Progress in the Development of the ADAPTS Dynamic Activity-Based Microsimulation Model

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Overview

- Introduction and Motivations
- ADAPTS Framework
- Current work on the ADAPTS model
  - Activity generation
  - Activity planning strategies
  - Attribute planning (destination choice)
  - Activity scheduling
- Discussion / Conclusions

Introduction and Motivation

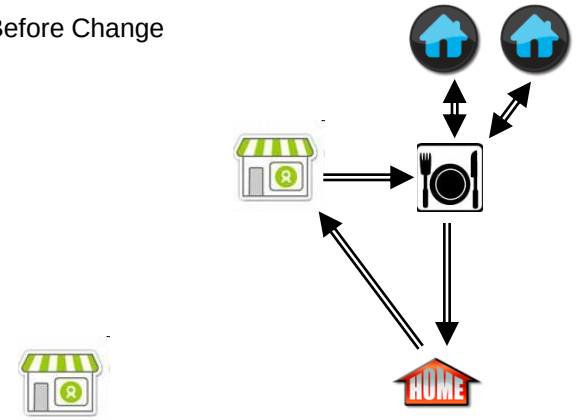
Issues in Activity-Based Modeling

- Preset activity priority order:
  - Activities added to schedule and attributes picked in fixed order
  - In other models: activities added in order of assumed priority
  - Does not match observations from data (Roorda et al. 2005)
- Fixed order of attribute scheduling:
  - Ex: Party > Duration> Location > Mode > Time
  - Gives fixed dependencies in the decisions
  - Again, does not match actual scheduling process
    - seen in CHASE, OPFAST, UTRACS (our GPS survey), etc.)
- Scheduling planning dynamics
  - Order of decisions can impact subsequent decisions
  - Impulsive/unexpected events in simulation or scenarios
  - Many have entire schedule generated then executed
- May lead to errors modeling behavioral-based policies

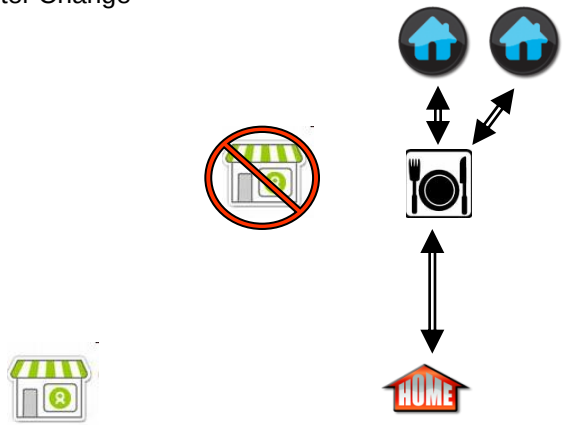
Scheduling Order Example

A) Impulsive Shop - Preplan Eat Out

Before Change

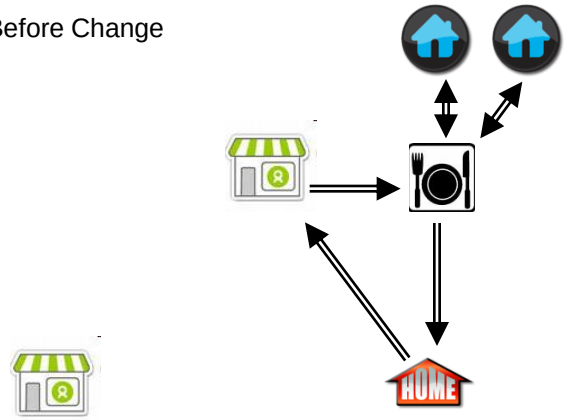


After Change

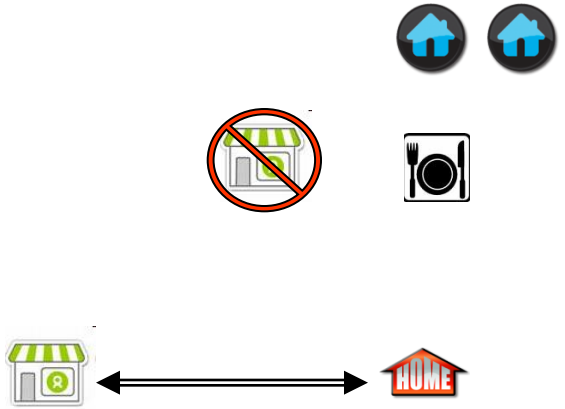


B) Preplan Shop - Impulsive Eat out

Before Change



After Change



Motivation for ADAPTS

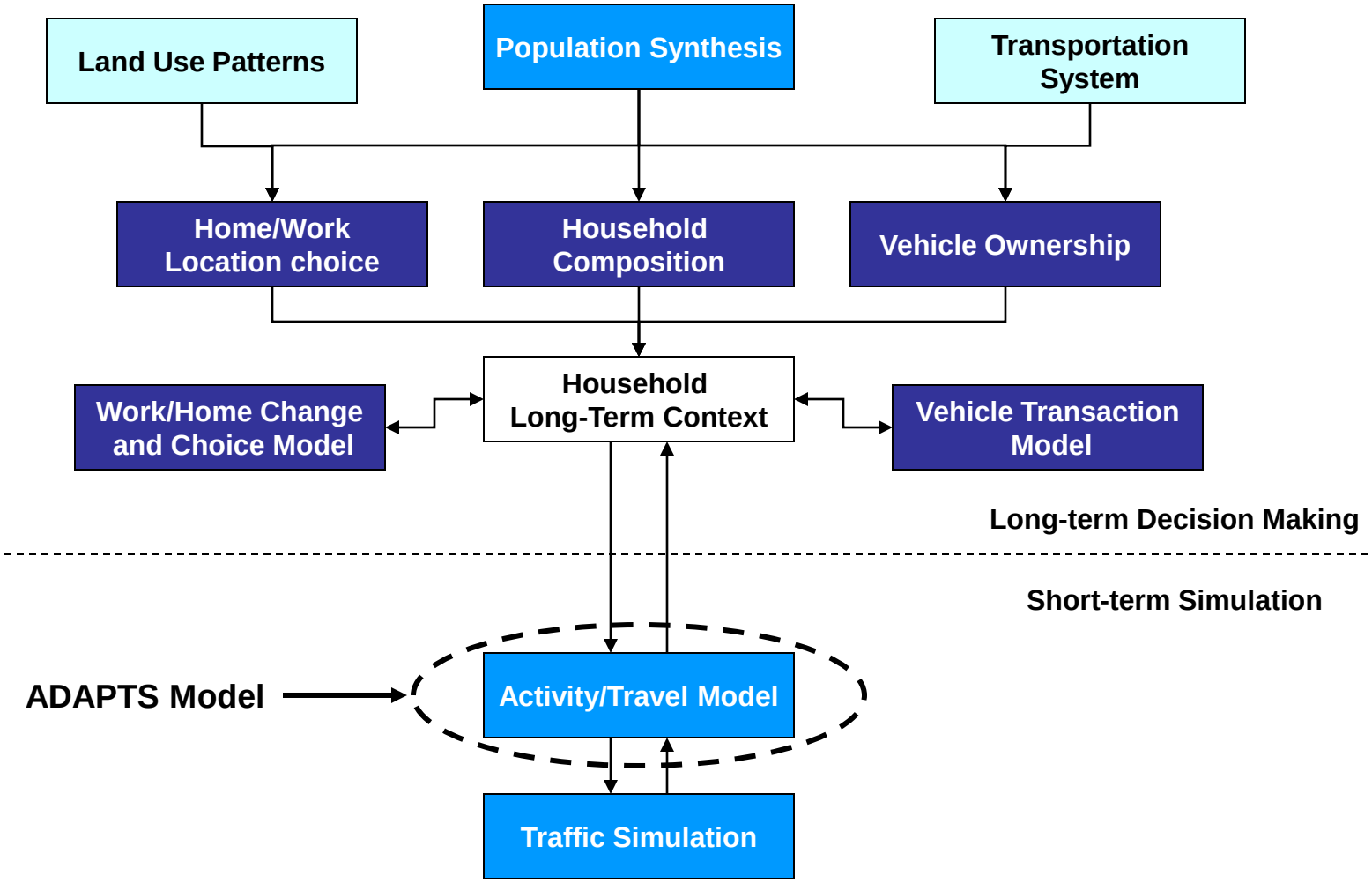
- When and how activity planning decisions are made can impact final daily activity pattern
  - In example, both situations start with same pattern
  - Small policy change creates large differences in pattern, depending only on activity planning
- ADAPTS: adds element of activity planning, to activity generation and activity scheduling
  - Simulation of planning steps
- Account for planning dynamics
  - when is each decision made in relation to other decisions, activities, schedule, etc.
- Represent pattern level changes from impacts of policies on planning dynamics at individual level

ADAPTS Model Framework

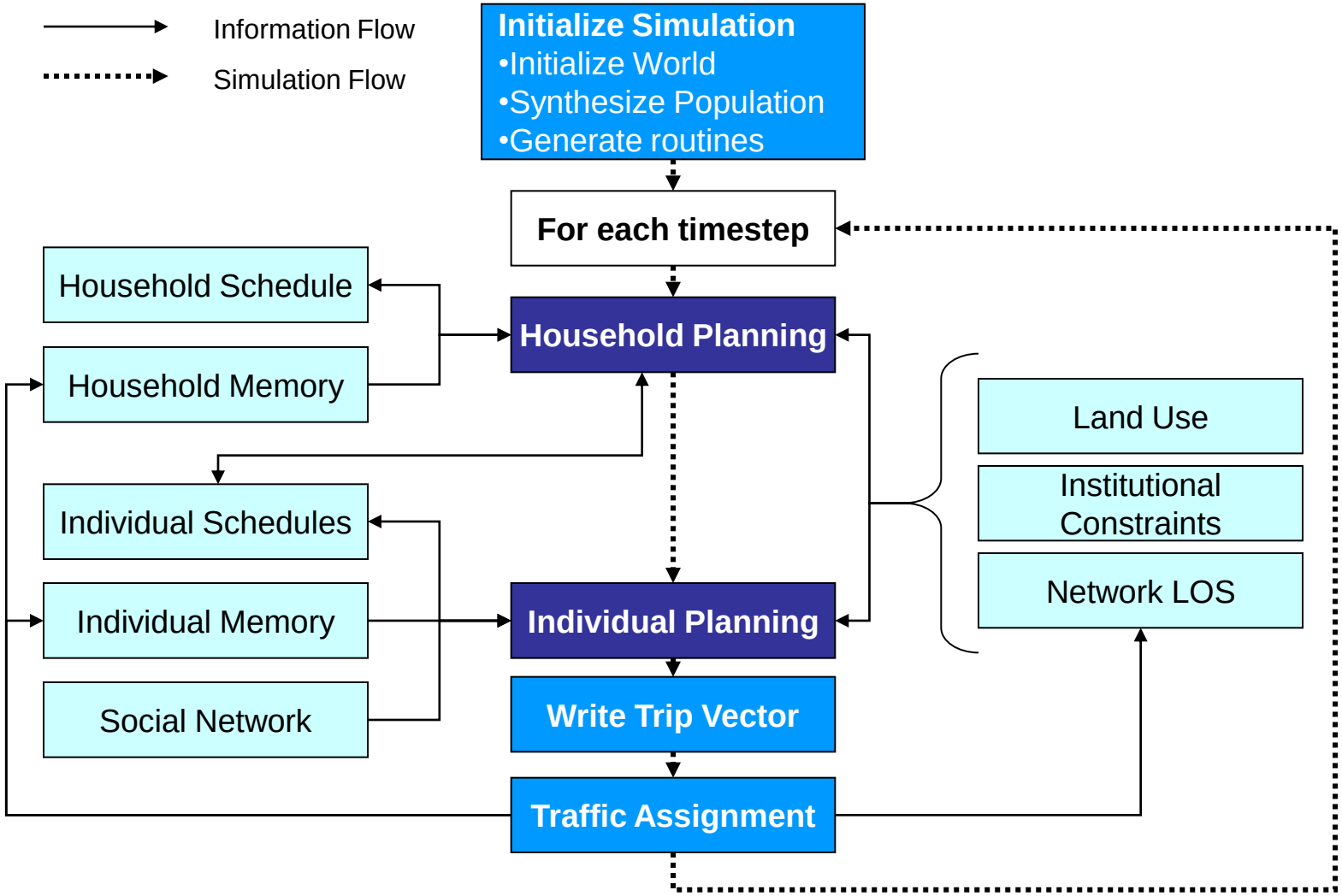
Framework - Introduction

- ADAPTS scheduling process model:
  - Simulation of how activities are planned and scheduled
  - Extends concept of “planning horizon” to activity attributes
  - Time-of-day, location, mode, party composition
- Fits within overall framework of activity-based microsimulation model
  - Constraints from long-term simulation (land-use model)
  - Combined with route choice and traffic simulation
- Models being generated for Chicago region
  - Datasources: UTRACS (GPS) Survey, CMAP household travel survey, CMAP land-use database, Census 2000, CHASE, etc.

Overall Integrated Land-Use Transportation Model Framework

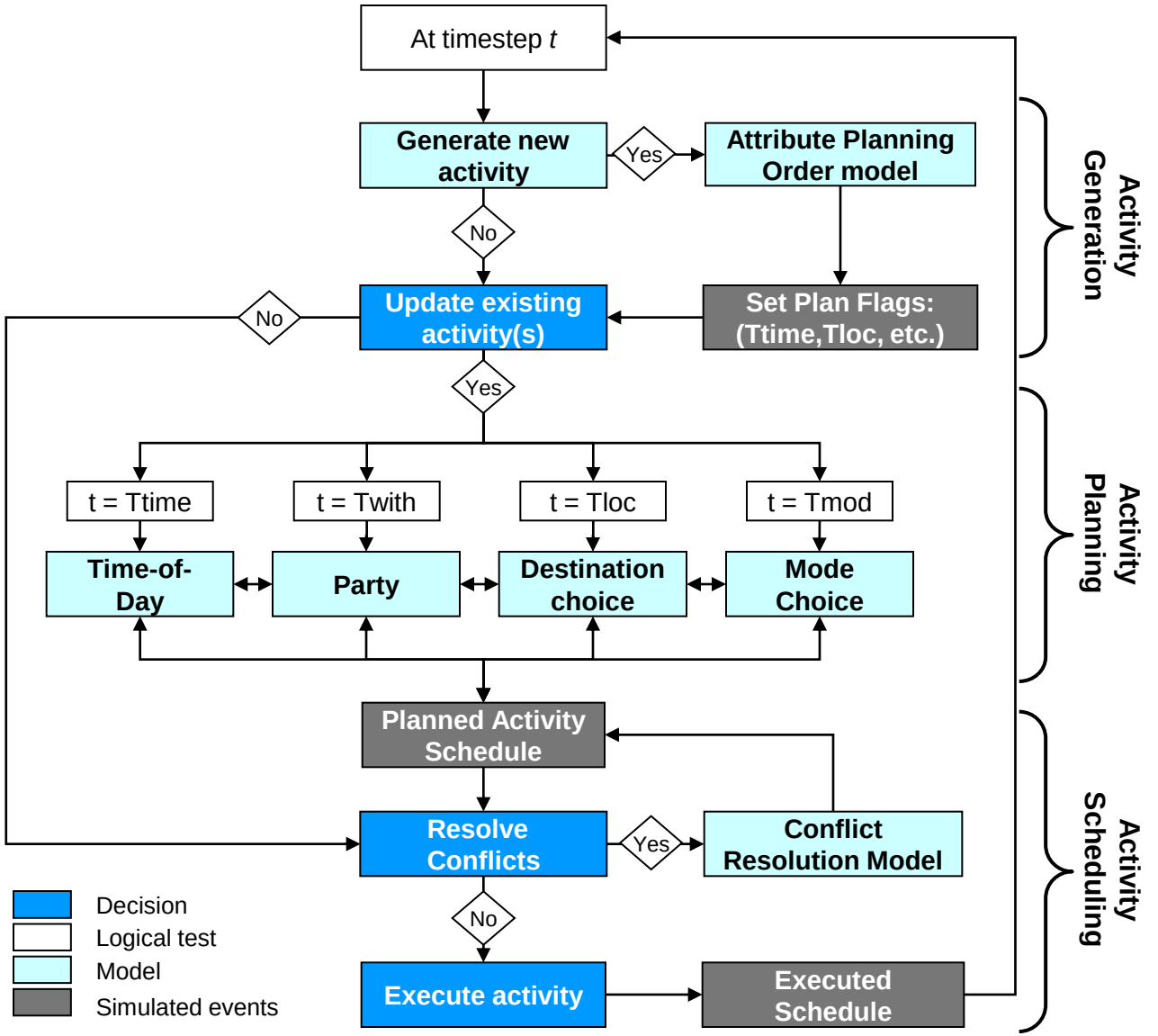


ADAPTS Simulation Framework

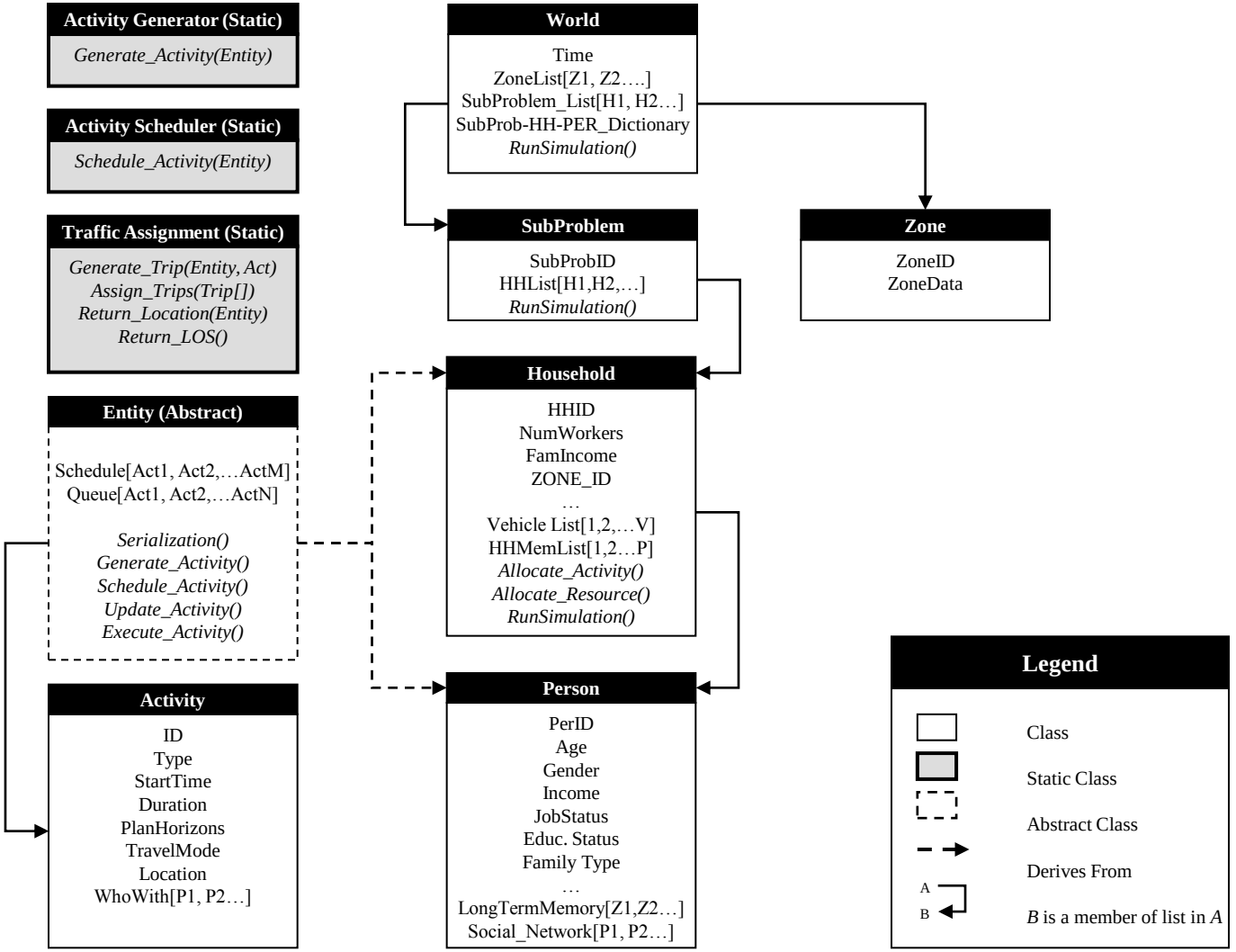


ADAPTS Planner/Scheduler

- ADAPTS planning and scheduling framework
- Handles at each timestep:
  - Generation
  - Planning
  - scheduling
- Generation, planning and scheduling can occur at different times for same activity
- Core of the framework is the *Attribute Plan Order Model*



Framework: C# Simulation Objects



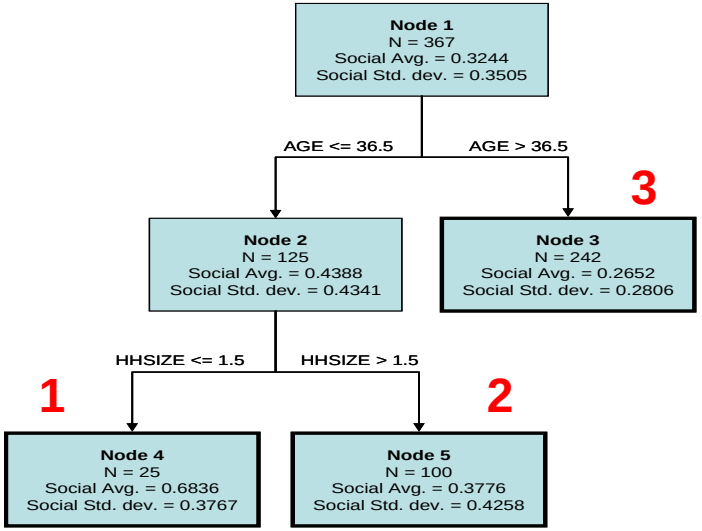
Completed Components of ADAPTS

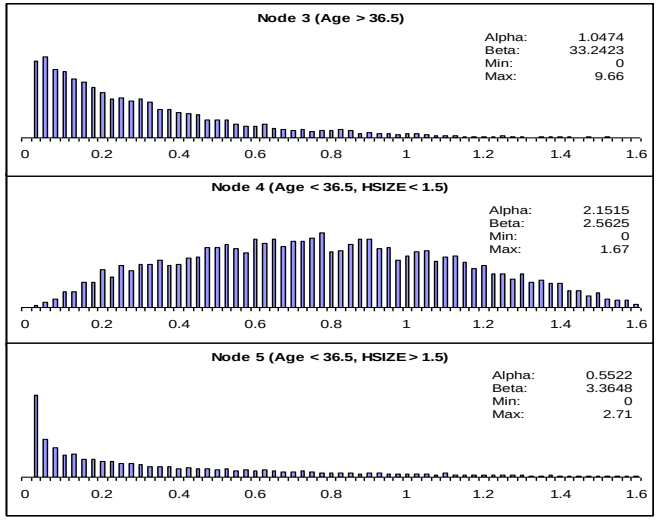
- Rest of discussion will focus on core components of ADAPTS which have been completed
  - Activity Generation
  - Activity Planning Strategies
  - Attribute Planning (Destination Choice)
  - Activity Scheduling

Activity Generation

Activity Generation

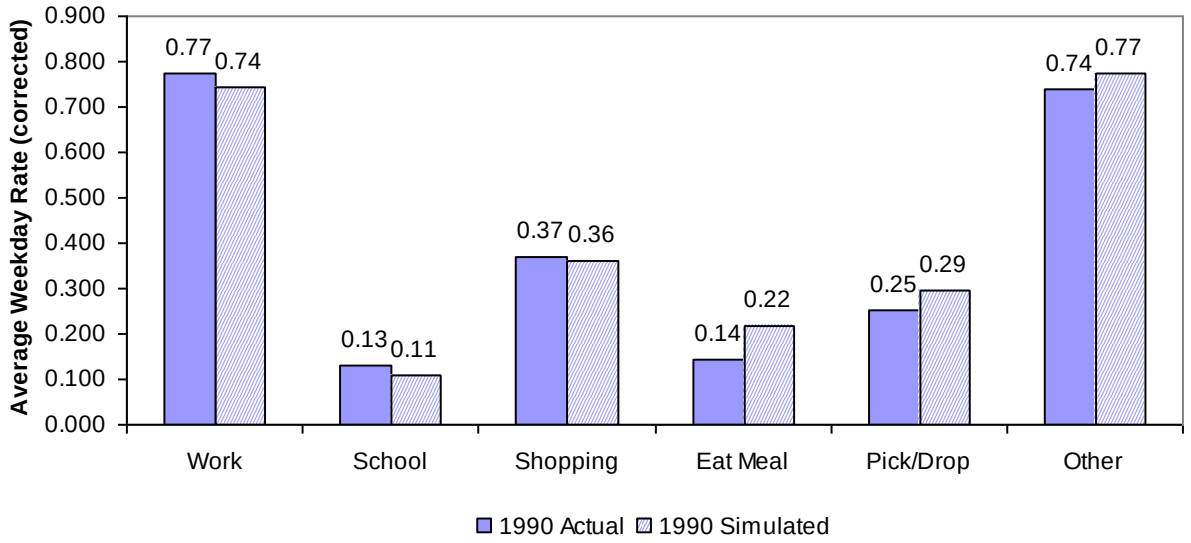
- Activity generation through set of decision trees
  - Classify HH/Person by socio-demographics
- Generation rates drawn from probability distribution fit at each node
  - Distributions estimated from 7-day CHASE data
  - Fit to Chicago 1-day survey through updating





Activity Generation

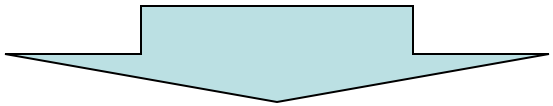
- Application to Chicago-region
  - Calibrated to 2007 data
  - Backcast validation to 1990 HHTS
  - Validated by activity-type, HH Type, etc.
- Currently updating to include generation dynamics
  - System of simultaneous hazard equations for generation



Activity Planning Strategies

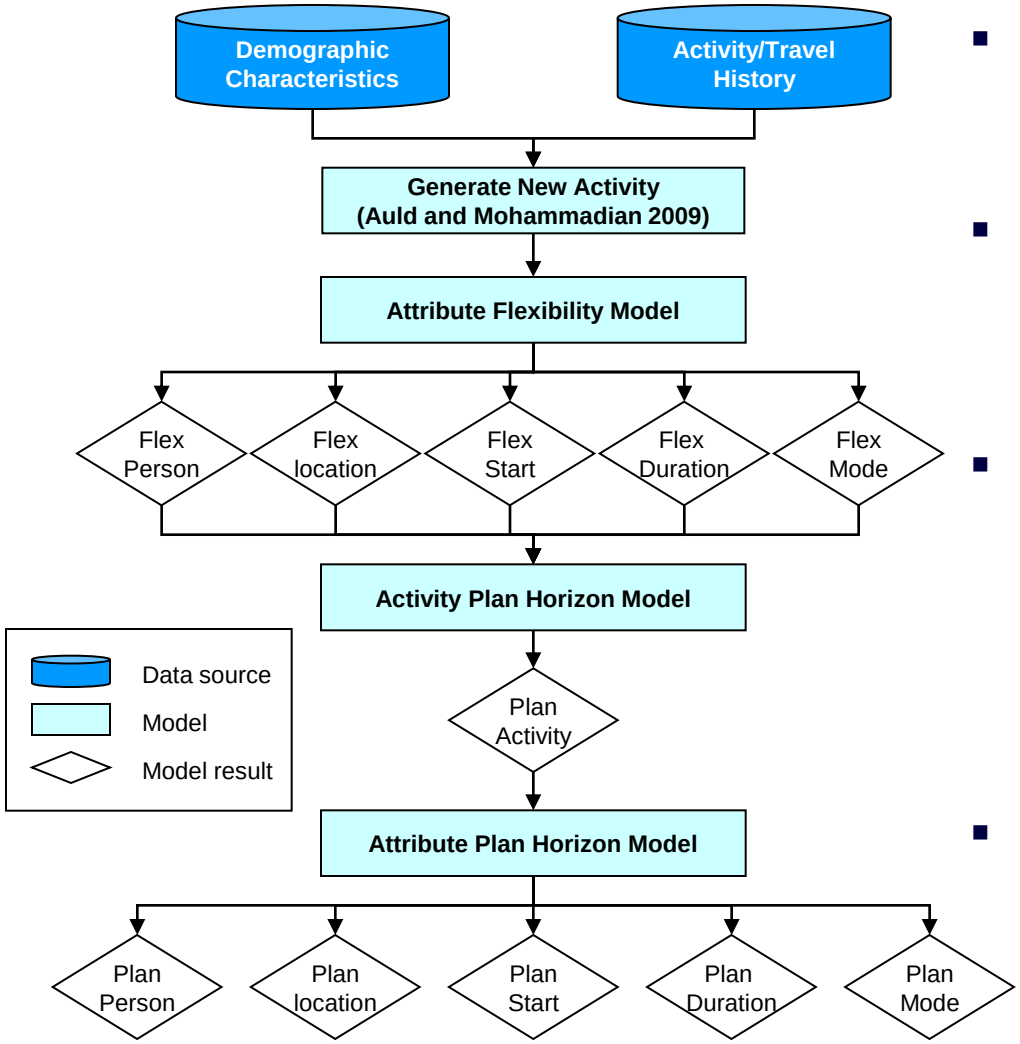
Activity Planning in ADAPTS

- Activities generated and planned dynamically
- Conditional decision making, dependent on
  - Past history
  - Current plans
  - Situation/resource/capacity/household constraints
- Need to know when activities/attributes are planned



- Activity planning order model
  - General categories of when activity generation and attribute planning occur in the schedule

Activity Planning Order Framework



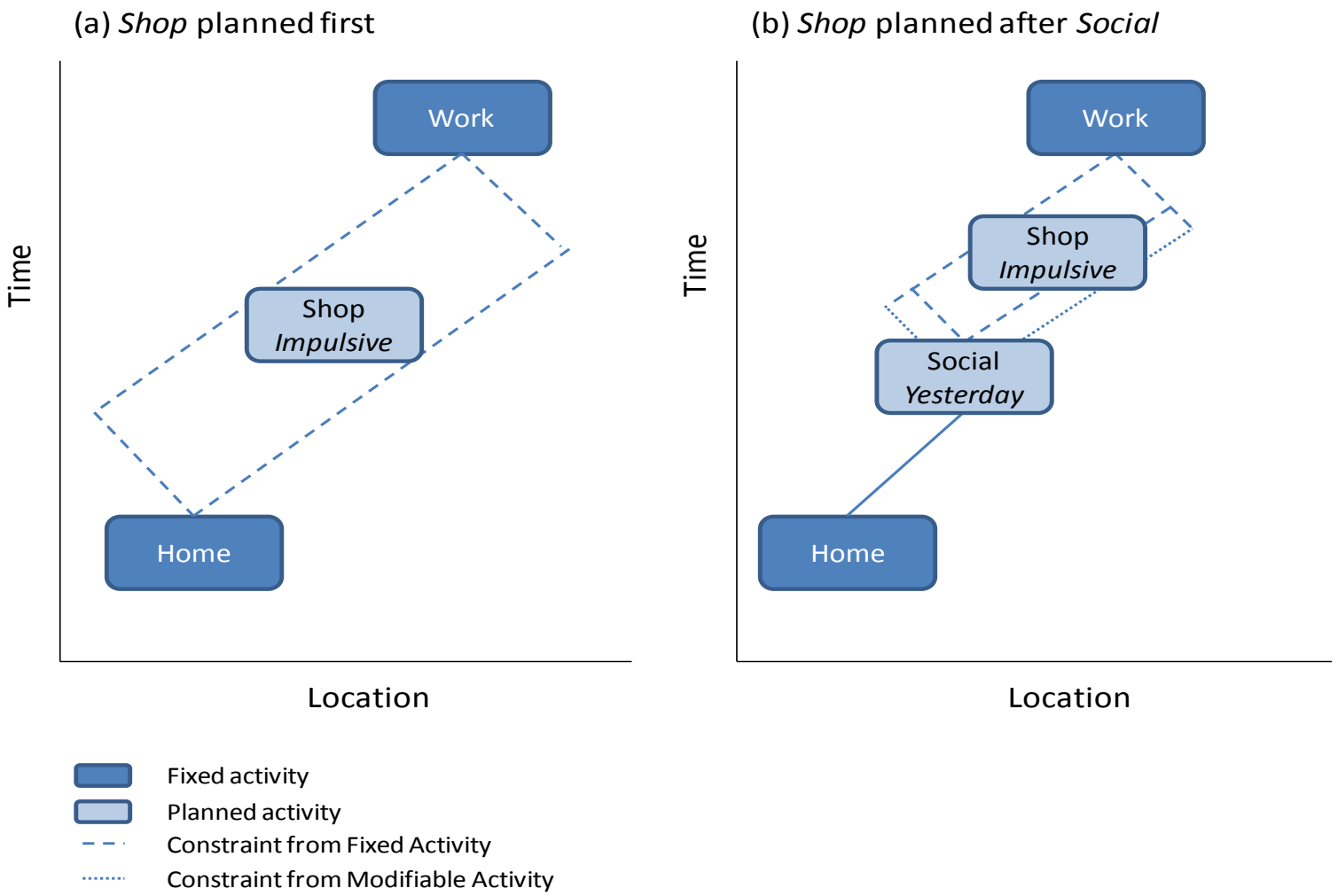
- Assign plan horizon to each attribute
  - After activity generated
- Plan order model process
  - Assigns attribute flexibility
  - Get activity plan horizon
  - Attribute plan horizons
- Plan horizons for each attribute based on:
  - Attribute flexibilities
  - Activity plan horizon
  - General activity attributes
  - Socio-demographics, etc.
- Defines the *meta-attributes* of the activity attributes

Planning Models Discussion

- Estimated set of ordinal/multivariate probit models
  - All models have acceptable goodness of fit
  - Significant improvement over null models
  - Generally have parameters significant at 0.05 level
- Determines how activity flexibility/plan horizon impact attribute planning
  - More expected planning/scheduling effort => more preplanning
- Includes policy sensitive variables relating to:
  - Telework and flex scheduling
  - ICT usage rates
  - Generalized travel costs
  - Endogenous scheduling variables (average frequency, duration)

Destination Choice Modeling

Planning Constrained Destination Choice



Destination Choice (continued)

- Choice set formed using plan-constrained prism
  - Importance sampling (on travel time, employment totals) from available zones
  - Clearly requires planning data to determine choice set
- Use variety of Competing-Destinations model:

$$V_{in} = \beta_T T_{in} + \beta_I ln(I_{in}) + \beta_R R_{in} + \sum_j^J \beta_j \ln(A_{ij}) + \sum_k^K \beta_k \ln(E_{ik}) + \sum_k^K \theta_k C_k + \ln\left(\frac{1}{p(i)}\right)$$

Where,

A_{ij} = Land use variables

E_{ij} = Employment variables

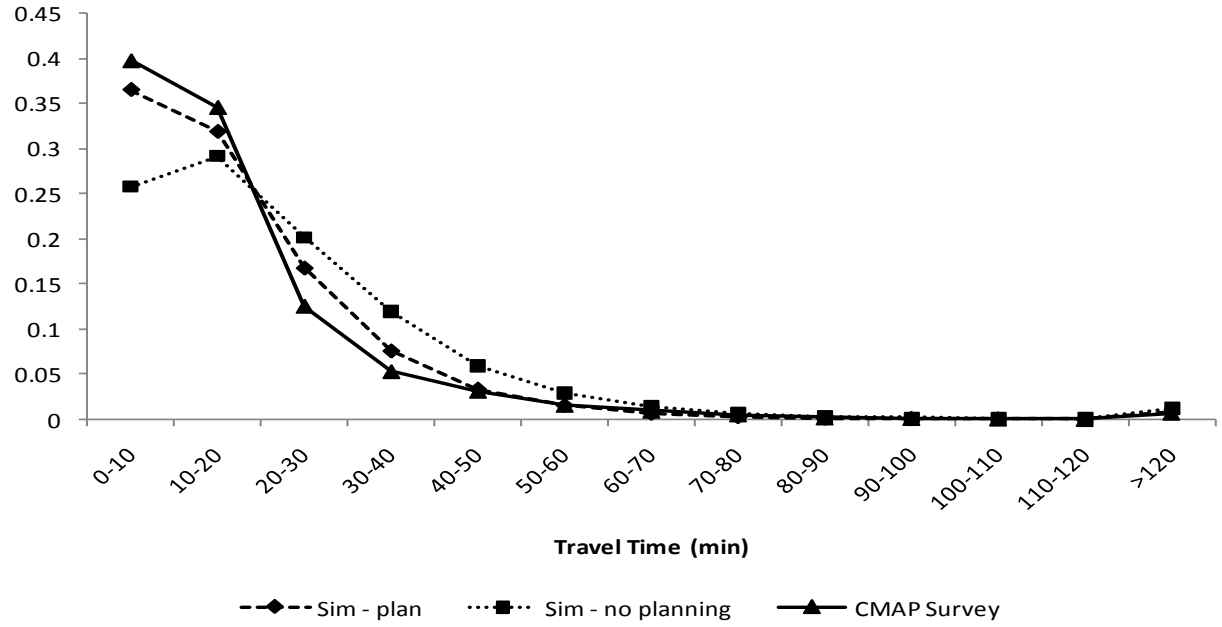
C_k = Competition/Agglomeration factor

$p(i)$ = Probability of zone being selected into choice set

$$C_k = \left(\frac{1}{N_{zone} - 1} \sum_{l \neq i}^{N_z} e_{lk} \, \mathrm{e}^{\frac{-d_{il}}{\gamma}}\right)$$

Destination Choice - Validation

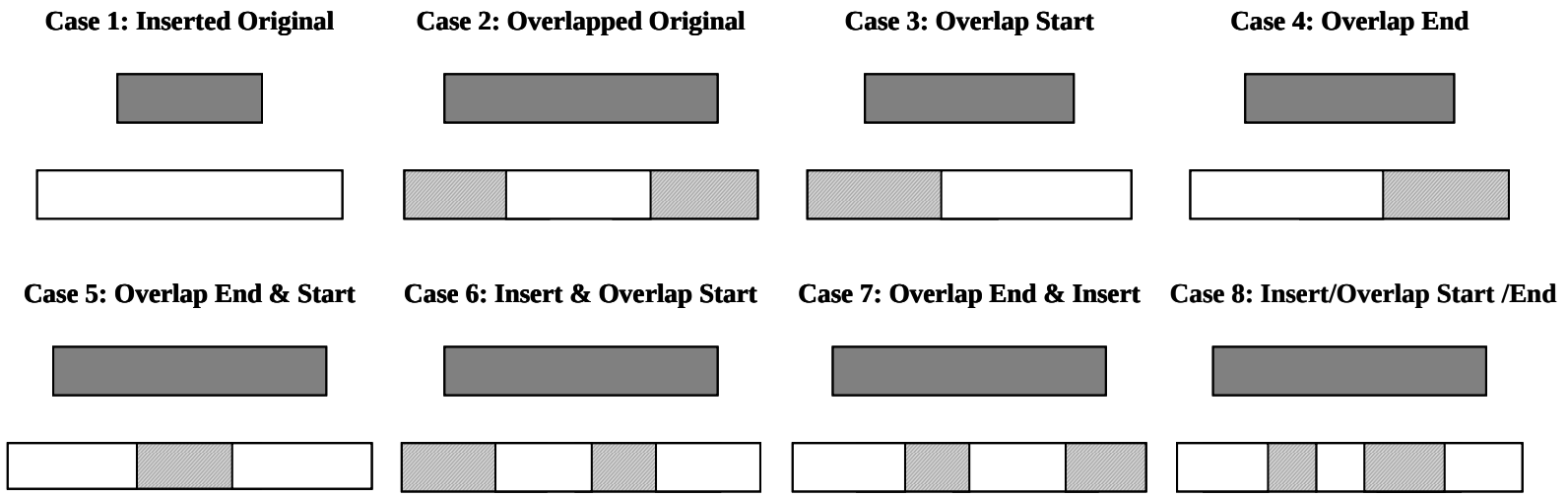
- Model estimated for Chicago using 2007 HHTS data
  - Simulated planning data using plan order model
- Compared to same model with no planning constraints on choice set formation
  - Trip time distribution much closer for plan constrained model
  - Higher aggregate R^2 (0.602 vs 0.571) over all activities



Activity Scheduling

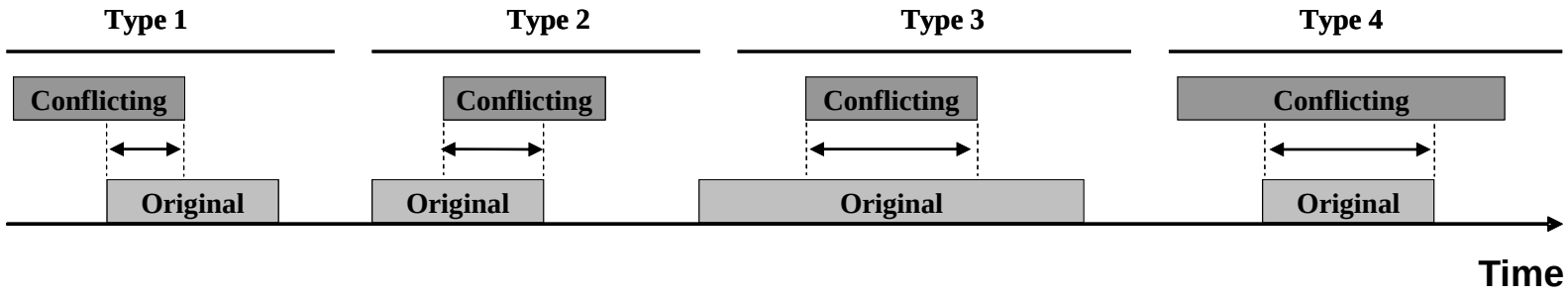
Scheduling – Overall System

- Rules for adding activity to existing schedule
- Based on conflict resolution model
  - Resolution strategy determines rules followed
- For all situations show below:
  - Determines how schedule is modified
  - Based on available time, act. type, resolution type, etc.
  - Insert new activity or drop depending on results



Scheduling - Conflict Resolution

- Due to dynamic nature of scheduling, conflicts naturally arise
  - Timing, location, resource
- Conflict resolution model chooses strategy for resolving conflict
  - Currently only for timing
  - Uses decision trees
  - Strategies based on demographics, constraints, schedule characteristics, etc.



Conclusion

Discussion and Conclusions

- ADAPTS framework represents dynamics of activity planning
  - Dynamic activity generation (when completed)
  - Conditional attribute planning (from plan order model)
- Plan order model sets when decisions about planning made
  - Correlated responses give more realistic planning order
  - Linked directly to key policy variables
  - Allows conditional attribute planning
- Flexible activity scheduling with conflict resolution
  - No predetermined order of activities entering schedule
- Future work:
  - Integration of plan horizon responses to simulation time
  - Development of rest of attribute models
  - Test impact of planning behavior changes on travel demand
  - Link to traffic simulation/assignment

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Thank You!

Questions?

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Integrative Graduate Education and Research Traineeship

IGERT Ph.D. Program in Computational Transportation Science