

# Analysis of Activity-Travel Patterns and Tour Formation of Transit Users

## Final Meeting

### Pacific Southwest Region University Transportation Center

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STATE AGENCY: California Department of Transportation

AGREEMENT: 65A0674, University of Southern California (TO 033)

PI: Michael G. McNally, Professor, Department of Civil & Environmental Engineering, UCI

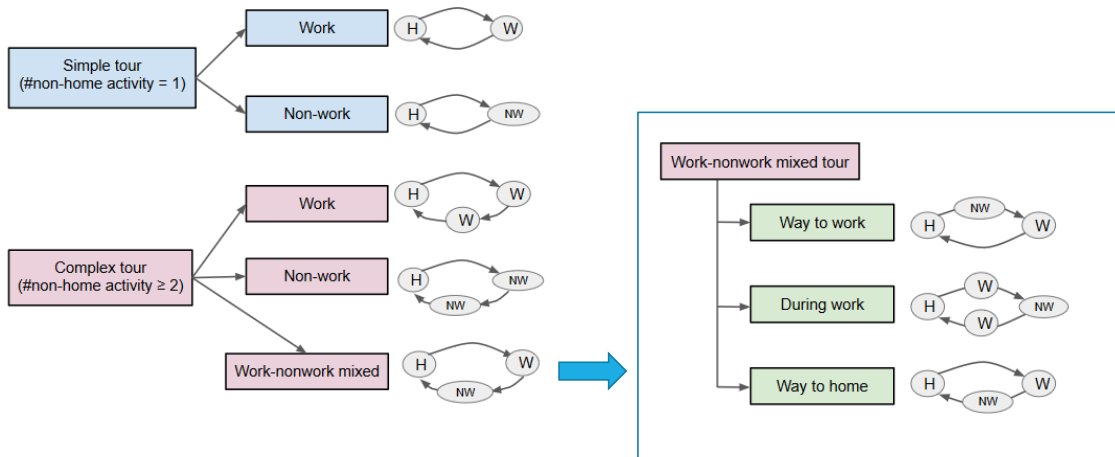
DATE: July 23, 2021



## Background

- Over the past 40 years, the **Activity-based Approach** has become a dominant theory of travel behavior, with UC Irvine as one of the major innovators and proponents
- The central tenet is that travel and activity behavior is fundamentally **complex** and cannot be properly analyzed with simple trip-based methods
- **Tour-based** and activity-based **models** are increasingly common, replacing trip-based models in major MPOs and some statewide models
- A **tour** is defined as a sequence of travel and activities that starts and ends at home
- An **activity pattern** is a (typically) 24-hour depiction of travel and activity, comprising one or more tours (for those with any travel on the survey day)
- A **transit user** has at least one travel segment on a tour completed using public transit.

## Tour Representation



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## Project Goals and Objectives

The primary project goal was an in-depth analysis of the complexity of **activity-travel patterns** for **transit users**.

Project research objectives included:

- To understand the socio-demographics and **tour behavior** of transit users.
- To identify **latent classes** of transit **users** based on heterogeneity in **activity-travel patterns** and tour formation.
- To develop a **tour choice model** to characterize transit **commuters** based on the complexity of work tours.
- To analyze activity-travel patterns of transit **disadvantaged groups**.

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## Project Tasks

Project research tasks include:

- Task 1. Literature Review
- Task 2. Empirical Analysis
- Task 3. Tour and Pattern Classification
- Task 4. Tour Choice Model for Transit Commuters
  - Sub-task 4b. Analyze activity-travel patterns of transit disadvantaged groups
- Task 5/6. Draft and Final Report

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## Task 1: Literature Review

### Objective

To identify research gaps from prior studies.

### Task Description

Review and assess current literature on the following “transit” issues:

1. Socio-demographic characteristics
2. Heterogeneity in users
3. Transit disadvantaged groups
4. Trip characteristics
5. Trip chain or tour characteristics
6. Daily activity-travel patterns

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## Task 2: Empirical Analysis

### Objective

To understand the **demographics** and **travel behavior** of transit users.

### Task Description

Used the 2017 National Household Travel Survey (NHTS) data to analyze:

1. Demographics of **transit users** (work and/or nonwork: **sample** size = 4,994)
2. Trip characteristics of **transit users** (work and/or nonwork)
3. Trip and tour characteristics of **transit commuters** (work purpose: **sample** size = 2,079)

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## Task 2: Empirical Analysis: Findings

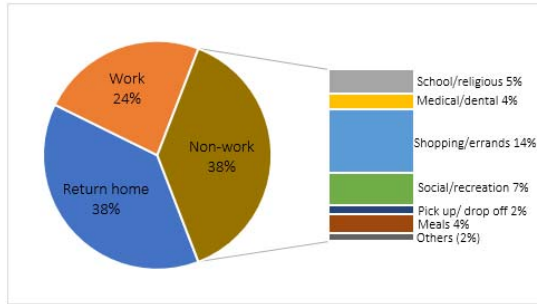
### *Socio-demographics of Transit Users*

- A higher fraction (37%) belongs to **low-income households** (less than \$35K).
- 52% of households are **car deficient households** (less than 1 car per licensed driver).
- **Fewer households with children** aged 0 – 17 years (19%).
- Similar across two **age groups**: 18-38 (34%) and 38 – 58 (32%).
- Similar across **gender**: male 49% and female 51%.
- A higher fraction **white** (59%) and **employed** (62%).

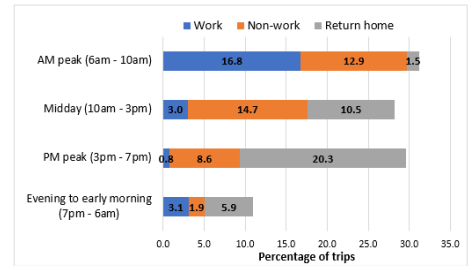
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## Task 2: Empirical Analysis: Findings

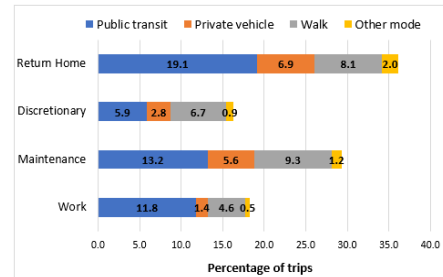
### Trip characteristics of Transit Users



Distribution of transit trips by activity purposes



Distribution of trip purpose by time of day

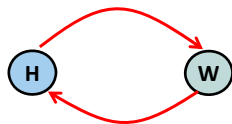


Distribution of travel mode by trip purpose

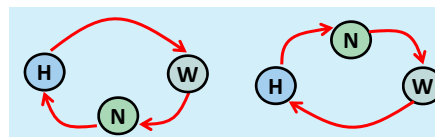
## Task 2: Empirical Analysis: Findings

### Tour characteristics of Transit Users

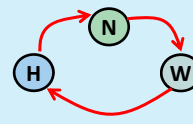
Identified 7 patterns that represent 80% of total work tours



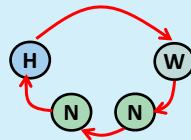
Pattern 1 (49%)  
*Simple work tour*



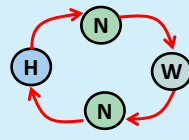
Pattern 2a (11%)



Pattern 2b (5%)

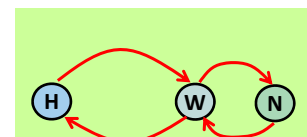


Pattern 2c (3%)

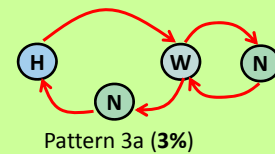


Pattern 2d (2%)

*Complex work tour*



Pattern 3a (8%)



Pattern 3a (3%)

*Complex with work-based*

## Task 3: Pattern Classification

### Objective

To identify the heterogeneity in activity-travel patterns of **transit users**.

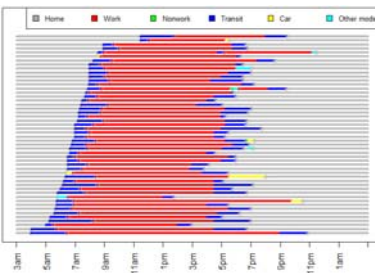
### Task Description

Apply Latent Class Analysis (LCA) to 2017 NHTS data to identify and evaluate:

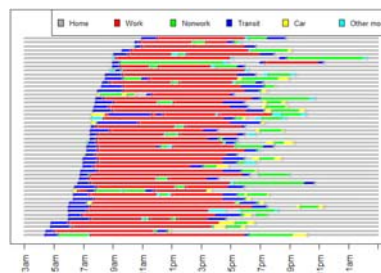
1. Homogeneous transit user **groups**
2. Representative **activity-travel patterns** for identified groups.

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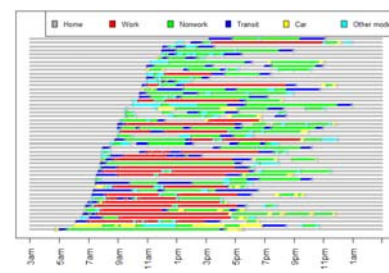
## Task 3: Pattern Classification: Findings



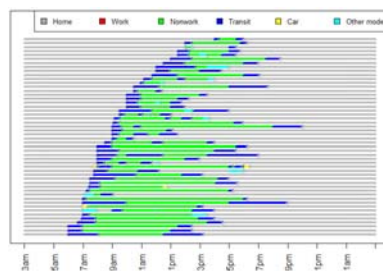
Class 1: Regular 9-to-5 commuters



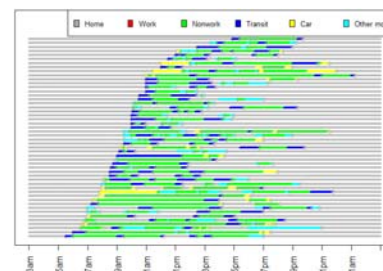
Class 2: After-work stop commuters



Class 3: Multimodal multiple trip makers



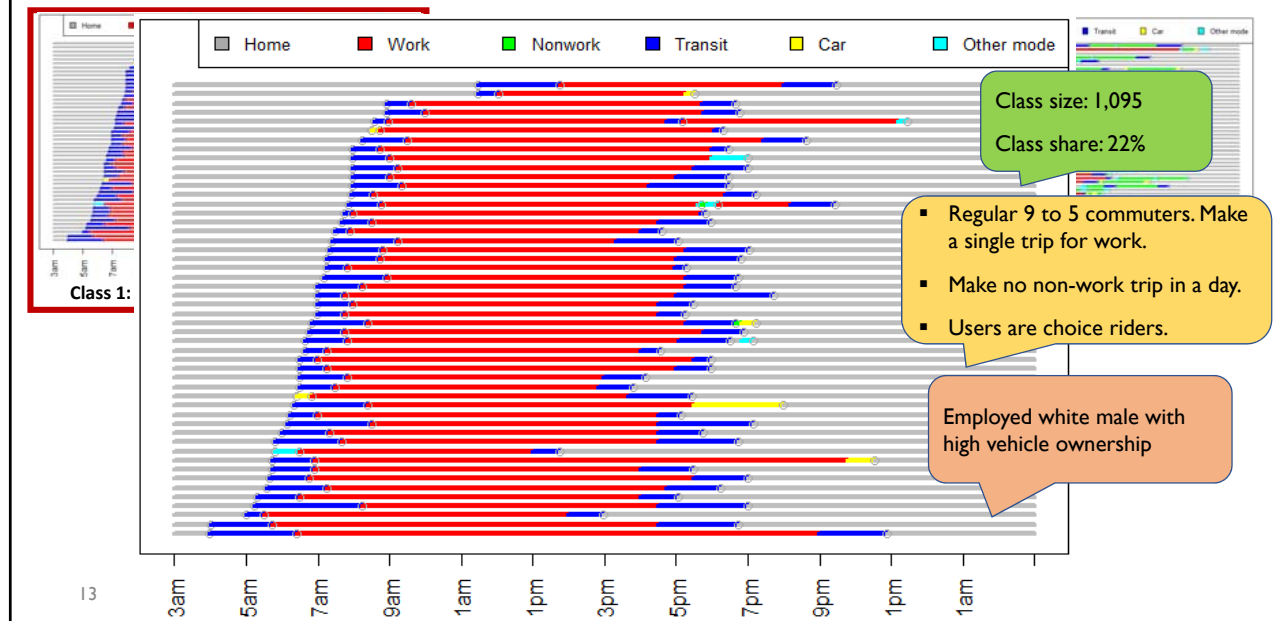
Class 4: Morning non-work travelers



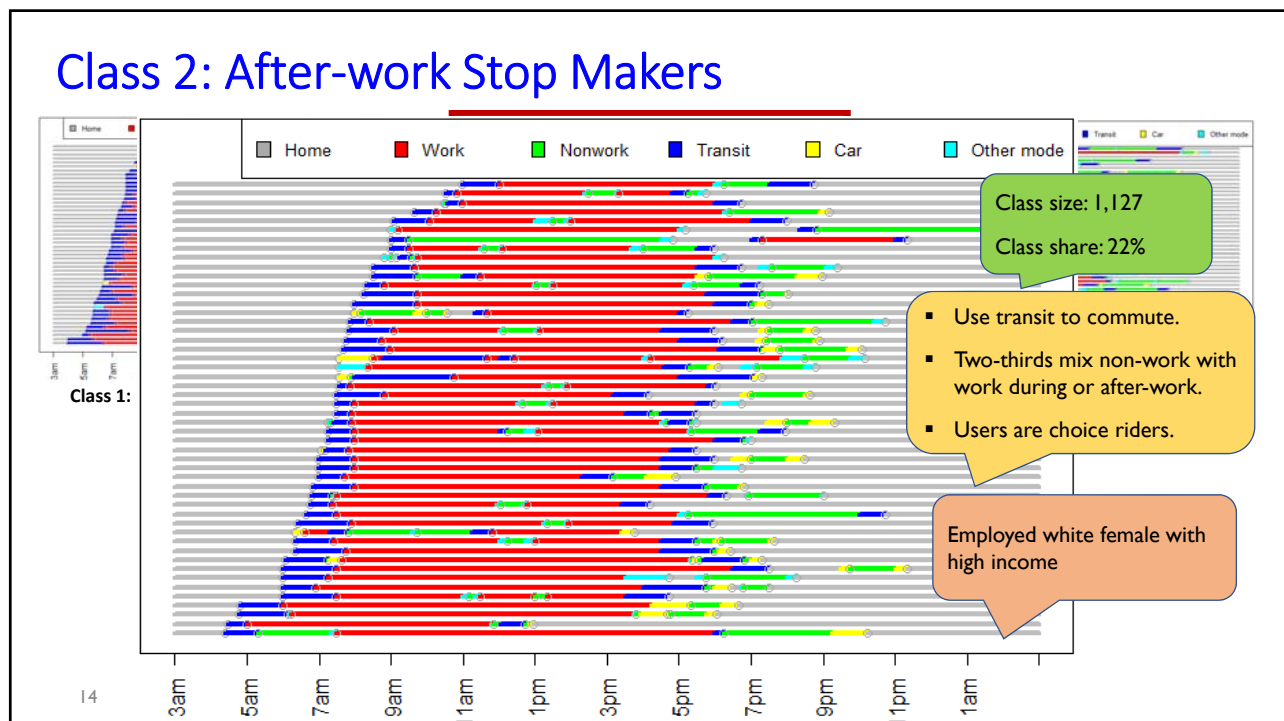
Class 5: Recurrent transit users

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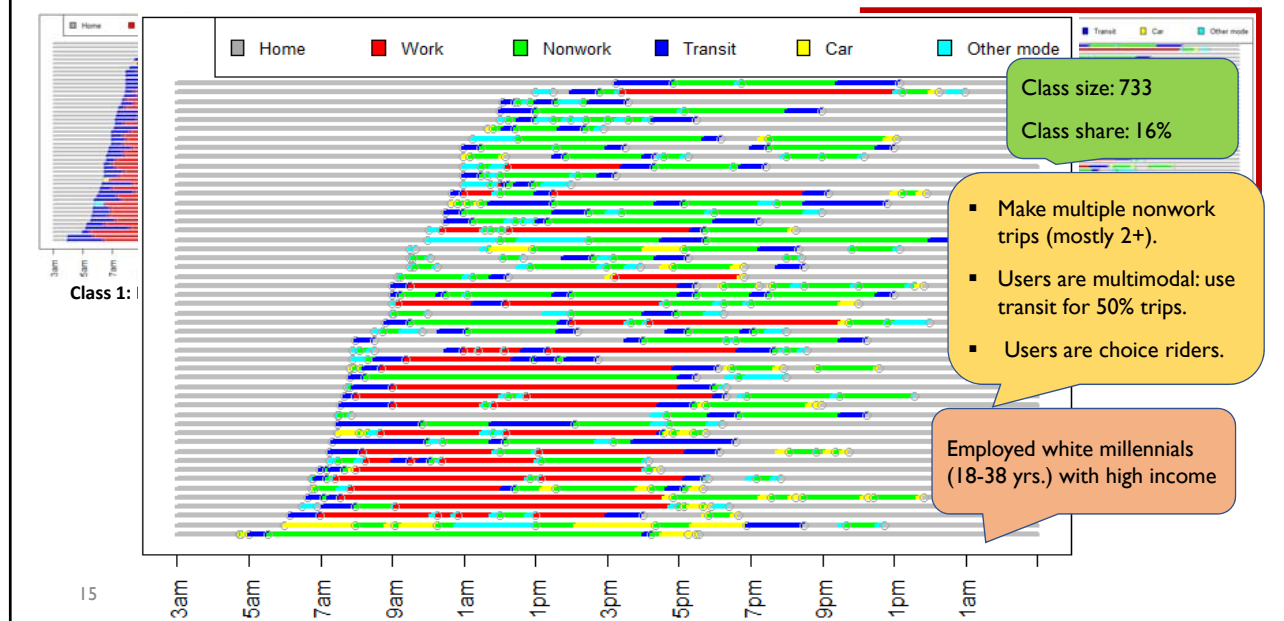
## Class 1: Regular 9-to-5 Commuters



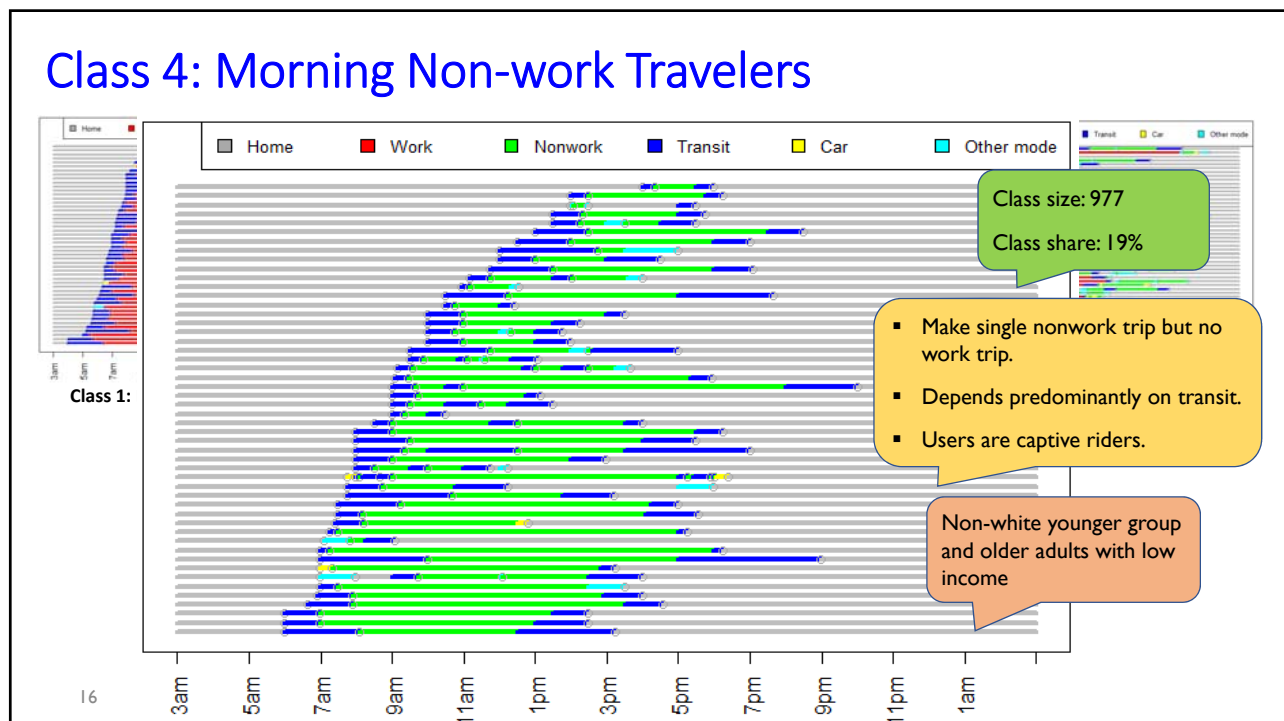
## Class 2: After-work Stop Makers



## Class 3: Multimodal Multiple Trip Makers

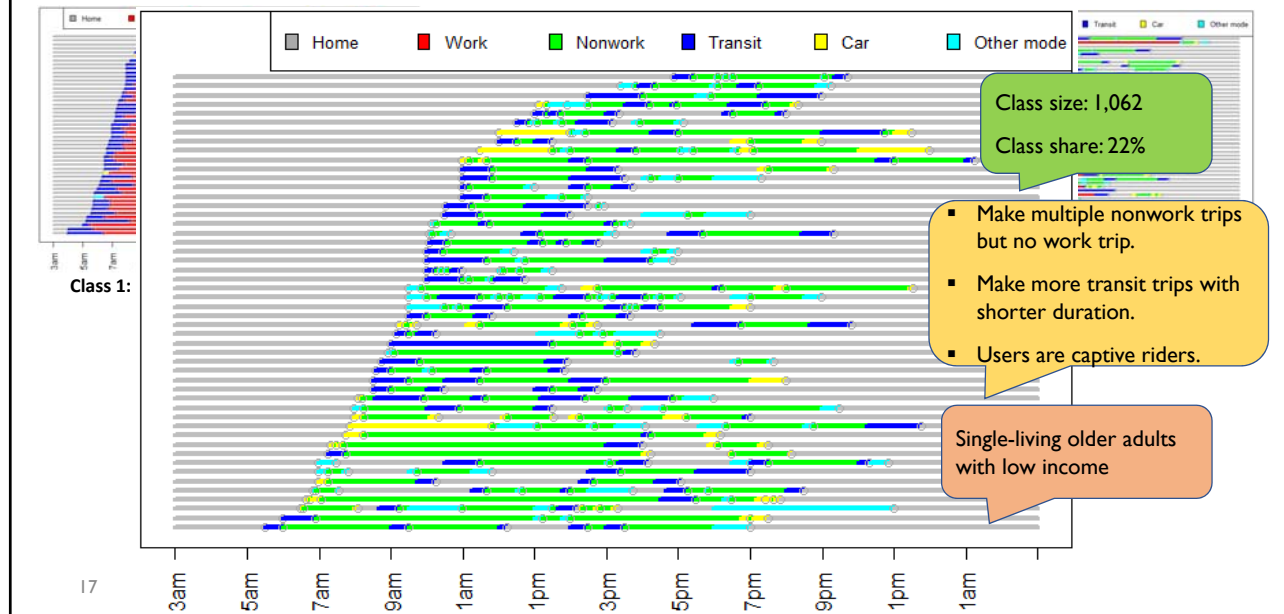


## Class 4: Morning Non-work Travelers

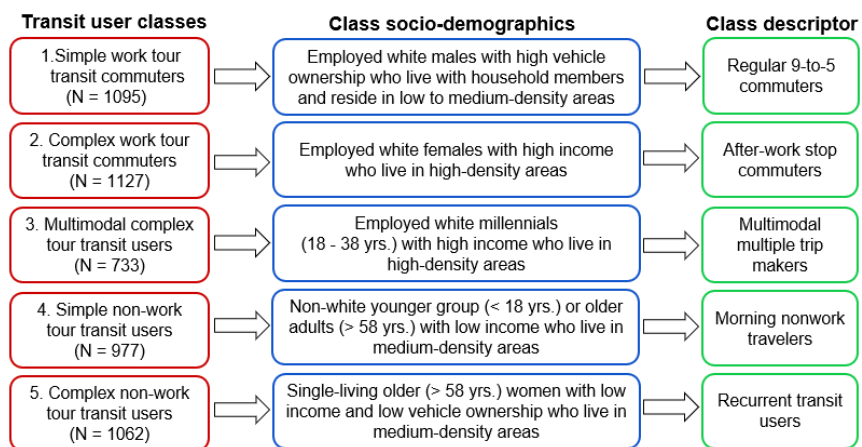




## Class 5: Recurrent Transit Users



## Task 3: Pattern Classification: Findings



Five transit user classes and their socio-demographic properties

## Task 4: Tour Choice Model

### Objective

To develop a tour choice model for **transit commuters**.

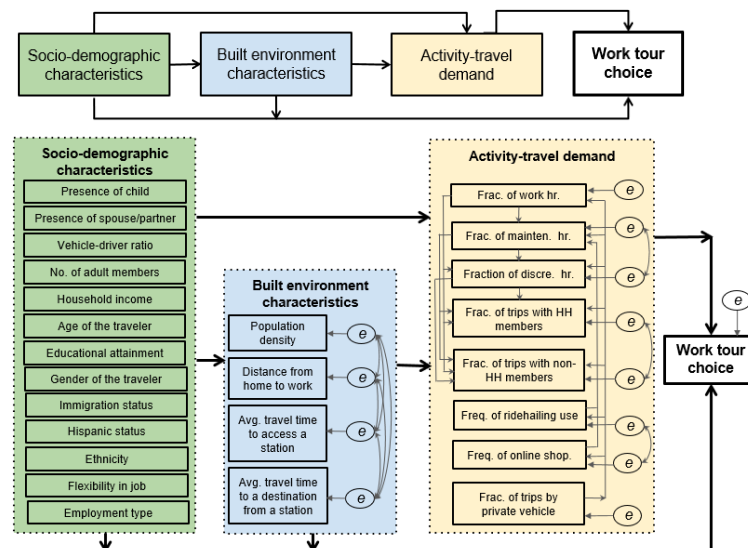
### Task Description

Apply Structural Equation Modeling (SEM) to the 2017 NHTS data to analyze:

1. Characterization of commuters based on **complexity** of work tours.
2. Impacts of socio-demographics, built environment, and activity-travel indicators on the likelihood of a commuter choosing a particular work tour.

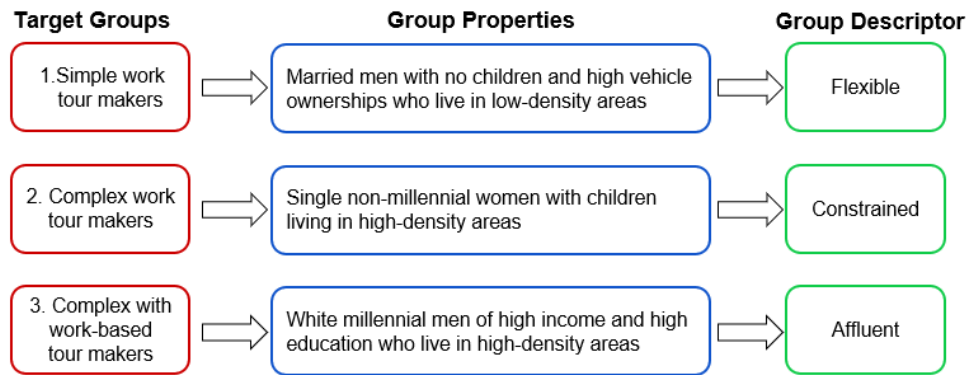
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## Task 4: Tour Choice Model: Conceptual Structure



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## Task 4: Tour Choice Model: Findings



**Three target groups of transit commuters and their properties**

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## Sub-Task: Transit Disadvantaged Groups

### Objective

To investigate the activity-travel patterns of transit **disadvantaged** groups.

### Task Description

Used 2017 NHTS data to analyze the activity-travel pattern of four groups of transit users who are traditionally considered as transit disadvantaged groups.

These four groups are people who lived in:

- 1) carless households,
- 2) low-income households (less than \$35K)
- 3) rural areas, and/or who are
- 4) older adults (aged 65+)

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## Sub-Task: Transit Disadvantaged Groups: Findings

### Distribution of disadvantaged groups by five identified transit user classes

Class	Class name	Class share(%)	Class size with no disadvantage (%)	Class size with disadvantage (%)	Carless (%)	Rural (%)	Low-income (%)	Older (>65) (%)
1	Simple work tour users	22	31	15	12	24	12	9
2	Complex work tour users	23	30	16	15	23	12	11
3	Multimodal tour makers	15	19	11	12	15	8	5
4	Simple nonwork tour users	20	11	27	28	20	32	32
5	Complex nonwork tour users	21	9	31	33	18	36	43
		100	100	100	100	100	100	100

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## Overall Findings

### Objective 1: Identify the Complex Travel Behavior of Transit Users

1. About 80 percent of work tours consist of **seven dominant patterns** whereas the other 20 percent of tours demonstrate a total of 106 diverse and more complicated patterns.
2. In terms of complexity, **half of the transit work tours are complex.**
3. In terms of mode use, **most simple work tours are transit-only tours** whereas most complex tours are multimodal tours.
4. Transit use is **more complex than the traditional home to work commute** with a diverse set of choices at various stages of activity scheduling.

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## Overall Findings

### Objective 2: Identify Classes of Transit Users based on Complex Behavior

1. Transit users can be classified into **five distinct classes**, each with a representative activity-travel pattern.
2. Transportation **disadvantaged groups have different** activity-travel patterns than those who do not belong to any of the specified disadvantaged groups.

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## Overall Findings

### Objective 3: Develop a Tour Choice Model for Transit Commuters

1. Structural model results provided the demographic characterization of **three groups of work tour makers** (simple, complex, and complex with work-based sub-tours).
2. Structural models suggest that neighborhood density, flexibility of work schedules, household activity interactions, travel party composition, and availability of private vehicles in work tours were important **determinants of work tour choice** for transit commuters.

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## Analysis of Activity-Travel Patterns and Tour Formation of Transit Users

Michael G. McNally and Rezwana Rafiq (2021).

Analysis of Activity-Travel Patterns and Tour Formation of Transit Users.

Final Report PSR-19-33.

<https://www.metrotrans.org/research/analysis-of-activity-travel-patterns-and-tour-formation-of-transit-users>

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