switched from path indicated by CC math

Math Path	Degree Type	Asian	African-American	Filipino	Hispanic	Native American	Other	Pacific Islander	White, non-Hispanic	Unknown	Total
not STEM	STEM	9%	3%	**0%**	**11%**	1%	4%	0%	**68%**	3%	100%
	Health	10%	5%	**6%**	**15%**	2%	3%	1%	**56%**	2%	100%
	Other	8%	5%	**2%**	**21%**	1%	3%	1%	**56%**	3%	100%
	Total	8%	5%	2%	21%	1%	3%	1%	56%	3%	100%
STEM	STEM	15%	3%	3%	16%	1%	4%	0%	53%	4%	100%
	Health	17%	4%	1%	18%	1%	3%	1%	54%	1%	100%
	Other	15%	3%	3%	20%	1%	4%	1%	50%	3%	100%
	Total	15%	3%	3%	19%	1%	4%	1%	51%	3%	100%

No significant difference in path switching by ethnicity for students on STEM math pathway. For "not STEM" math path students, significant differences by ethnicity shown in bold (Likelihood Ratio (16) = 47.918, $p < 0.0005$).

University degree by math path of last community college math class successfully completed by ethnicity

Green = stayed in path indicated by CC math

Blue = switched from path indicated by CC math

Math Path	Degree Type	Filipino	Hispanic	White, non-Hispanic
not STEM	STEM	0%	11%	68%
	Health	6%	15%	56%
	Other	2%	21%	56%
	Total	2%	21%	56%

University degree by math path of last community college math class successfully completed by gender

Green = stayed Blue = switched

Math Path	Degree Type	Female	Male	Total
not STEM	STEM	69%	31%	100%
	Health	88%	12%	100%
	Other	61%	39%	100%
	Total	70%	30%	100%
STEM	STEM	58%	42%	100%
	Health	89%	11%	100%
	Other	46%	54%	100%
	Total	56%	44%	100%

All differences significant.
Not STEM Chi-square (2) = 78.528, p <0.0005
STEM Chi-square (2) = 101.805, p <0.0005

Exploratory Analysis

★ Use classification and regression tree (CART) to predict degree based upon:
- ★ Highest level math completed at community college
- ★ Number of classes passed and units earned at a CC in
  - ★ Biology,
  - ★ Chemistry,
  - ★ Physics,
  - ★ Mathematics
- ★ Financial aid, time at CC, time at university, time to degree
- ★ Whether student had same major in first and last university term
- ★ Ethnicity, gender, age, disability status

Using CART to Predict Degree

★ Highest level math completed at community college (available for n=2,764) correctly predicted 49% of balanced sample compared to 33% with random guess

★ Using all variables correctly predicted 76% of balanced sample compared to 33% with random guess

★ Using all variables correctly predicted 90% of total sample compared to 88% for guessing "other" for all degrees

Model using CART on balanced sample

Last Math <= 7
  Units Bio <= 7.500
    Units Health <= 0.750
        Chem courses <= 0.500 → Other Degree (1,019; 0.755)
        Chem courses > 0.500
            Last math <= 6 → Health Degree (154; 0.442)
            Last math >= 7 → STEM Degree (52; 0.538)
    Units Health > 0.750
        Time between CC and Univ <= -1.875 → STEM Degree (50; 0.46)
        Time between CC and Univ > -1.875 → Health Degree (126; 0.833)
  Units Bio > 7.500
    Time to degree <= 1.562 → STEM Degree (37; 0.892)
    Time to degree > 1.562 → Health Degree (687; 0.846)

Last Math >= 8
  Health courses <= 0.500 → STEM Degree (634; 0.852)
  Health courses > 0.500 → Health Degree (60; 0.5)

CART v. CHAID v. Multinomial Logistic Regression

★ Risk in balanced sample
  ★ CART = 76%
  ★ CHAID = 78%
  ★ MLR = 87%, Cox and Snell R^2 = 0.77

★ Math most important variable for all models

Summary

★ Ethnicity generally not associated with path switching

★ Gender strongly associated with path switching

★ Last community college math course a good predictor of degree path

★ Including other course work strengthens predictions but complicates model and lessens influence of demographics

★ Implications for counseling

★ These findings may not apply to other institutions and require further validation

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Thank you!

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