Mode Choice

CEE320

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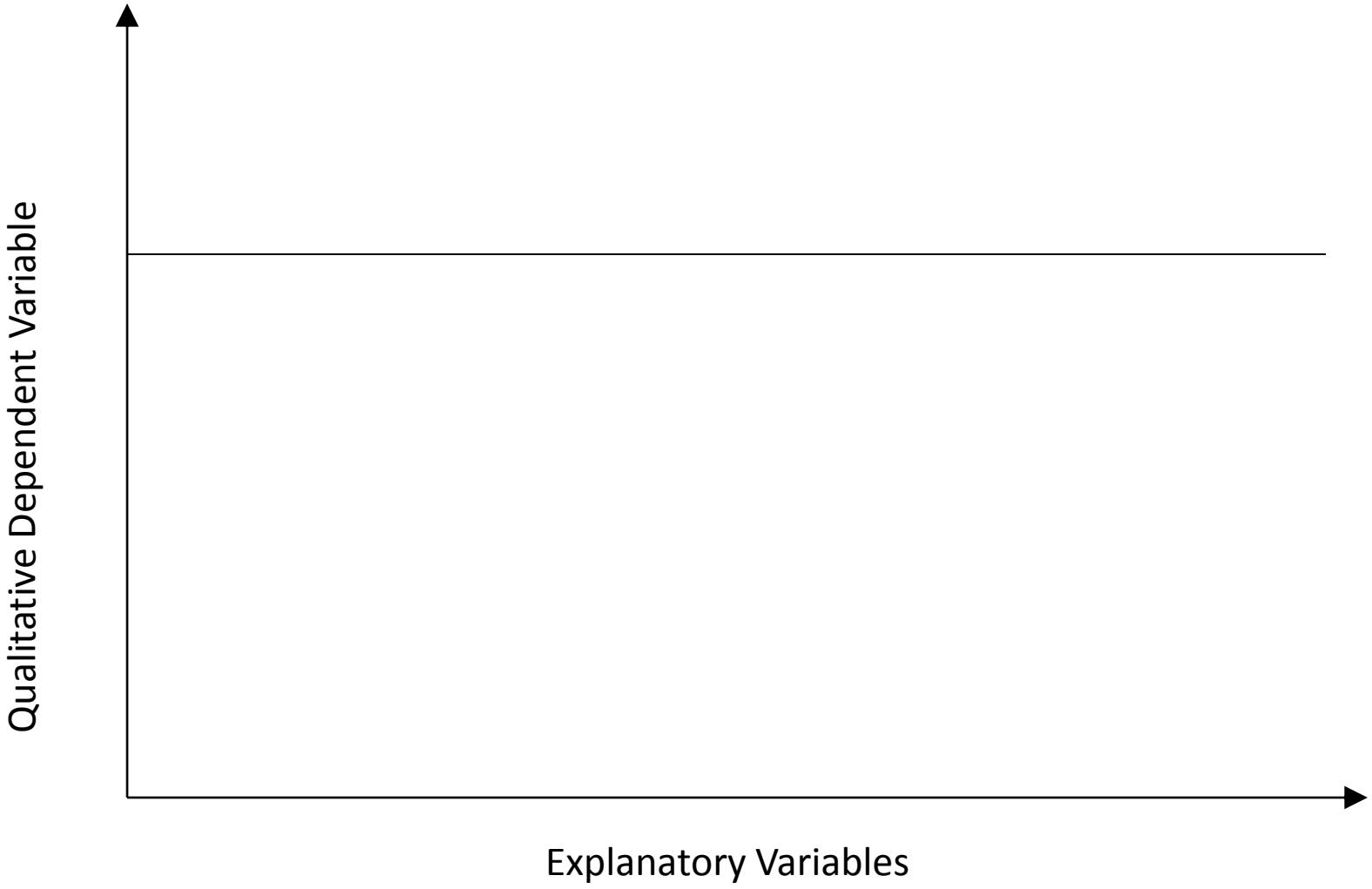
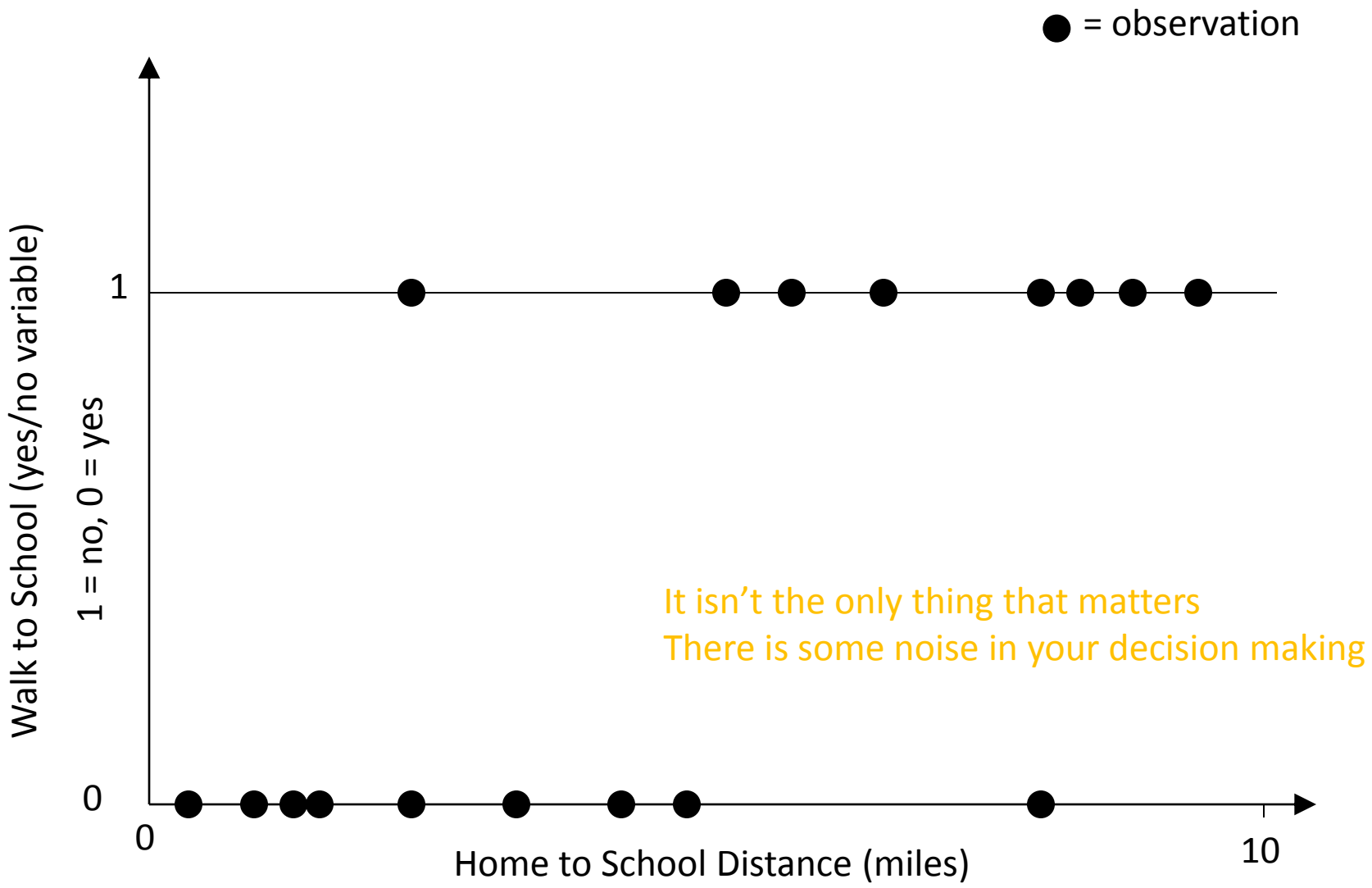
Mode Choice

- Purpose
  - Predict the mode of travel for each trip
- Approach
  - Categorized modes (SOV, HOV, bus, bike, etc.)
  - Generate Model
    - Predict choice based on measurable characteristics of mode

Dilemma



Dilemma


● = observation
Walk to School (yes/no variable)
1 = no, 0 = yes
1
0
0
10
Home to School Distance (miles)
It isn't the only thing that matters
There is some noise in your decision making

A Mode Choice Model

- Logit Model

$$V_{mk} = \underbrace{\sum_n \beta_{mn} z_{kmn}}_{\text{Specifiable part}} + \underbrace{\varepsilon_{mk}}_{\text{Unspecifiable part}}$$

$$U_{mk} = \sum_n \beta_{mn} z_{kmn}$$

- Final form

$$P_{mk} = \frac{e^{U_{mk}}}{\sum_s e^{U_{sk}}}$$

s = all available alternatives
m = alternative being considered
n = traveler characteristic
k = traveler

Discrete Choice Example

- **Buying a golf ball**
  - **Price**
  - **Driving distance**
  - **Life expectancy**

Typical ranges

Consumer's ideal

- *Average Driving Distance: 225-275 yards*
- *Average Ball Life: 18-54 holes*
- *Price: $1.25-$1.75*

Producer's ideal

- *Average Driving Distance: 225-275 yards*
- *Average Ball Life: 18-54 holes*
- *Price: $1.25-$1.75*

Would you rather have:

- 250 yards
- 54 holes
- $1.75

- 225 yards
- 36 holes
- $1.25

If we ask enough of these questions, and respondent has some underlying rational value system, we can identify the values for each attribute that would cause them to answer the way that they did.

Utilities

- What is the respondent willing to pay for one additional yard of driving distance?
- What is the respondent willing to pay for one additional hole of ball life?
- Assume no value for the bottom of the range
- Calculate their utility for any ball offering, then the probability they will choose each offering.

Concerns

- All attributes must be independent
- Must capture everything that is important (or use constant)
- Can present a set of choices and predict population's response
  - Offer complete set of choices
  - Red bus/blue bus

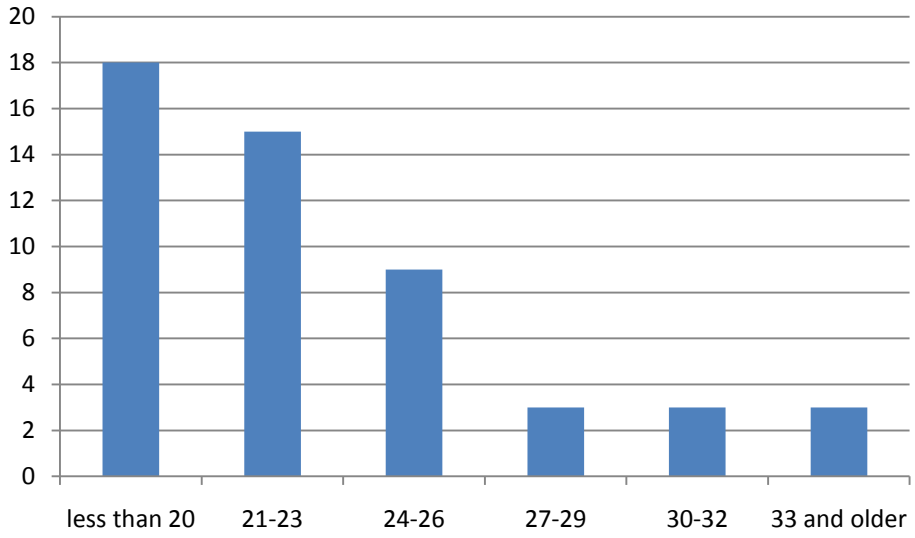
Which variables do you think matter?

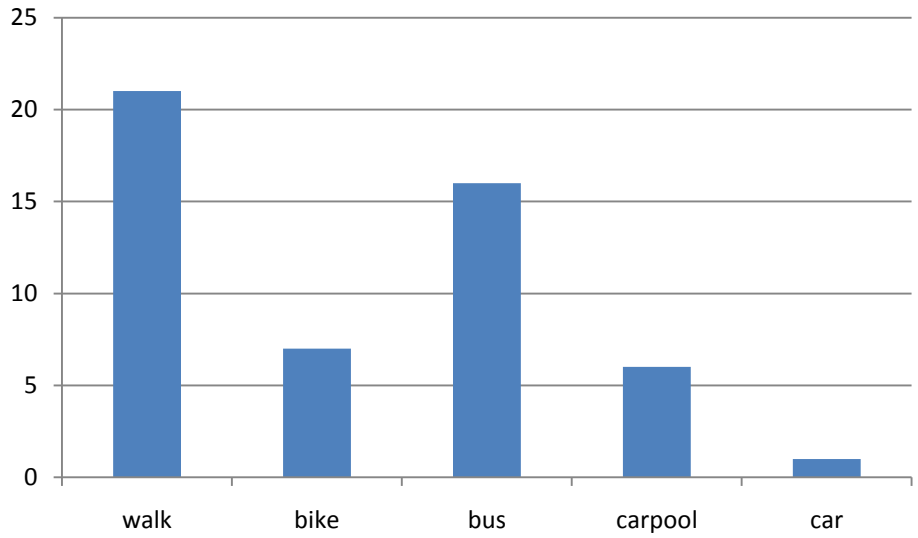
- What is your age?
- How far from campus do you live?
- Which statement best describes today's weather at your home when you left for school?
- Do you own an automobile?
- Do you own a bicycle?
- Are you married?
- When did you arrive on campus today?
- What is your gender?
- How far is the nearest bus stop from your home?

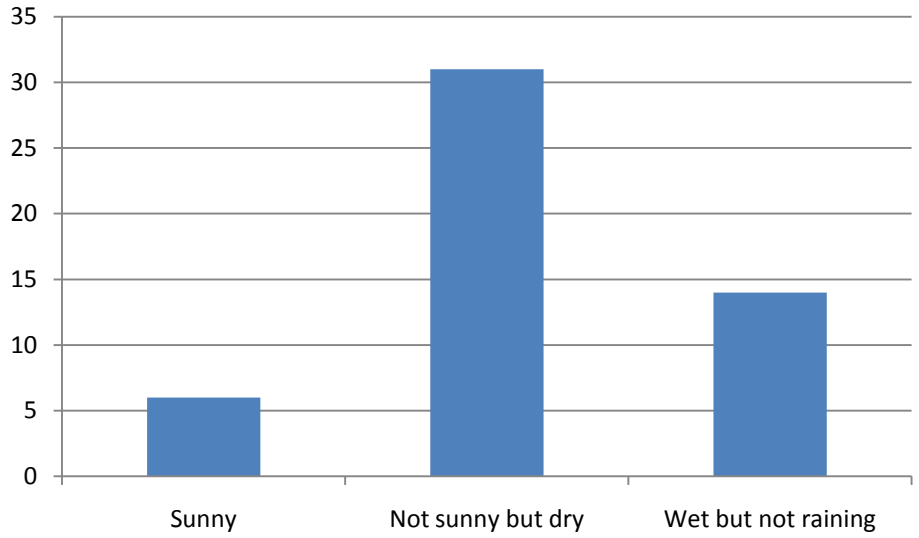
Needs to differentiate within class, affect choice

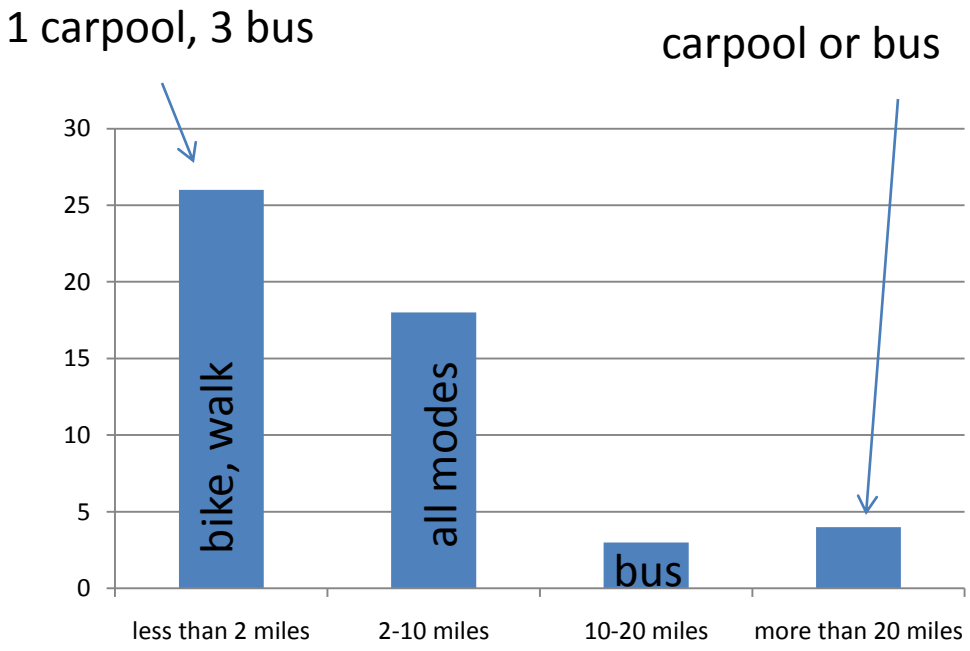
Demographics

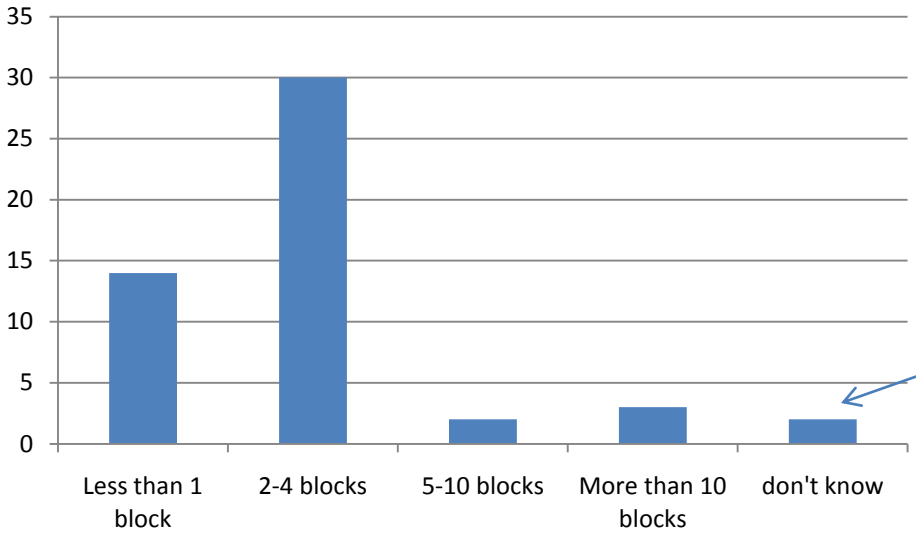
- 73% Male
- 67% own their own motorized vehicle
- 57% own their own bicycle
- 14% married


20
18
16
14
12
10
8
6
4
2
0
less than 20
21-23
24-26
27-29
30-32
33 and older


25
20
15
10
5
0
walk
bike
bus
carpool
car

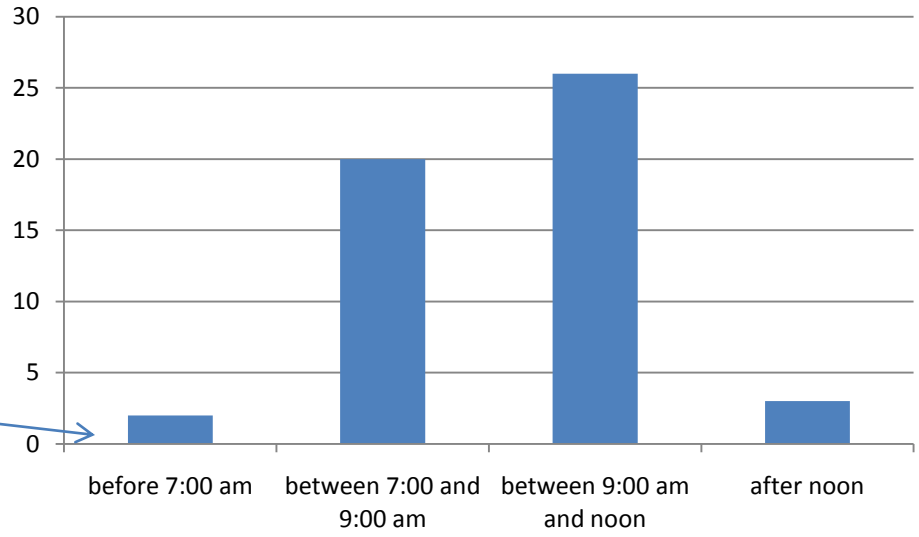

35
30
25
20
15
10
5
0
Sunny
Not sunny but dry
Wet but not raining


1 carpool, 3 bus
carpool or bus
30
25
20
15
10
5
0
bike, walk
all modes
bus
less than 2 miles
2-10 miles
10-20 miles
more than 20 miles



bike, walk

bus, SOV



Variables

Variables

ShortDistance	=	Distance from school indicator (1 if < 1 mile, 0 otherwise)
AutoOwn	=	Car ownership indicator (1 if yes, 0 if no)
BikeOwn	=	Bike ownership indicator (1 if yes, 0 if no)
Gender	=	Gender indicator (1 if female, 0 if male)
ArrivalTime	=	Time arrived on campus in hours (e.g. 9am = 9)

Variables not used

Weather

Age

Married (25% of class married)

Bus stop proximity

Utility Model

$$U(\text{Walking}) = 1.977 + 7.049(\text{ShortDistance})$$

$$U(\text{Bicycle}) = 3.797(\text{ShortDistance}) + 3.997(\text{AutoOwn}) + 0.859(\text{BikeOwn}) - 1.849(\text{Gender})$$

$$U(\text{Bus}) = 3.391 - 0.471(\text{Gender})$$

$$U(\text{Car}) = 0.303 - 0.254(\text{Gender}) + 0.239(\text{ArrivalTime})$$

Compute Probabilities

$$P_{mk} = \frac{e^{U_{mk}}}{\sum_{s} e^{U_{sk}}}$$

For example:

$$P_{walk} = \frac{e^{U_{walk}}}{e^{U_{walk}} + e^{U_{bike}} + e^{U_{bus}} + e^{U_{car}}}$$

My Responses

- What transportation mode did you use to get to school today?
  - Walk
- What is your age
  - 33 and over
- How far from campus do you live?
  - 0 – 2 miles
- Which statement best describes today's weather at your home when you left for school?
  - Not sunny but definitely dry
- Do you own an automobile?
  - Yes
- Do you own a bicycle?
  - Yes
- Are you married?
  - Yes
- When did you arrive on campus today?
  - Between 7 am and 9 am
- What is your gender?
  - Female
- How far is the nearest bus stop from your home?
  - 1 block or less

Because my daughter takes the school bus on Thursdays I walk to work……

My Results

$$\sum_s e^{U_{sk}} = e^{9.026} + e^{6.804} + e^{5.92} + e^{5.961} = 9986.772$$

$$P_{walk} = \frac{e^{U_{mk}}}{\sum_s e^{U_{sk}}} = \frac{e^{9.026}}{9986.8} = 0.833$$

With what predicted probability would I drive to campus?

$$P_{bike} = \frac{e^{U_{mk}}}{\sum_s e^{U_{sk}}} = \frac{e^{6.804}}{9986.8} = 0.09$$

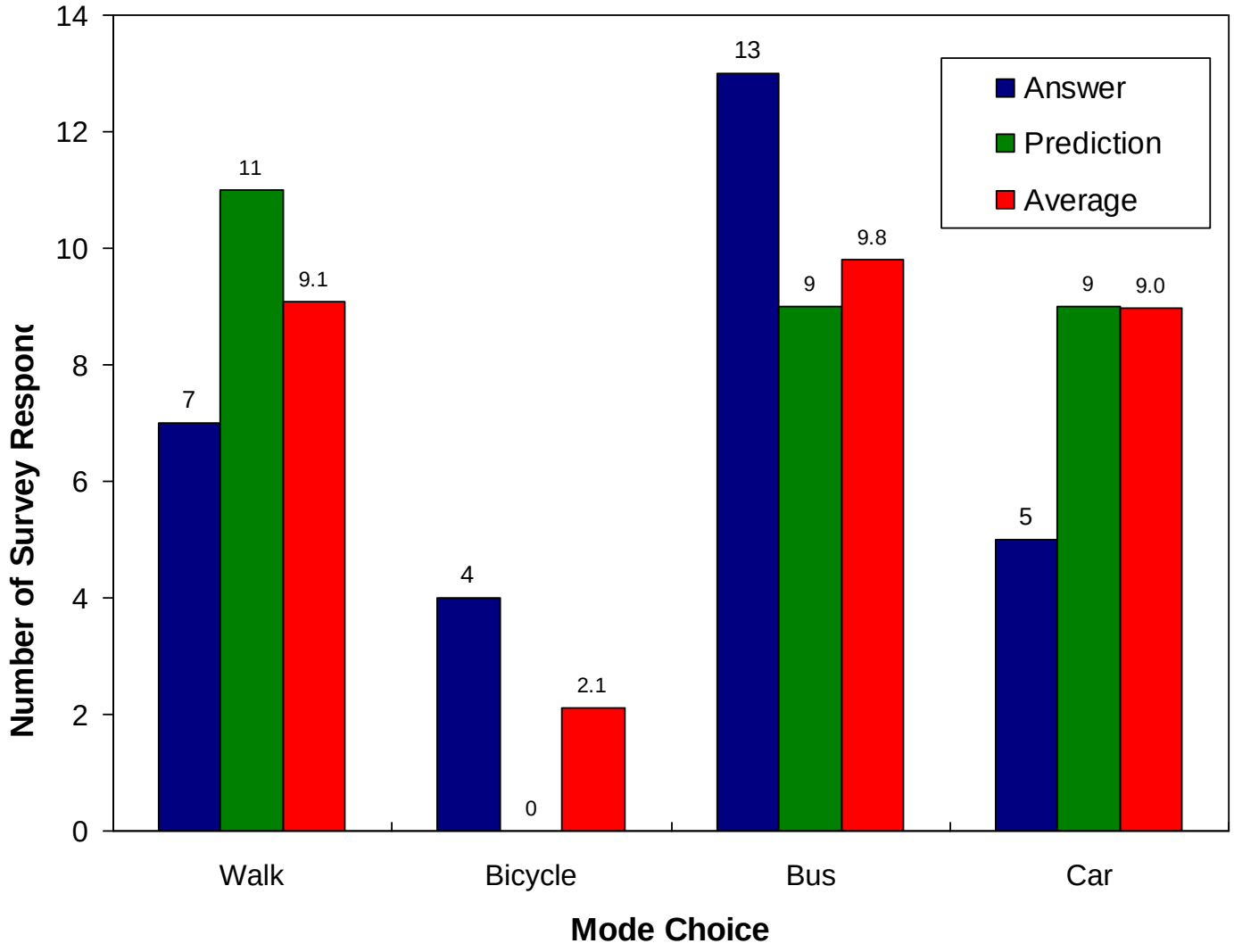
Of 100 trips, how many times would you expect me to walk?

$$P_{bus} = \frac{e^{U_{mk}}}{\sum_s e^{U_{sk}}} = \frac{e^{5.92}}{9986.8} = 0.03$$

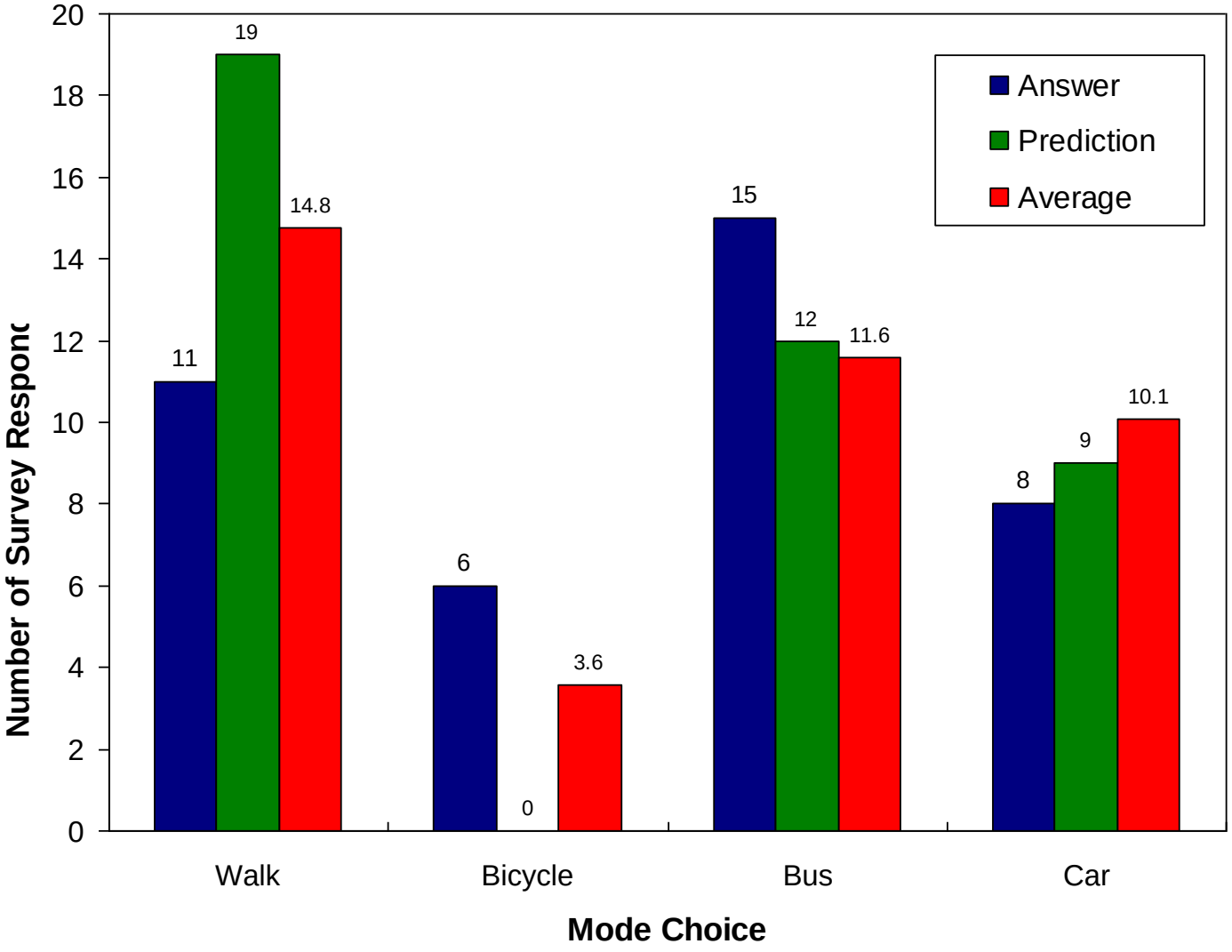
What is my preferred mode of transportation?

$$P_{car} = \frac{e^{U_{mk}}}{\sum_s e^{U_{sk}}} = \frac{e^{5.961}}{9986.8} = 0.031$$

Day 1


14
12
10
8
6
4
2
0
Number of Survey Respons
Answer
Prediction
Average
7
11
9.1
4
0
2.1
13
9
9.8
5
9
9.0
Walk
Bicycle
Bus
Car
Mode Choice

Results Day 2



Discussion points

- Why the underpredicting of bicycle?
  - Most often when bicycle had a high probability, walking was slightly higher
  - Didn't ask a question that would discern between walkers and bikers
  - Didn't capture the deciding factor for driving
- Is this an easy task?
- Some of these variables are picking up important unknown variables (e.g., income, disposable income, etc.)
- Problems
  - Interpretation of questions
  - Incorrect reporting
  - Reporting what they would like to be rather than what they actually did
  - Unknown significant variables