

# **Transit Maps: Power of Cartographical Features Revealed**

CP 264 Class Project  
Spring 2011

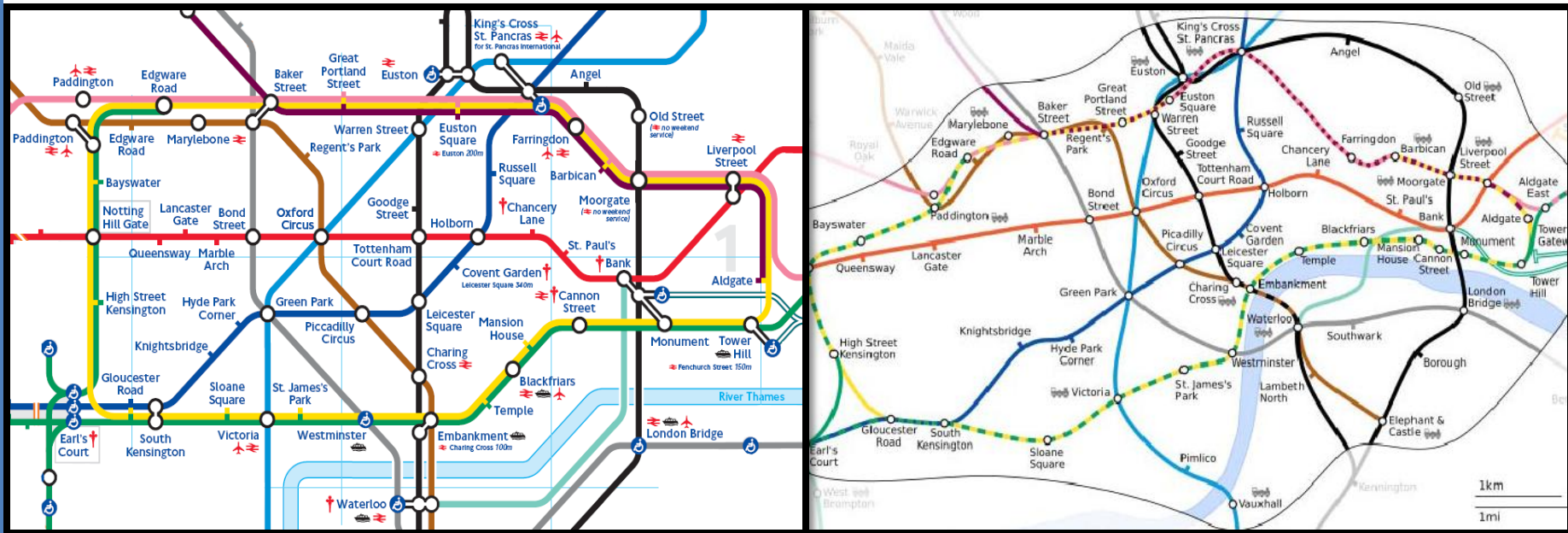
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# OUTLINE

- Literature Review
- Research Question/Hypothesis
- Methodology
  - Survey design
  - Sampling
- Analysis
  - Findings
- Lessons Learned

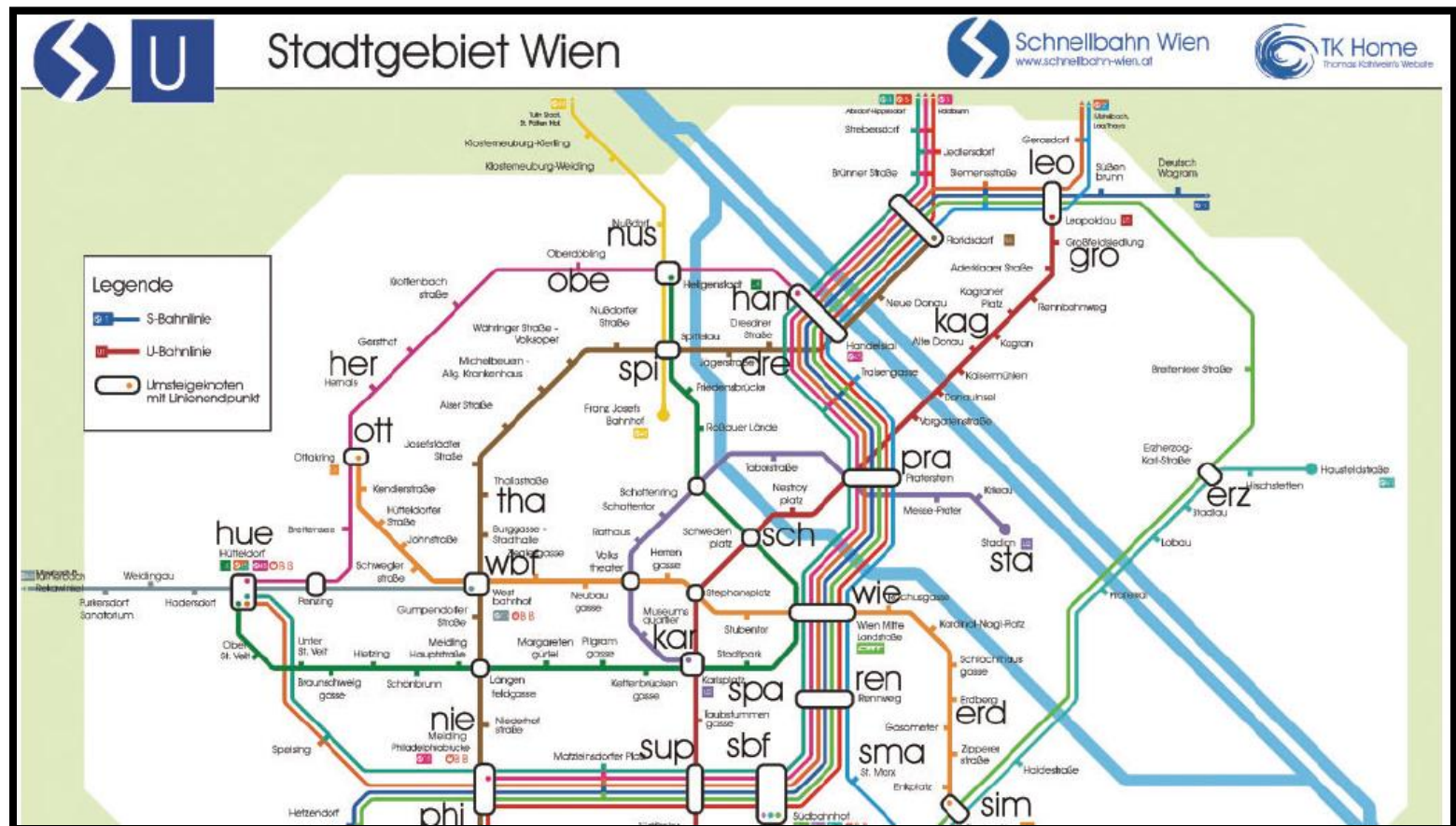
# LITERATURE REVIEW

Z. Guo, "Mind the Map! The Impact of Transit Maps on Travel Decisions in Public Transit" (TRB Pres. 2011)



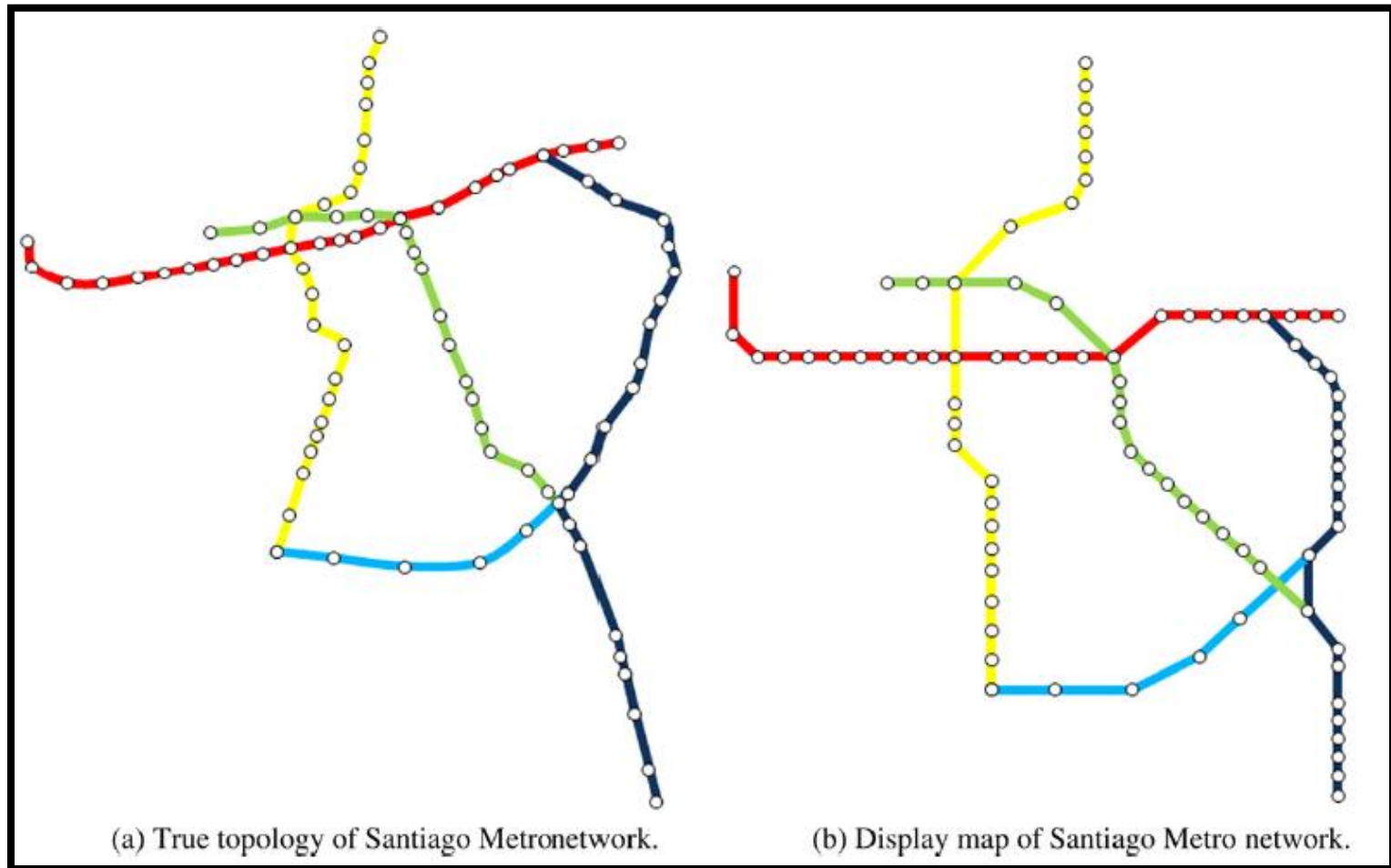
# LITERATURE REVIEW

H. Hochmair, "The Influence of Map Design on Route Choice from Public Transportation Maps in Urban Areas"  
(2009)



# LITERATURE REVIEW

S. Raveau, J. C Munoz, and L. de Grange, “A topological route choice model for metro,” (2011)



# LITERATURE REVIEW

- Four considerations in designing a transit map:
  - Restoration (geographic references)
  - Distortion (level of geographic accuracy)
  - Codification (systematic display of information)
  - Cognition (interpretation of information)
- Perceptions of travel time are highly influenced
- Transit agencies should consider showing time characteristics (e.g. frequency) dynamically on maps

# RESEARCH QUESTION

Can a better bus transit map increase transit mode share?

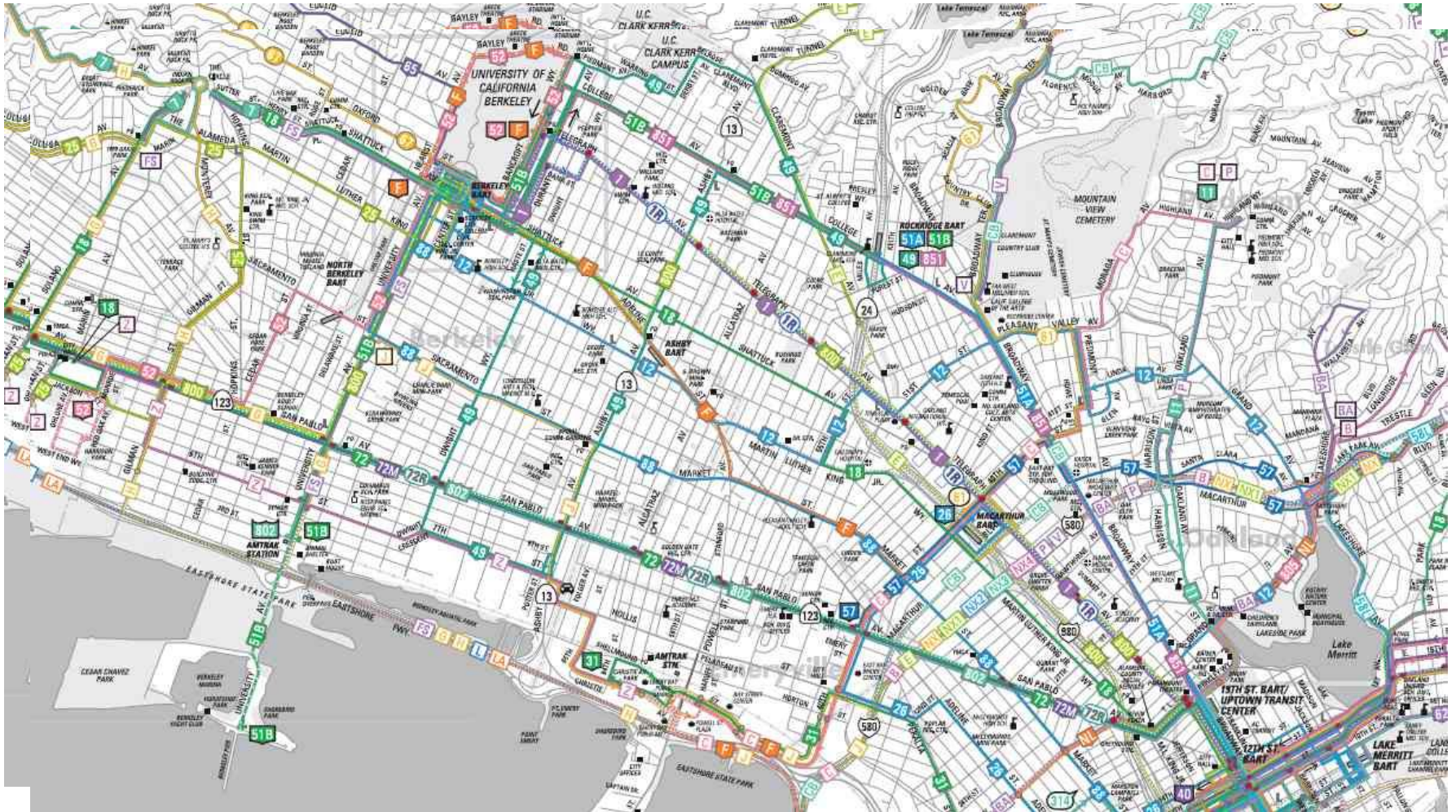
*Our definition of “**better**” is an easier-to-read map that has visual codification of frequency and transfer points*

# METHODOLOGY

- Developed our own Alternative Map
- Designed Stated Preference Survey
- Collected Data
  - Random Sample (by birthday)
- Analyzed Data
  - Summary Statistics
  - Binomial Logit Model
  - Mixed Logit Model



# CURRENT AC TRANSIT MAP



# OUR ALTERNATIVE MAP



- Simplified with distorted angles
- Codification of transfers
- Varying line thickness based on frequency



# VARIABLES TESTED

Variable	Description	Type
Map	Respondents given one of two transit maps for reference – AC Transit map or Distorted Map	Attribute
Trip Scenario (O-D pair)	5 Trips/respondent; Non-appointment trips (e.g. shopping, visiting friend, leisure)	Attribute
Distance	Varied across Trip Purpose	Attribute
Cost	3 levels of auto cost (low, medium, high) 3 levels of transit cost (low, medium, high)	Attribute
Familiarity	Respondents asked AC Transit familiarity based on the number of known routes	Characteristic
Attitude	5 questions on attitude towards transit	Characteristic
East Bay Resident	Respondent asked if they live in the East Bay	Characteristic
Gender	Demographic Question; Male or Female	Characteristic
Age	Demographic Question; Age Range include 5 choices	Characteristic

# SURVEY DESIGN

- Each person asked to choose mode for 5 separate O-D pairs
- Beta testing
- Question randomization
  - 18 surveys with similarly formatted questions
  - Half received alternative map, other half received AC Transit map
  - Each survey had consistent auto and transit cost relationship (e.g. low auto cost and high transit cost for all 5 O-D pairs)
- Sampling
  - Collected Random Samples by using birthday methodology

# SURVEY

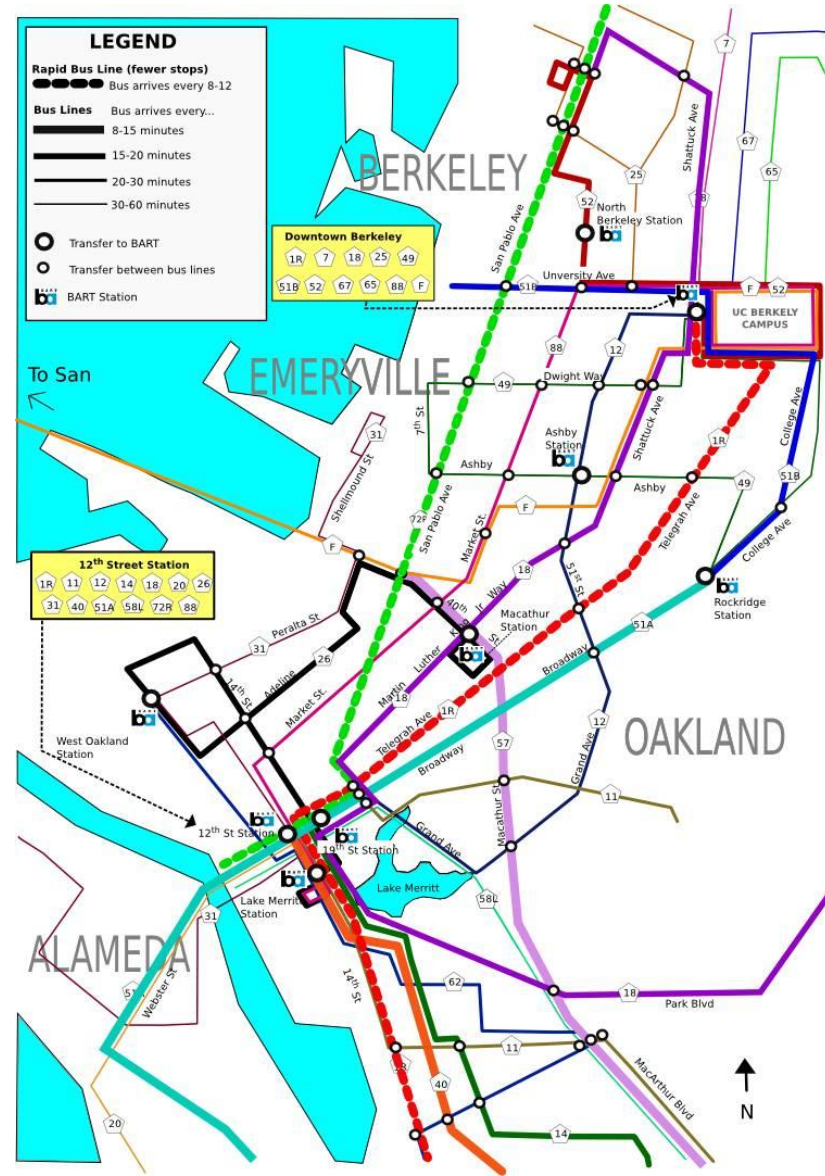
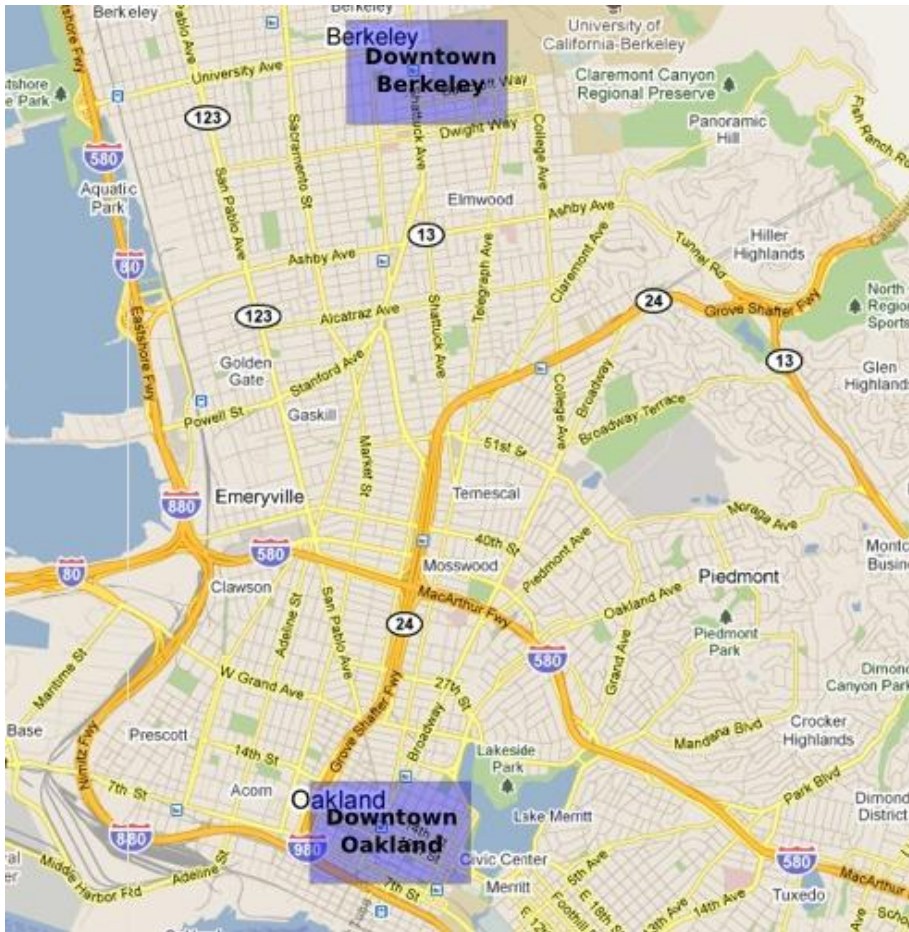
For the following five trip scenarios, assume that a power outage occurred on the BART network system and the two available mode choices are auto and AC Transit. In addition, assume:

- AC Transit always runs on-time
- there is always a seat available on the bus
- there is a stop one block from both your origin and destination.

Imagine you are taking a leisure trip by yourself from downtown Berkeley to downtown Oakland. To take the trip, you can travel by AC Transit or by auto. You have the following maps, cost and distance tables. Use the information below to select your preferred travel mode.

**a) For your reference, below is a map of the origin (downtown Berkeley) to destination (downtown Oakland).**

# SURVEY



# SURVEY

1. Trip Information: The trip distance is 5 miles. The total cost by auto is \$6.00 and the total cost by AC Transit is \$0.50.

Given the maps and information above, which mode would you choose?

- AC Transit
- Auto

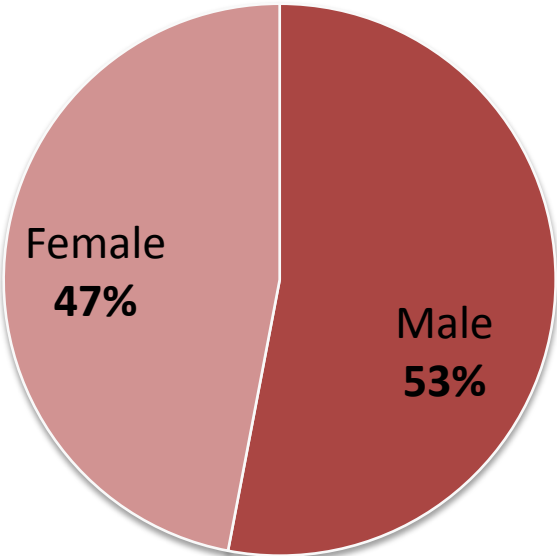
# ANALYSIS

- Summary statistics
- Model specification
- Findings

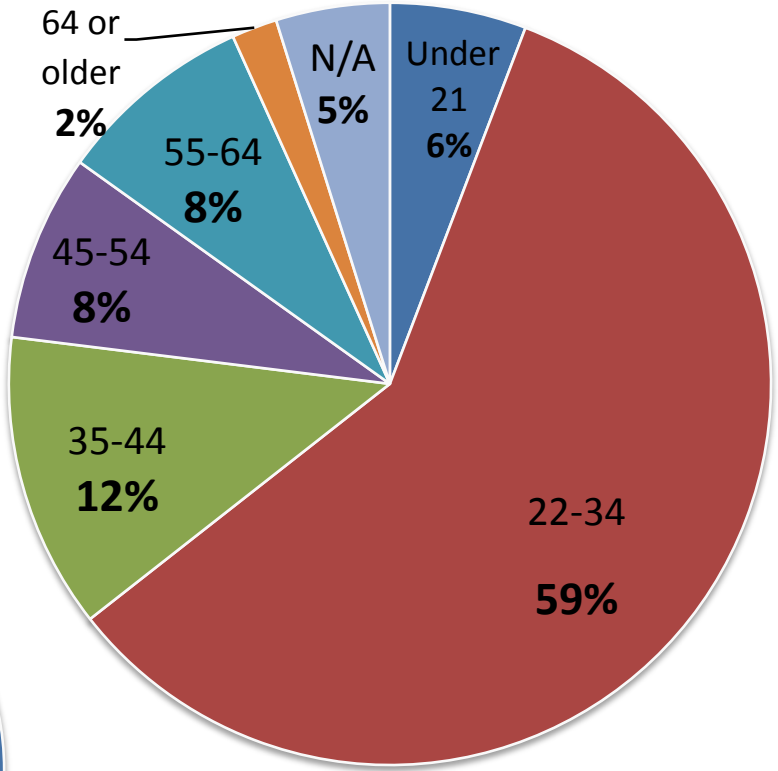


# SUMMARY OF RESPONDENTS

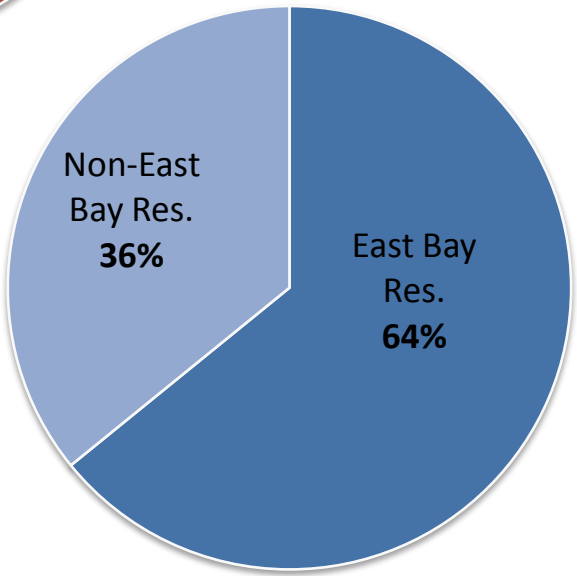
### Gender



### Age Range

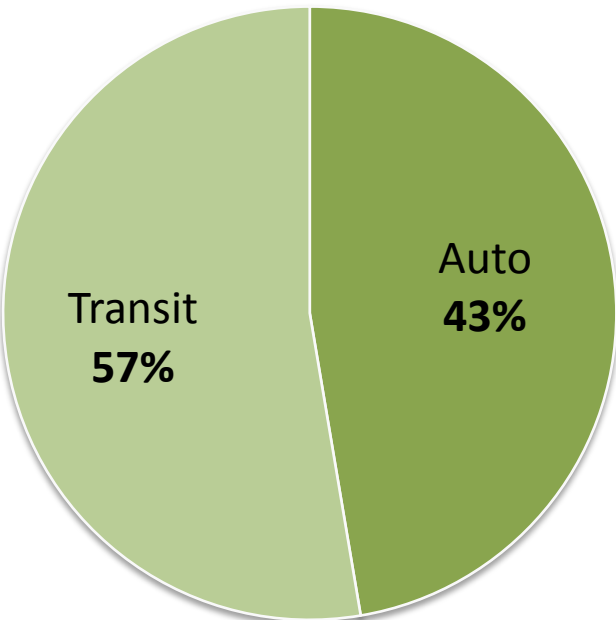


### Local Resident

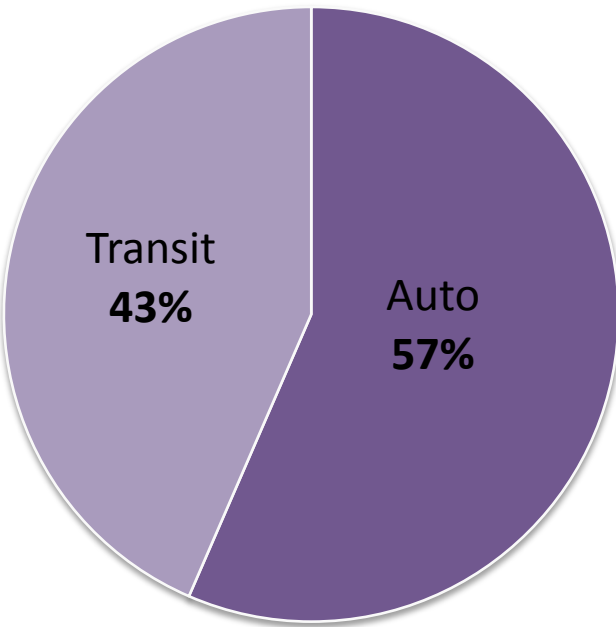


# SUMMARY OF RESPONDENTS

Current AC Transit Map



Alternative AC Transit Map



# TRANSIT SHARE BY O-D

Trip 1	Trip 2	Trip 3	Trip 4	Trip 5
Downtown Berkeley to Downtown Oakland	Downtown Berkeley to the UC Village	Downtown Berkeley to Berkeley Bowl	Downtown Oakland to Grand Lake Theater	Downtown Berkeley to Bay Street Shopping

Map	Transit Share by Trip Number				
AC Transit	68%	60%	54%	44%	36%
Distorted Map	58%	57%	43%	32%	24%
Both	63%	58%	49%	38%	31%

# BINOMIAL MODEL SPECIFICATIONS

- $V(car) = \beta_0 + \text{auto cost}$
- $V(bus) = AC \text{ Transit cost} + \text{map dummy} + \text{east bay res} + od1 + od2 + od3 + od4 + conv + conv\_na$

# BINOMIAL LOGIT RESULTS

Parameter	Estimate	T-Stat
B_cost	-0.155	-7.71
B_map	-0.673	-6.28
B_eb	-0.101	-0.86 **
B_OD1	0.391	2.28
B_OD2	0.814	4.77
B_OD3	0.448	2.64
B_OD4	0.477	2.79
B_CONV	0.253	1.56 **

# Model Improvements

- Why Mixed Logit?
  - 5 choices for the same individual
- Interaction terms
  - Headways might be important difference
  - Disaggregate the map coefficient to see why it is negative

# MIXED LOGIT SPECIFICATION

- $V(car) =$

$$\beta_0 + \text{auto cost}$$

- $V(transit) = \text{bus cost} + \text{od1} + \text{male} +$

*map dummy*

\*

$$\begin{aligned} & \beta_1 \\ & + \beta_2 * \text{age} \\ & + \beta_3 * \text{eb\_res} \\ & + \beta_4 * \text{headway} \\ & + \beta_5 * \text{influence} \\ & + \beta_6 * \text{convenience} \end{aligned}$$

Dummy

Numerical

Likert  
Scale

# MIXED LOGIT RESULTS

Coefficient Name	Estimate
ASC car	Fixed
ASC bus	0.0935 (0.41) **
Cost	-0.220 (-5.31)
Male	0.420 (1.59) **
<b>Map (base)</b>	<b>1.37 (2.38)</b>
<b>Map * age</b>	<b>1.12 (2.58)</b>
<b>Map * east bay resident</b>	<b>-1.03 (-2.47)</b>
<b>Map * headway</b>	<b>-0.188 (-7.85)</b>
<b>Map * map influence</b>	<b>0.887 (2.22)</b>
<b>Map * ACT is convenient</b>	<b>1.84 (3.92)</b>
OD == 1	-0.884 (-3.80)
Sigma Car	1.49 (2.76)
Sigma Transit	-1.21 (-1.92) **



# MIXED LOGIT FINDINGS

- Map coefficient significantly depends on who you are and how you feel about buses
- Example:

Carmen                    -- is an East Bay Resident (-1.03)  
                              -- is 26 years old (+1.12)  
                              -- thinks that AC Transit is convenient (+1.84)  
                              -- thinks that maps are influential (+0.887)

**What is her beta map?**

Beta map (before headways) = **1.37** +  $\sum$  beta coeff's = **4.187**

Headway contribution = - **0.188** \* headway (in minutes)

# APPLICATIONS

## How can a Transit Agency use the results?

- Alternative map increases transit utility (but)
- Visualizing large headways actually decreases transit utility

## Concerns of Transit Agency

- Our map represents small geographic range
- Our map was designed with our definition of “better”
- Stated Preference Survey
  - Missing trip attributes
  - Missing some demographics
  - Forced people onto only two modes (realism)
  - Homogeneous sample population

# REFLECTION

## Survey Lessons

- Creating a survey is difficult
  - Can't include everything
- Carefully consider variability across questions AND across surveys

## Model Lessons

- Do not get discouraged when actual  $\beta$  contradicts hypothesis
- Taste variation is significant



# THANK YOU

ESPECIALLY THANKS TO **AKSHAY VIJ** FOR HIS  
DEDICATED HELP THROUGHOUT THE PROCESS