FSUTMS MODELING TRAINING SERIES

FSUTMS Executive Summary Modeling Seminar

FORECASTING AND TRENDS OFFICE
FLORIDA DEPARTMENT OF TRANSPORTATION

AGENDA

- Workshop Introduction
- What is a “Travel Demand Model”?
- Who uses travel demand models and what are they used for?
- How do models work?
- How do I know if I have a good model?
- What do we need to develop and use models?
- Evolving trends in modeling

SEMINAR OBJECTIVES

- Provide an understanding of what travel demand models are and how they are used in Florida as tools to help planners address planning analysis needs
- Provide a basic understanding of travel modeling using FSUTMS*, how it works, and the information that can be obtained from model results

* **FSUTMS, Florida Standard Urban Transportation Model Structure,** is a computerized transportation planning model package developed by the Florida Department of Transportation and Florida's Model Task Force

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TRAINING OPPORTUNITIES

- http://www.fsutmsonline.net/online_training/index.html
- FSUTMS Executive Summary Modeling Seminar
- FSUTMS Comprehensive Modeling Workshop
- Python for Transportation Modeling
- Advanced Python Programming: Choice Modeling

CONTINUING EDUCATION CREDITS

- P.E.
  - Include P.E. number on attendee list and self-report your credit hours

KNOWLEDGE SHARING OPPORTUNITIES

- Florida Full Model Task Force (MTF) (annually)
- MTF Committees
  - Model Advancement
  - Data / Geographic Information Systems (GIS)
  - Transit
  - Freight

KNOWLEDGE SHARING OPPORTUNITIES (CONT'D)

- FSUTMS Users Groups
  - Central Florida Transportation Planning Group (CFTPG)
  - Southwest Florida FSUTMS Users Group
  - Panhandle Transportation Applications and FSUTMS Users Group
  - Northeast Florida Transportation Applications Forum
  - Southeast Florida FSUTMS Users Group
  - Tampa Bay Transportation Applications Group (TB-TAG)

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What is a Travel Demand Model?

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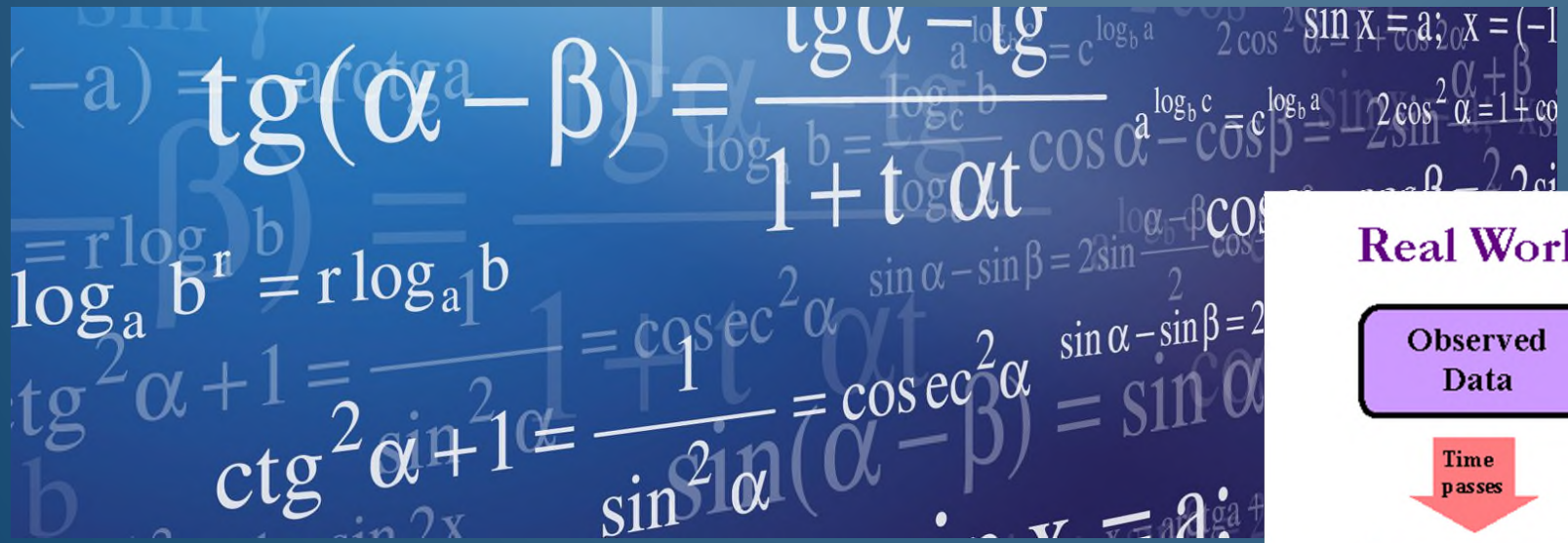
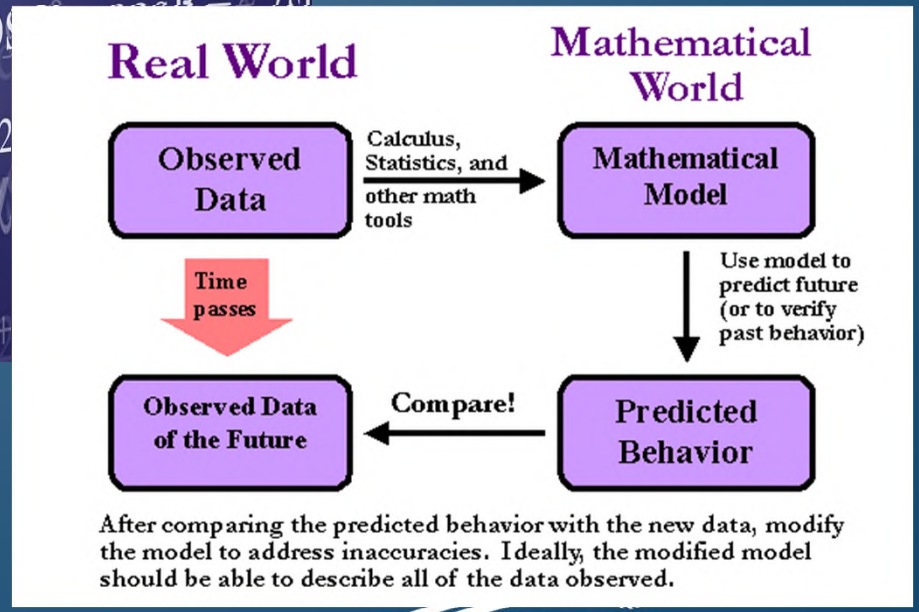
THIS SECTION:

- What a model is (and what it isn't)?
- Elements of travel models
- The model development process

WHAT IS A MODEL?

A schematic description of a system that accounts for its known properties and may be used for further study of its characteristics





A TRAVEL DEMAND MODEL …

- … takes a set of available *input data* …
- … and converts it to a set of *output data*, needed for planning analyses …
- … using a set of *mathematical formulations*…
- … which use *parameters* to perform the conversions

WHAT A MODEL IS…AND IS NOT

- A model is…
  - An analytical tool to provide important information to planners
  - A means to quantitatively estimate the effects of transportation planning, policy, or investment decisions—or external factors—on transportation demand
- A model is not…
  - A crystal ball—it does not predict the future
  - A way to get "the answer" on a planning decision

PLANNING TERMS

- Transportation planners may use the terms modeling and forecasting interchangeably as "**Travel Demand Modeling**" or "**Travel Demand Forecasting**"
- A ***travel demand model*** is a mathematical description of how a transportation system's characteristics—including land use, transportation network, and number and type of travelers—affect the use of the system

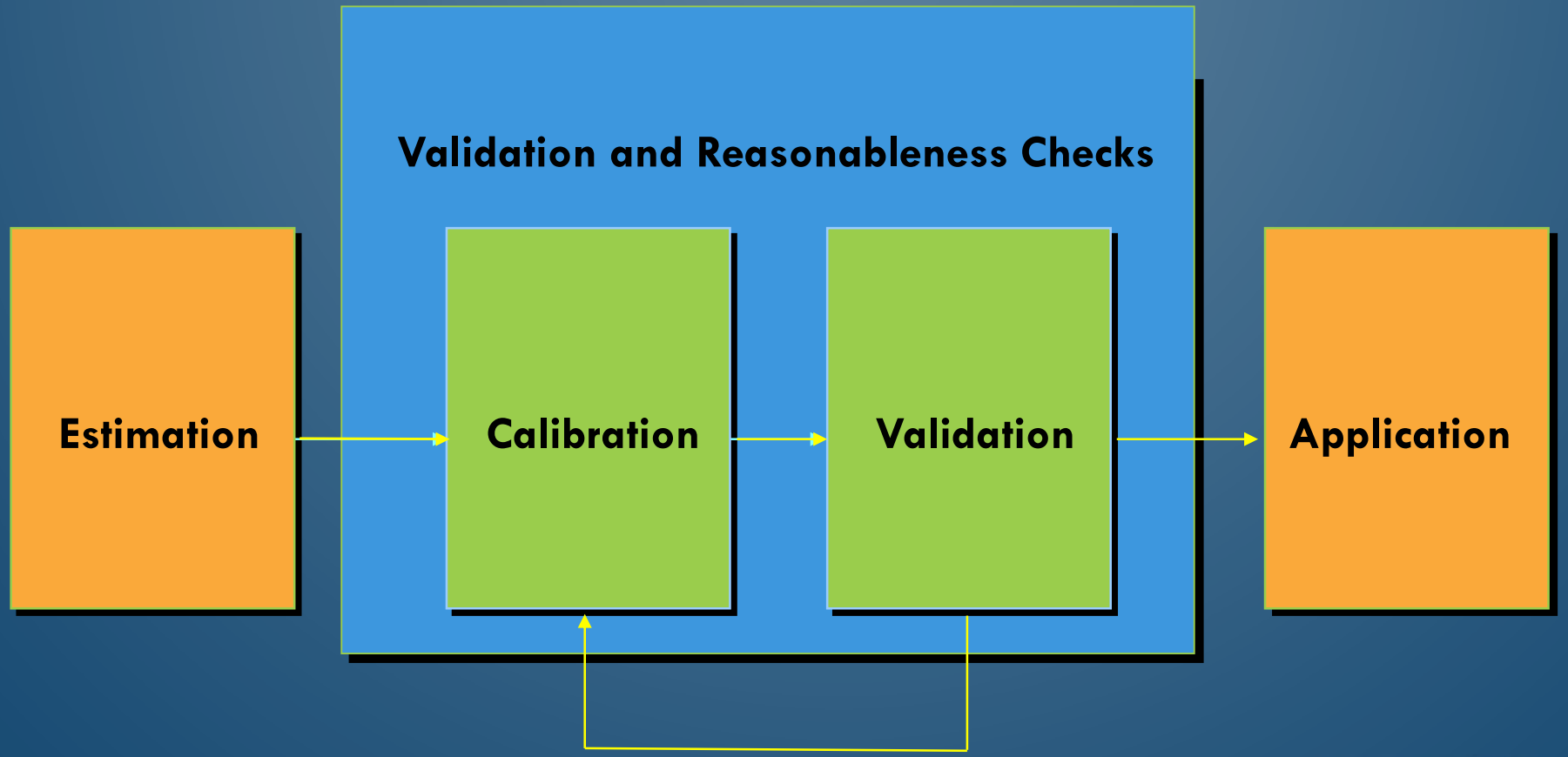
BASIC ELEMENTS OF A TRAVEL MODEL

- The ***Model*** is the various mathematical relationships, equations, and data which reflect travel behavior and relate the input data to the output data
- The ***Software*** is the platform to implement the mathematical computations

MODEL INPUT AND OUTPUT DATA

- Input data
  - Highway and transit networks
    - Highway time and distance, capacities, tolls, etc.
    - Transit in-vehicle/walk/wait time, fare, transfers, etc.
  - Socioeconomic/land use data (population, employment, etc.)
  - Non-residential travel demand
  - Other (e.g., auto operating costs)
- Output data
  - Trips by mode, time of day
  - Roadway volumes
  - Transit line volumes and station boardings

THE MODEL DEVELOPMENT PROCESS



MODEL DEVELOPMENT – GETTING STARTED

1. Define requirements
   - Extent of the model region
   - What the model will be used for (more later)
2. Determine what scenarios are needed initially (base year, forecast years)
3. Determine the overall structure of the model
   - What are the components?
   - What needs to be included (next slide)
   - Which mathematical forms will be used for the components
4. Identify data sources
   - For model estimation
   - For model validation
   - For model application

WHAT NEEDS TO BE INCLUDED

- Types of travel
  - Travel by residents of the region (commuting, school, shopping, social, recreational, etc.)
  - Travel related to uncommon features in the region (airports, seaports, major universities, recreational attractions, etc.)
  - Travel into, out of, through the region ("external travel")
  - Travel by visitors to the region
  - Freight movements, other trucks/commercial vehicles

WHAT NEEDS TO BE INCLUDED

- Modes of travel
  - Autos
  - Trucks
  - Public transportation
  - Walking
  - Bicycling
  - TNCs (Uber, Lyft)
  - Taxis
  - Shared mobility
  - Connected/autonomous vehicles

MODEL DEVELOPMENT – GETTING STARTED (CONTINUED)

5. Define Transportation Analysis Zones (TAZ)

   IN MOST CASES, A PREVIOUS MODEL VERSION WILL PROVIDE THE STARTING POINT

6. Get the data together…
   - Model input data – base and forecast years
     - Create networks (highway, transit)
     - Assemble socioeconomic data (more on this tomorrow)
     - Other (e.g., costs)

   IN MOST CASES, A PREVIOUS MODEL VERSION WILL PROVIDE THE STARTING POINTS

7. Model estimation and validation data
   - Surveys
   - Traffic counts
   - Transit ridership counts
   - Big data sources (e.g., LBS, travel time data)

MODEL ESTIMATION

- We have the *input data* and *mathematical formulations*
- We need the *parameters* – How do we get them?
  - Estimate them from observed data using statistical procedures
  - Transfer them from another context
  - Assert them based on experience

MODEL CALIBRATION AND VALIDATION

- Making sure that the model produces reasonable results (validation)
- Adjusting the model as needed to make the results reasonable (calibration)

(more on this tomorrow…)

MODEL APPLICATION

- Running the model to get the results needed for planning analyses
- Requires definition of a "*scenario*"
- *ALWAYS* check model results before using them
- More on using model results later…

IMPORTANT THINGS TO REMEMBER ABOUT MODELS…

- They are simplifications of real behavior

  "All models are wrong, but some are useful"

- Some of the simplifications are aggregations of individual features
- When used in forecasting, they are not "crystal balls"
- There are many areas of uncertainty that cannot be removed from models
  - Data used in model development
  - Data used in model validation
  - Model input data
  - Model parameters
  - Land use/demographic forecasts
  - Changes in behavior over time
  - New transportation modes
  - New technologies

SUMMARY

- We covered:
  - What a model is and is not
  - The process of developing a model

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Who Uses Travel Demand Models and What Are They Used For?

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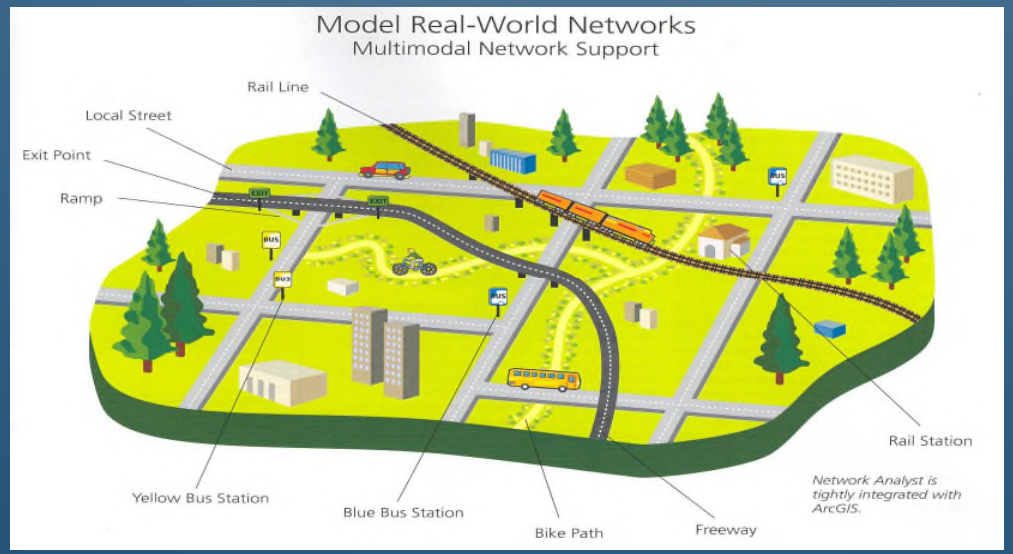
THIS SECTION

- In this section we will learn who uses travel demand models and how they are used in Florida
- We will also give you some examples of model applications



USES OF TRAVEL DEMAND MODELS

- MPO Plan Updates
- Comprehensive Plans
- SIS/FIHS Planning
- Campus Master Plans
- Concurrency Applications
- Congestion Management Systems
- Corridor Studies
- Freight Studies
- Air Quality Analysis
- ITS Evaluation Strategies
- Project Development & Environment (PD&E) Studies
- Interchange Justification/ Modification Reports (IJR/IMR)
- Developments of Regional Impacts (DRIs)
- Toll Feasibility Studies
- Economic Analysis

WHO USES TRAVEL DEMAND MODELS?

- In this section we will look at the following to help you understand who uses travel demand models:
  - Users of Models
  - Level of Expertise Required to Develop and/or Apply the Models
  - Florida's Distribution of the Models
  - Exchange of User Knowledge

USERS OF MODELS

- Metropolitan Planning Organizations (MPOs)
- FDOT District Offices
- Regional Planning Councils (RPCs)
- City and County Planners
- FDOT Central Office (Statewide Model)
- University Staff (Research and Teaching)
- In-State and Out-of-State Consultants
- Florida's Turnpike Enterprise

LEVELS OF EXPERTISE

- **Supervisor/Manager** – Basic understanding of the overall modeling process, how the models are applied, and how the results are used
- **User of Model Results** – Understanding of overall modeling process, including inputs and outputs
- **Applier** – Detailed understanding of modeling process, including the ability to maintain, apply and analyze model outputs for a wide variety of analyses
- **Developer** – Detailed understanding of modeling process and software, including the ability to design, create, and implement new model processes

DISTRIBUTION OF MODELS

- In Florida, the **Regional Models** are normally developed, maintained and distributed by the FDOT District staff or by the Regional Planning Councils with the assistance and support of the MPOs
  - FDOT Central Office participates by facilitating the Model Task Force where model development and usage guidelines are formulated

DISTRIBUTION OF MODELS (CONTINUED)

- Once the model is adopted by the regional planning agencies comprising the local MPOs and other stakeholders in the region, interested planning agencies/consultants can request a copy of the model with a simple request to the distribution agency
  - The model data is distributed free of charge
- The requesting agency/consultants are responsible for any changes made to the model
- FDOT District Offices distribute any regional models by district

OVERVIEW OF FSUTMS SOFTWARE

- FSUTMS, Florida Standard Urban Transportation Model Structure, is a computerized transportation planning model package developed by the Florida Department of Transportation and Florida's Model Task Force
- FSUTMS is used by all 26 Metropolitan Planning Organizations, FDOT Districts, and other planning agencies in Florida

EXAMPLE APPLICATIONS OF MODELS

- Determine impact of specific transportation improvements
- Determine impact of proposed developments
- Determine origin and destination of trips
- Determine the type of trips being made in the region (trip purpose)
- Determine use of truck lanes, High Occupancy Vehicle lanes (HOV), and toll facilities

GENERAL MODEL APPLICATION PROCESS

1. Define the scenario that the model will be used to analyze—for example:
   - LRTP scenario (e.g., 2050 E+C or cost feasible)
   - Proposed transit service change
   - Proposed highway improvement
   - Managed lanes implementation
   - Impacts of DRI

GENERAL MODEL APPLICATION PROCESS (CONT'D)

2. Identify a **base scenario** to which model results for the application scenario will be compared. It may be:
   - The model's validated base year scenario
   - A previously adopted forecast year scenario
   - A "no build" scenario without the changes to model inputs related to the alternative

GENERAL MODEL APPLICATION PROCESS (CONT'D)

3. Define and code the changes to model inputs associated with the scenario
   - Land use/socioeconomic data changes
   - Highway network changes
   - Transit network changes
4. Check results! (to ensure coding and model run were done correctly)
5. Compare results of application scenario to base scenario and check measures of interest

MEASURES OF INTEREST

- Traffic volumes on specific roadways
  - Tabular comparisons
  - Visualizations, e.g., maps showing road volume by bandwidth, or color-coding volume increases and decreases
- Travel times
  - Minimum travel times can be mapped based on shortest distance or congested speed
- Comparing transit ridership systemwide, or by route and station or stop

COMPARING STATISTICS

- Comparing systemwide statistics are useful when determining the impacts of alternatives
- Examples of statistics that may be evaluated include, but are not limited to:
  - Vehicle Miles Traveled (VMT)
  - Vehicle Hours Traveled (VHT)
  - Volume-to-Capacity Ratio
  - Congested Speed
  - Average Travel Times

BE CAREFUL WHEN USING MODEL RESULTS!

- Results from modeling software look very precise—but they're not!
- There is error associated with models and the data used to develop, validate, and apply them
- In some cases, the error may be greater than the differences between the alternative and base scenario results

SUMMARY

- We covered:
  - Who uses travel demand models
  - Levels of expertise
  - Distribution of models and software
  - Model applications
  - Using model results

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Questions and Discussion from Day 1

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Additional Questions from Day 1

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How do models work?

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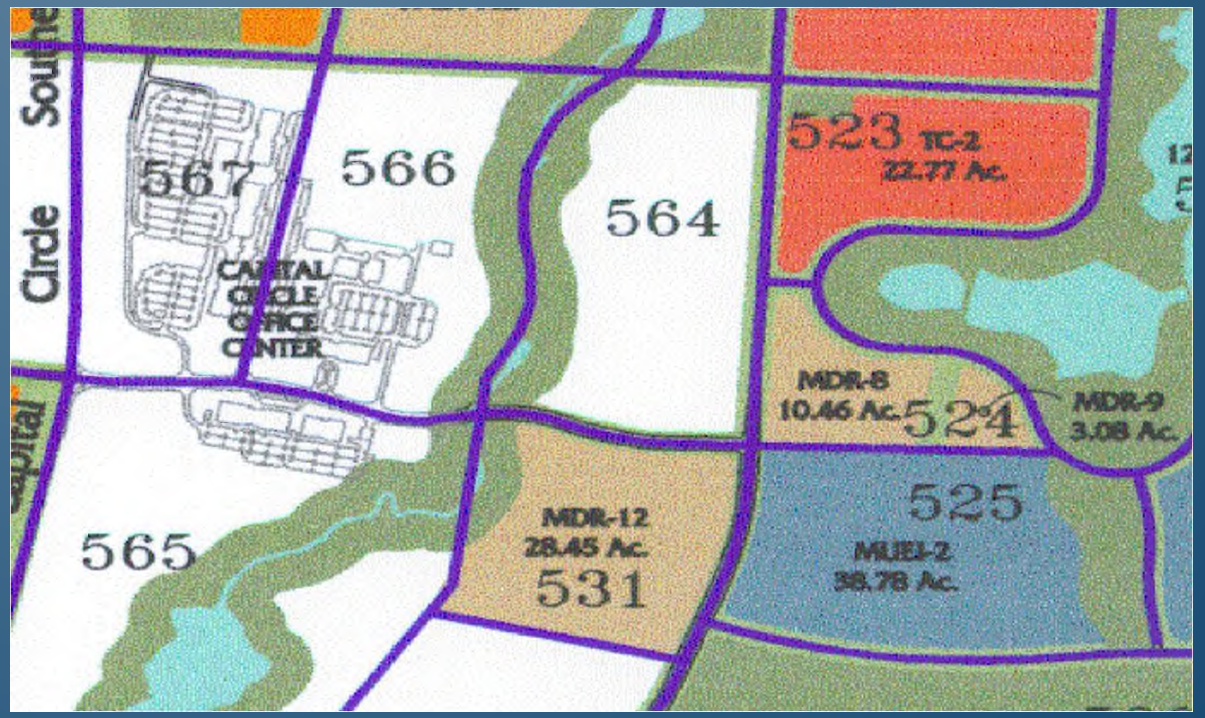
TYPES OF MODELS

- Types of Models by Mode
  - Highway Vehicle Models
  - Multimodal Models
  - Freight or Truck Models
- Types of Models by Geography
  - Regional Models
  - Statewide Models
- Other Tools
  - Sketch planning models
  - STOPS

BASIC CONCEPTS OF MODELS: ZONES

- Model region divided into ***Transportation Analysis Zones*** (TAZ)
- Zone boundaries follow physical, political, and census features
- Trips begin and end at TAZs using ***zone centroids***
- Amount of activity in zones based on households, employment, etc.



BASIC CONCEPTS OF MODELS: TRIPS

- A ***trip*** is a person or vehicle movement from an origin zone to destination zone
- Trips are classified by purpose
  - Why is the trip being made (work, school, shopping, etc.)
  - Is the trip to or from home? If not, is it to or from work? Or between two other locations?
- The model creates ***trip tables*** of zone-to-zone movements:
  - By trip purpose
  - By mode (auto vehicle trips, transit person trips, etc.)
  - By time of day

BASIC CONCEPTS OF MODELS: NETWORKS

- Represent highway and transit systems
- ***Nodes*** represent intersections, transit stops, zone centroids
- ***Links*** represent road segments, transit route segments, centroid connectors
- ***Trip assignment*** loads the trips onto the network to get highway volumes and transit boardings/alightings

THE FOUR-STEP MODELING PROCESS*

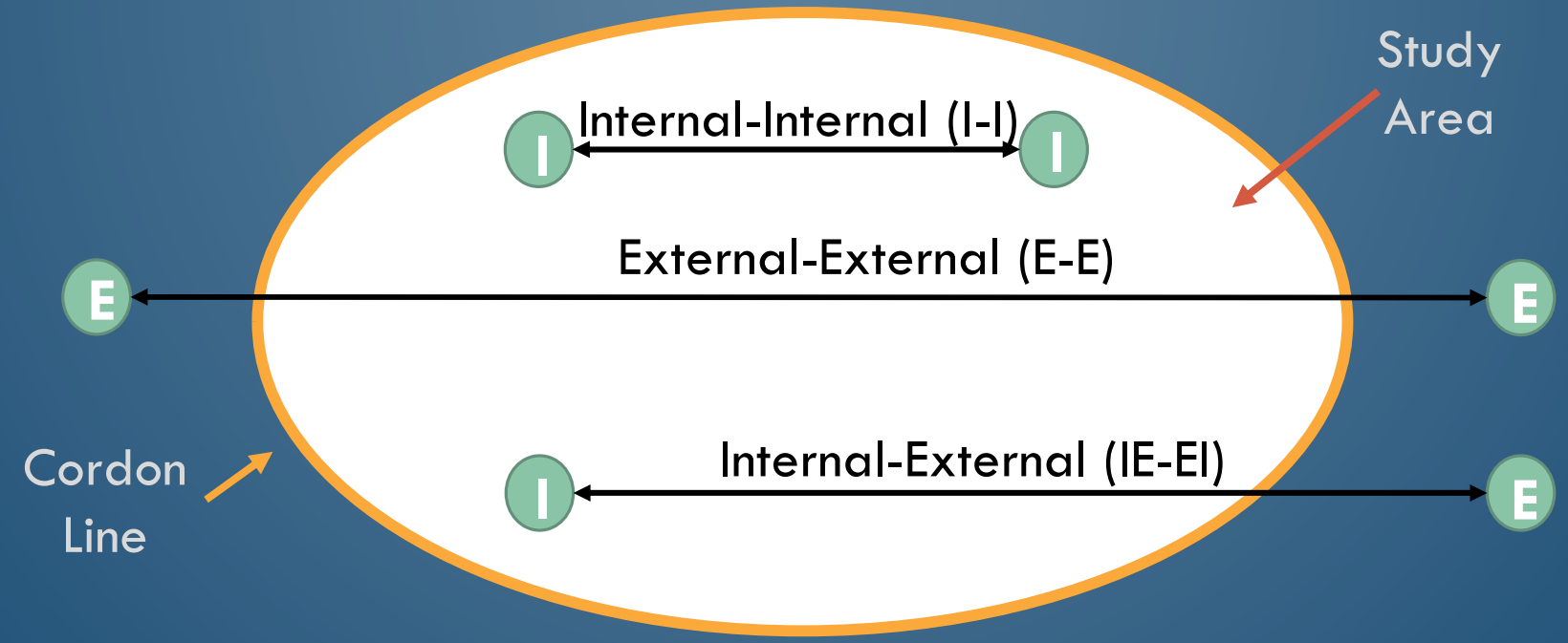
- Traditionally, a travel demand model is structured around the following four sequential steps:
  - **Trip Generation** (How many trips?)
  - **Trip Distribution** (Where to?)
  - **Mode Choice** (Which mode of travel?)
  - **Trip Assignment** (What route?)
- Additional steps commonly include external travel, time-of-day, freight/truck movements, and others

** As distinguished from "activity-based models," to be discussed later*

TRIP PURPOSES

- In general, **trip generation models** are used to predict the number of trips within geographical subareas (zones), usually on for an average weekday and for several trip purposes
- The number of purposes may vary from one area to another, depending on the nature of travel in the area
- The purposes are, at a minimum, divided into home-based work, home-based non-work and non-home-based trips

TYPES OF TRIPS



II Trips have both ends of trip inside the study area

EE Trips have both ends of trip outside the study area

IE-EI Trips have one end inside and one end outside

FSUTMS TRIP PURPOSES – PERSON TRIPS (II)

- Home Based Work (HBW)
- Home-Based School (HBSc)
- Home-Based University (where applicable) (HBU)
- Home Based Shop (HBSh)
- Home Based Social/Recreation (HBSR)
- Home Based Other (HBO)
- Non-Home Based Work (NHBW)
- Non-Home Based Other (NHBO)

FSUTMS VEHICLE TRIPS

- External (at least one trip end outside region)
  - External-External (both ends outside region) (EE)
  - External-Internal/Internal-External (one end inside region) (EI/IE)
- Truck
  - Freight (often mostly external)
  - Non-freight commercial vehicles (e.g., service trucks)
  - May include taxis
- Special generators – region-specific (e.g., airport, theme parks)*
- Visitors (where appropriate)*

* Visitors are sometimes modeled as person trips

TRIP DEFINITIONS

"TRIP ENDS"

- Trip generation models estimate **trip ends** by traffic analysis zone, not **trips** upon the travel network, which may be origins or destinations
- The trip distribution model creates **trip tables** by matching together pairs from each of the two classes of trip ends:
  - **Production** – The home end of a home-based trip or the origin of a non-home-based trip
  - **Attraction** – The non-home end of a home-based trip or the destination of a non-home-based trip

TRIP GENERATION – HOW MANY TRIPS?

Trip Generation estimates the number of trips produced by and attracted to each TAZ, based upon the socioeconomic characteristics (i.e., population and employment) of each zone

TRIP GENERATION EXAMPLE

	SFDU	MFDU
1	xxx	xxx
2	xxx	xxx
3	xxx	xxx
4	xxx	xxx

Household and Population Zone Data

	EMPLOYMENT		
1	xxx	xxx	xxx
2	xxx	xxx	xxx
3	xxx	xxx	xxx
4	xxx	xxx	xxx

Employment Zone Data

SPECIAL GENERATORS				
2	xxx	xx	xxx	xx
3	xxx	xx	xxx	xx

Special Generator Zone Data

TRIP GENERATION

TAZ	PRODS	ATTRS	PRODS	ATTRS
1	xxxx	xxxx	xxxx	xxxx
2	xxxx	xxxx	xxxx	xxxx
3	xxxx	xxxx	xxxx	xxxx
4	xxxx	xxxx	xxxx	xxxx

ADJUSTED

COMPUTING TRIP PRODUCTIONS/ATTRACTIONS

- **Household** – Basic unit for home-based trip productions (dwelling units, apartments, hotel/motels, group quarters)

HBW Prod	0 workers	1 worker	2 workers	3+ workers
0 autos	0	1.0	2.4	5.1
1 auto	0	1.0	2.6	5.1
2 autos	0	1.3	2.6	5.1
3+ autos	0	1.3	2.6	5.1

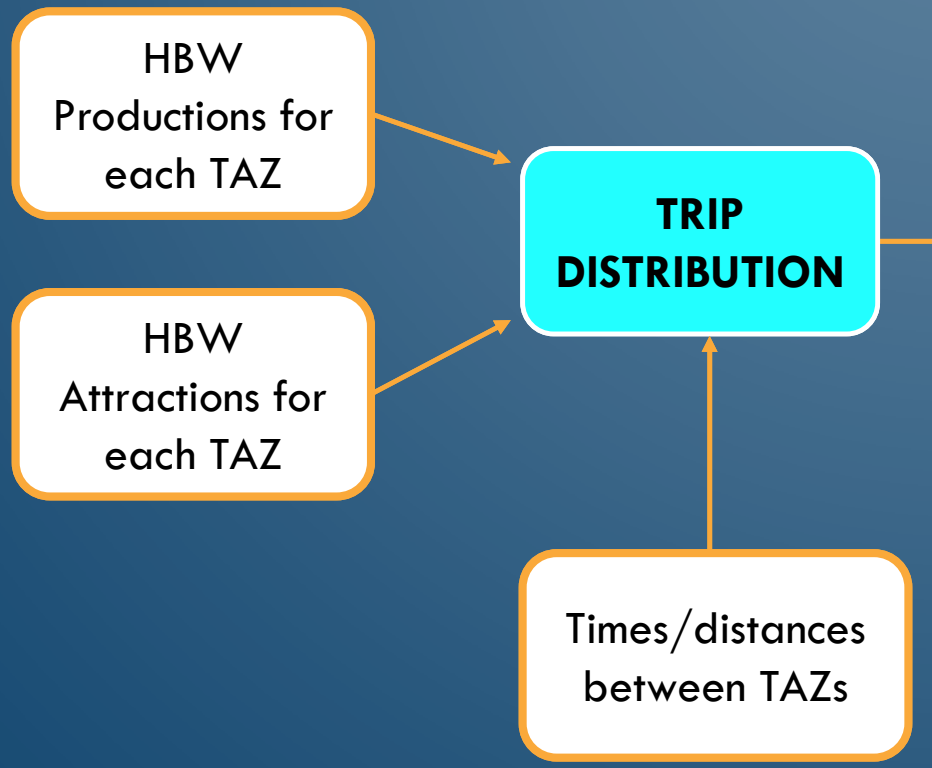
- **Employment** – Basic unit for trip attractions (businesses, factories, plants, office buildings, shopping centers)

HBW Attractions = 1.2 * Total Employment

TRIP DISTRIBUTION – WHERE TO?

Trip Distribution determines the number of trips between each pair of zones based on the amount of activity in each zone and the cost of travel (impedance) between zones

TRIP DISTRIBUTION EXAMPLE – HBW



HBW Person Trip Table

TO

FROM	TAZ	1	2	3
	1	XXXX	XXXX	XXXX
	2	XXXX	XXXX	XXXX
	3	XXXX	XXXX	XXXX

TRIP DISTRIBUTION COMPUTATION

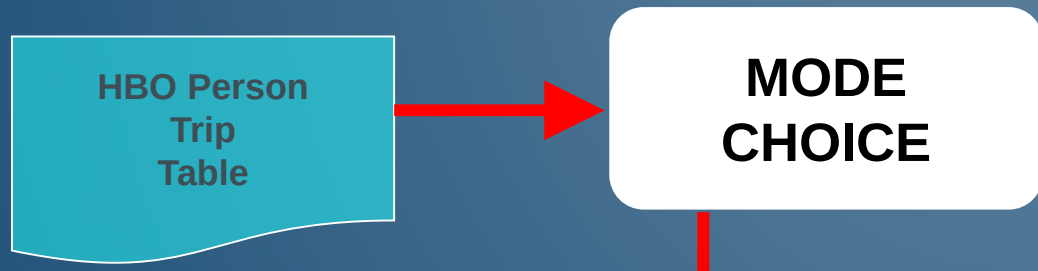
- Trips produced in a zone are distributed to attraction zones based on:
  - How many trips are attracted to the zone
  - The travel impedance between the production and attraction zone (travel time, distance, cost)
- Common functional forms: gravity model, logit model
- Separate computations for each trip purpose

  (because people have different sensitivities to travel impedance when traveling for different purposes)

MODE CHOICE – WHICH MODE OF TRAVEL?

Mode Choice estimates which trips will use the auto, transit, and (increasingly) active transportation modes

MODE CHOICE EXAMPLE - HBO



HBO Transit Person Trip Tables

FROM \ TO	1	2	3	4
1	xx	xx	xx	xx
2	xx	xx	xx	xx
3	xx	xx	xx	xx
4	xx	xx	xx	xx

HBO Auto Vehicle Trip Tables

FROM \ TO	1	2	3	4
1	xx	xx	xx	xx
2	xx	xx	xx	xx
3	xx	xx	xx	xx
4	xx	xx	xx	xx

MODE CHOICE APPLICATION

- Mode Choice application differs by model type:
  - For ***Highway-Only*** applications, mode choice splits auto vehicle trip tables into tables by auto occupancy level (1 occupant, 2, occupants, 3+ occupants)
  - For ***multimodal*** models, mode choice splits person trip tables by mode:
    - Auto trips by occupancy level—converted to vehicle trips
    - Transit trips by submode (access modes, transit types)
    - Non-motorized trips (walk, bicycle)

MODE CHOICE COMPUTATION

- Usually uses discrete choice (logit) formulation
- Probability of each mode being chosen for each O-D zone pair based on:
  - Travel time using the mode
  - For transit, walk access/egress, wait, and transfer times
  - Cost (auto operating, transit fare, parking, tolls, etc.)
  - Land use characteristics of the zones
  - Demographic characteristics (e.g., auto ownership, income level)
- Person trip tables split by mode based on probabilities
- Separate computations for each trip purpose

TIME OF DAY

- Trip generation estimates the number of trips on an average weekday
- In most areas, model results for different periods of the day are useful for planning analyses
- Therefore, trip assignment is performed separately by time period

GETTING TRIP TABLES FOR ASSIGNMENT BY TIME PERIOD

- Define time periods
  - Example: AM peak (6-9 AM), Mid-day (9 AM – 3PM), PM peak (3 PM – 6 PM), Night (6 PM – 6 AM)
- Need to split daily trips into trips by period between steps
  - After trip generation
  - After trip distribution
  - After mode choice

TIME-OF-DAY APPLICATION

- Usually done with factors based on observed data, separately by trip purpose
  - After trip generation – factor daily trip productions and attractions
  - After trip distribution – factor daily person trip tables
  - After mode choice – factor daily person trip tables by mode
- Considerations…
  - Data availability
  - Analysis needs
  - Model run time

TRIP ASSIGNMENT – WHICH ROUTE?

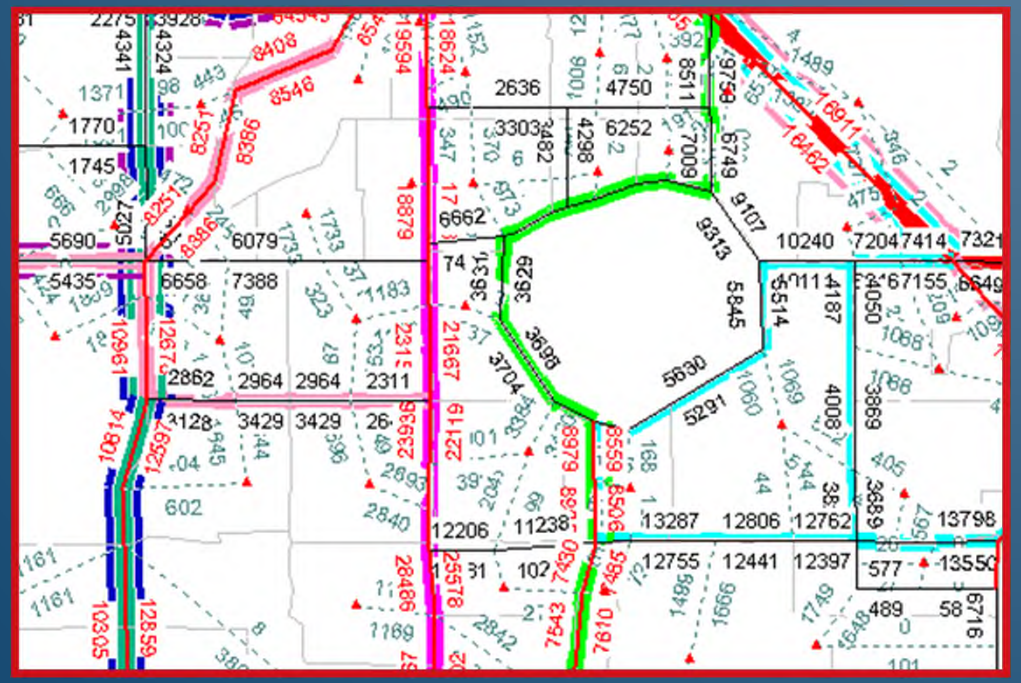
Trip Assignment determines the routes that the trips between each pair of zones will take, accounting for travel times, for each time period

- **Highway assignment** routes vehicle trips on the highway network
- **Transit assignment** routes transit person trips along routes on the transit network

TRIP ASSIGNMENT EXAMPLE (HIGHWAY)

Vehicle Trip Table

HIGHWAY ASSIGNMENT



Network Link Volumes

From Node	To Node	Volume
1001	1002	xxxx
1001	1003	xxxx
1002	1004	xxxx

75

HIGHWAY ASSIGNMENT APPLICATION

- Based on lowest cost paths from origin to destination
  - Cost is mainly highway travel time but considers tolls where applicable
- Considers that congestion affects travel time through relationships among volume, capacity, and speed
- Iterative process to balance out volumes among competing routes

TRANSIT ASSIGNMENT APPLICATION

- Based on shortest cost paths from origin to destination
  - Cost includes in-vehicle travel time, wait time, walk access/egress time, transfers, and fare
- In most applications, all trips are assigned to the lowest cost path (though in some newer models with large transit system, multi-path procedures are used)

HIGHWAY ASSIGNMENT RESULTS

- Link volumes (by time of day)
- Vehicle miles traveled (VMT) and vehicle hours traveled (VHT)
  - By area type, facility type, and number of lanes
- Volume/capacity ratios
  - By area type, facility type, and number of lanes

HIGHWAY ASSIGNMENT RESULTS (CONT'D)

- Free-flow and congested speeds and percent difference
- Additional results used for base year model validation:
  - Root mean square error (RMSE) by volume group (variance)
  - Volume/count ratios by area type, facility type, and number of lanes

TRANSIT ASSIGNMENT RESULTS

- Boardings and alightings by stop and direction
- Estimated number of transfers by mode and route
- Peak period transit vehicle requirements
- Estimated ridership by mode and route by time period

SUMMARY

- We covered:
  - Types of Models
  - Overview of four-step modeling process
    - Trip Generation
    - Trip Distribution
    - Mode Choice
    - Trip Assignment

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How do I know if I have a good model?

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THIS SECTION

- In this section:
  - The model is just one tool for planners
  - Model validation
  - Use of numeric validation guidelines

THE MODEL IS JUST ONE TOOL FOR PLANNERS

- Travel demand models are used as tools and should *not* be considered the "final word" on policy decisions, etc.

  They do not give you "the answer."

- Remember the important things to know about models and the associated uncertainties

- Local knowledge and logic should be applied when considering model results

MODEL CALIBRATION AND VALIDATION

- **Model Validation** is making sure the model is a useful analytical planning tool:
  - Checking model results for the base year (and forecast years)
  - Reasonableness checking
  - Testing the model for appropriate sensitivity to input data
- **Model Calibration** is the adjustment of model parameters to ensure that the model is well validated

WHEN DO YOU NEED TO VALIDATE A MODEL?

- When developing new models from scratch
- At the beginning of a long-range transportation plan update or when updating to a new base year
- After refining all or portions of a model

Models are calibrated and validated to a **base year** to ensure the model is simulating existing conditions

Once the base year model is calibrated and validated, future year models can be developed

MODEL VALIDATION RESOURCES

- FSUTMS Model Validation Guidelines (awaiting adoption)
- FHWA Model Validation and Reasonableness Checking Manual
- NCHRP Report 716
- FHWA Quick Response Freight Manual
- Experience from other models inside and outside Florida

ELEMENTS OF MODEL VALIDATION PROCESS

- Model Validation Plan Specification
- Collection and Assessment of Validation Data
- Validation of Model Components
- Validation of Model System
- Documentation of Validation Results

MODEL VALIDATION PLAN

- Defines validation checks to be done
- Identifies data sources
- Sets guidelines for validation checks
- Describes temporal and sensitivity testing to be done

VALIDATION OF *ALL* MODEL COMPONENTS

- Model input data
- In a four-step model
  - Trip generation (productions and attractions)
  - Trip distribution
  - External travel
  - Mode choice
  - Time of day
  - Trucks
  - Highway assignment
  - Transit assignment

VALIDATION EXAMPLE – INPUT DATA

- Socioeconomic data
  - Review population/household relationships:
    - Average persons/household, workers/household, income levels
    - Distributions of household size, number of vehicles, etc.
    - Compare to Census, ACS or other sources
    - Employment compared to number of workers
  - Review forecasts

Know your region!

- High number of retirees?
- University dominated?
- Large number of commutes from outside region?

VALIDATION EXAMPLE – INPUT DATA

- Networks
  - Highway network
    - Visual checks (GIS)
    - Sorted database checks
    - O-D path time checks
  - Transit network
    - Sorted database checks
    - O-D path time checks
    - Compare paths to survey results

Know your region!

- What are typical speeds?
- Managed lanes?
- How transit is used?

VALIDATION EXAMPLE – TRIP PRODUCTIONS

- Trips per household by purpose
  - Typically 9-12 trips/household
  - 10%-20% HBW, 25%-35% NHB
  - Compare to FSUTMS guidelines, survey data, other regions, national references

Know your region!

- High number of retirees?
- Recreational facilities?
- High or low number of children?

VALIDATION EXAMPLE – TRIP DISTRIBUTION

- Average trip lengths by purpose
- Trip length frequency distribution
- Aggregate O-D checks
- Intrazonal trips
- Compare to FSUTMS guidelines, survey data

Know your region!

- Typical O-D patterns
- Long commutes?
- Orientation of travel

VALIDATION EXAMPLE – MODE CHOICE

- Compare trips by mode and purpose to observed (may need transit assignment results)
- Compare transit O-D patterns to observed
- Compare to FSUTMS guidelines, survey data, ridership counts

Know your region!

- Who uses transit?
- Park-and-ride use
- High active transportation use?

VALIDATION EXAMPLE – HIGHWAY ASSIGNMENT

- VMT checks
  - Compare modeled to observed
    - By facility type
    - By geography
- Volume checks
  - Screenlines
  - Major highways
  - % root mean square error
- Compare to FSUTMS/FHWA guidelines

Know your region!

- Which screenlines define major O-D flows
- How are managed lanes used?
- How accurate are the traffic counts?

USE OF NUMERIC GUIDELINES

- Helpful to assess reasonableness
- Guidelines are not "standards" or pass/fail tests
- Calibration changes made to meet guidelines may reduce the model's sensitivity to key variables (and therefore its usefulness)

SUMMARY

- We covered:
  - Model is just one tool
  - Model validation concepts and process
  - Use of numeric validation guidelines

FSUTMS MODELING TRAINING SERIES

What do we need to develop and use models?

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THIS SECTION

- In this section we will introduce you to things needed to develop and use models:
  - Hardware requirements
  - Data requirements
  - FSUTMS
  - Software requirements

HARDWARE REQUIREMENTS

Differ based on Model type:

- Example: Simple four-step model covering small geography and < 100 zones
  - Typically, Intel Core i5 CPUs
  - At least 4 effective cores
  - 8 GB RAM
  - 200 GB Hard Drive
  - Color Display
  - Windows 7, Windows 10, UNIX, Mac OS

The larger and more complex the model, the higher the minimum requirements

HARDWARE REQUIREMENTS (CONTD.)

- Activity-based model
  - At least 16 effective cores
  - Typically, Intel Core i7 CPUs
  - 32 GB RAM
  - 500 GB Hard Drive
  - Color Display
  - Windows 7, Windows 10, UNIX, Mac OS

The larger and more complex the model, the higher the minimum requirements

DATA REQUIRED TO DEVELOP A MODEL DATA SET

- Much of the data are available free of charge
- Some data require additional agency cost
  - Depends on complexity of model
  - Some local data may be recent enough that it still accurately depicts travel characteristics of the region
  - Sometimes data from comparable regions can be used, but it will not be as accurate as local data

TYPICAL DATA REQUIREMENTS

Data Free of Charge – Included in Developed Models

Data	Categorized by	Source
Population	Single-family, multi-family Hotel-motel occupants	U.S. Census Visitor Data
Dwelling Units	Single-family and multi-family; Percent vacant and percent non-permanent	U.S. Census
Auto Availability	Single-family and multi-family; Percent 0, 1, 2+ vehicles available per household	U.S. Census American Community Survey (ACS)
Hotel-Motel Units	Total hotel-motel units; Percent occupied	Local Chambers of Commerce Department of Business and Professional Regulation
Employment	Industrial, commercial, and service employees by place-of-work	2020 Dun & Bradstreet statewide data purchased by FDOT available free of charge to MPOs

TYPICAL DATA REQUIREMENTS (CONT'D)

Data	Categorized by	Source
School Enrollment	School location	Local School Boards
Parking Cost	Short-term and long-term	Individual paid parking lots/garages Municipalities
Traffic Counts	24-hour and hourly/15-minute traffic counts	County or City Public Works Departments FDOT Traffic Count CD
Roadway Characteristics	Facility type, speed limits, and number of lanes for roads included in model	County or City Public Works Departments Road characteristic inventory Other GIS databases

TYPICAL DATA REQUIREMENTS (CONT'D)

Data	Categorized by	Source
Toll Facility Data (if toll facilities included in model)	Location, type, toll fares, service time, ratio of heavy trucks	Local toll authorities Florida's Turnpike Enterprise
Transit Network Data (if transit network included in model)	Route, stop, and station locations, mode, speed, time, fare, headway, passenger capacity, park & ride locations and capacities, short- and long-term parking cost, walk time from park & ride and kiss & ride to station	Local transit agencies General Transportation Feed Specification (GTFS)

TYPICAL DATA REQUIREMENTS (CONT'D)

Data Requiring Additional Agency Cost

Data	Categorized by	Source
External Trips	Internal-External and External-External by origin/destination zone pairs	Origin/Destination Survey (estimated cost $100k-$200k) Location-Based Service (LBS) data
Trip Production and Attraction Rates	Trip production and attraction rates by trip purpose and attraction rates by employment category, total dwelling units, and school enrollment	Household Travel Surveys (estimated cost $250k-$1M)
Supplemental Traffic Counts	24-hour traffic counts for daily models and by 15-minute intervals for time-of-day models	County or City Public Works Departments or contract with data collection firms (estimated cost $200-$1,000 per location)
Transit Rider Survey Data	Transit O-D patterns, transit trip purposes riders by access mode, transfers	Local transit rider surveys (recommended if more than 5 years old, estimated cost $100k-$200k)

NHTS ADD-ON

- NHTS: National Household Travel Survey
  - National inventory of daily and long-distance travel
  - Only source of information at national level on the relationships between the characteristics of personal travel and demographics of the traveler
  - Sampling Unit – Household and household members
  - Conducted every 5 to 8 years (most recently 2017)
    - The Metropolitan Planning Organization Advisory Council (MPOAC) purchased an add-on to the 2009 NHTS which included additional samples for Florida—some models have used this data in previous updates

AMERICAN COMMUNITY SURVEY

- Annual, rolling survey began in 2005
- 2014-2019 5-Year data released December 10, 2020
- Sampling Unit – Household and Household Members.
- Sample rate ~2%
- Greater geographic resolution with 5-year rolling averages – down to block group level
- See https://www.census.gov/programs-surveys/acs

"BIG DATA"

- Global Positioning System (GPS) tracking data
  - Based on data passively collected from GPS in vehicles (so no respondent error)
  - Very large sample sizes
  - Available from vendors – costs vary depending on amount of data
    - Need to make sure you know how data are collected and what is real vs. imputed
  - Much larger sample sizes than surveys (and often cheaper), can cover longer periods
  - A good source for (vehicle trips only):
    - O-D patterns
    - Time of day
    - Route choices
  - But surveys/LBS are better for:
    - Non-auto/truck modes
    - Detailed demographics of travelers
    - Trip purposes

"BIG DATA" (CONTINUED)

- Location-based service data
  - Based on data passively collected from mobile devices
  - Available from vendors – costs vary depending on amount of data
    - Need to make sure you know how data are collected and what is real vs. imputed
  - Much larger sample sizes than surveys (and often cheaper), can cover longer periods
  - A good source for:
    - O-D patterns
    - Time of day
    - External travel
    - Visitor travel
  - But surveys are better for:
    - Detailed demographics of travelers
    - Trip purposes
    - Mode choices

FSUTMS STANDARDS

- Why have FSUTMS standards?
  - Ensures integrity of model structure
  - Portability of model from one region to another
  - Improves data sharing capabilities
  - Streamlines technical support process
  - Provides a user community
- What do the standards cover?
  - Model structure
  - Trip purposes
  - Data formats and structures*
  - Directory structure and file naming convention*
  - Validation guidelines

* Under review as modeling software is evolving

STATUS OF FSUTMS STANDARDS

- Trip purposes have been adopted by Model Task Force
- Validation guidelines currently under review
- Other standards are pending
- Objectives for additional standards:
  - Accommodate ABM's and other advanced techniques
  - What aspects can be standardized?
  - Does it make sense to have separate standards for separate levels of model complexity?
- Surveys among Florida model users undertaken
  - Reponses used to guide process

SUMMARY

- We covered:
  - Hardware Requirements
  - Data Requirements
  - FSUTMS Standards

FSUTMS MODELING TRAINING SERIES

Evolving Trends in Travel Modeling

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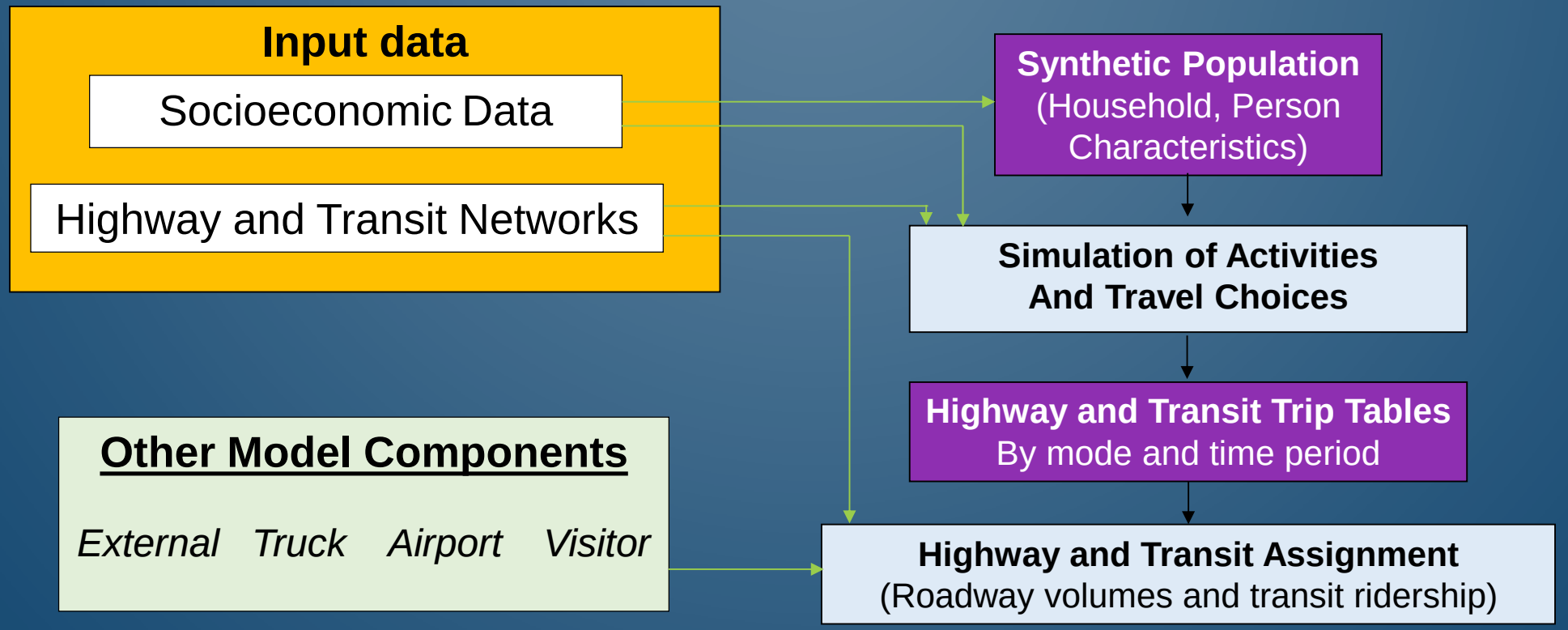
EVOLVING TRENDS IN MODELING

- Activity-based models
- Advanced toll modeling procedures
- Dynamic traffic assignment
- Emerging mobility
- Dealing with uncertainty

HOW AN ACTIVITY-BASED MODEL WORKS



ACTIVITY-BASED MODEL – DISAGGREGATE APPROACH

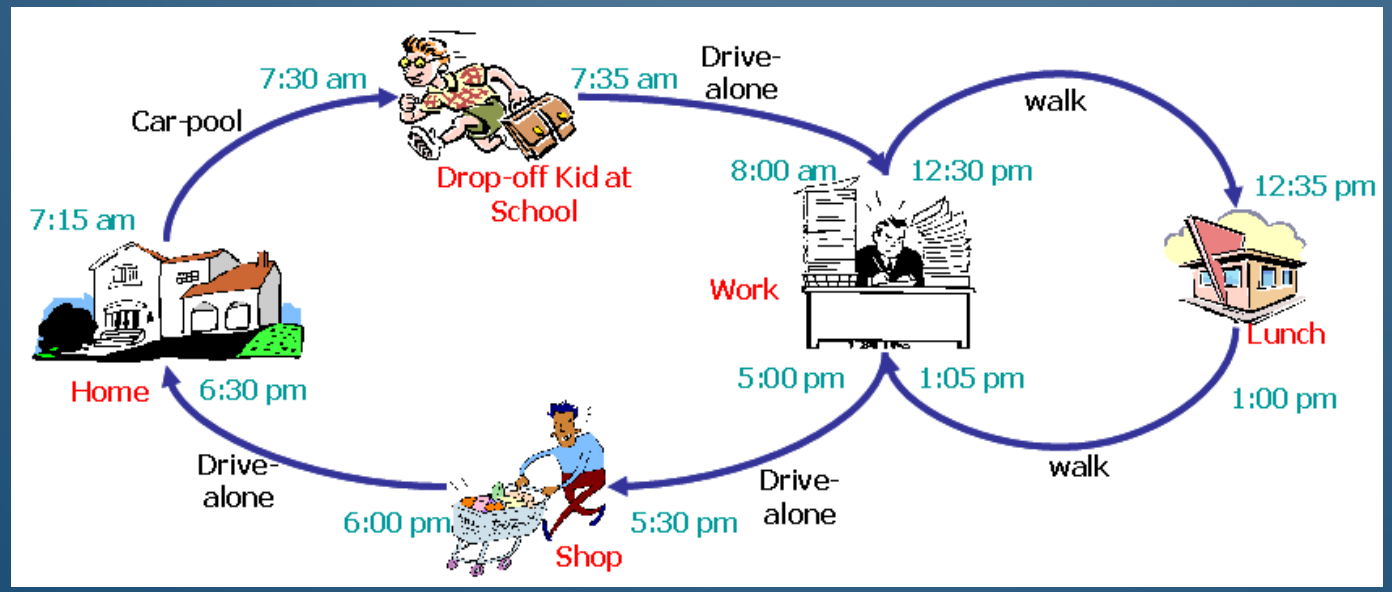
- Each traveler is simulated individually
- Aggregation error greatly reduced
- Demand model results can be segmented according to any available variables (e.g., for equity analysis)
- Some aggregation still present (TAZs, assignment)

ADVANTAGES OF AN ACTIVITY-BASED MODEL

- Better representation of small but important travel segments
- Considers the role of travel *not as a goal in itself*, but *as a means to perform activities* of different types in different places
- Explicitly considers *coordination of travel across the day*, including trip chaining, and within each household
- Results can be summed to estimate *impacts on population segments* (e.g., equity analysis)

ACTIVITY-BASED MODEL – TOURS

- Daily activity patterns have related travel patterns, which are expressed as tours (account for entire daily activity chain)



ACTIVITY-BASED MODEL CHALLENGES

- Greater complexity
  - Harder to understand
  - Much more effort to validate
- Longer run times
- More costly to develop
- Therefore, better suited for larger regions – current implementations in Florida:
  - Northeast Florida
  - Southeast Florida (SERPM and TBRTM)
  - Tampa Bay

TOLL/MANAGED LANE MODELING

- Advanced toll modeling procedures
  - Open road tolling - No delay at the toll plaza
  - Distance-based tolls - Considers tolls based on distance traveled
  - Discrete Tolls - Toll based on number of toll facilities crossed
- High Occupancy Toll (HOT) lane or value-priced tolls
- Ramp-to-ramp tolls
- Congestion pricing

DYNAMIC TRAFFIC ASSIGNMENT

- More behaviorally sound approach to describe time-varying network and demand interaction
  - More realistic representation of roads, intersections, traffic flow
- Routes and flow rates change during the model period based upon congested costs
- Useful for evaluating:
  - Changes in roadway configuration
  - Travel demand management strategies, such as congestion pricing or peak spreading
  - HOT and HOV lanes
  - Transit vehicle behavior (shared guideway)

TRANSPORTATION NETWORK COMPANIES

- Almost non-existent before 2014, growing by about 30% per year through 2019
- How to model
  - Include explicitly in mode choice (competes with auto, transit, walking)
  - Use auto travel times, add wait times
  - Consider as access/egress modes for transit
  - Consider repositioning (vehicle trips between passenger episodes)
- Major challenges
  - Getting data on use (needed for estimation, validation)
  - Complex fare structures (including surge pricing)
  - Need assumptions for forecasting

MICROMOBILITY

- Bike share use low before 2010 but grew rapidly through 2019
- E-scooters took off in 2018
- How to model
  - Include explicitly in mode choice?
  - Must estimate travel times (vary greatly among cyclists)
  - Consider as access/egress modes for transit
- Major challenges
  - Getting data on use (needed for estimation, validation)
  - Define coverage areas (now and for forecasting)
  - Spatial resolution for short trips
  - Cost structures vary
  - Need assumptions for forecasting

CONNECTED/AUTONOMOUS VEHICLES

- Planners have looked into this since ~2014
  - Model Task Force Meeting presentations since 2015
- How to model
  - Change roadway capacities?
  - Increase accessibility of autos to non-drivers? Reduce escorting trips?
  - Increased value of auto in-vehicle time? Induced travel?
  - Changes in parking behavior?
  - "Zero-occupant vehicle" trips?
  - Consider as access/egress modes for transit?
  - Increased home-work distances?
- Major challenges
  - No data on use (needed for estimation, validation)
  - Rate of AV adoption, and how the transition period will work

MODELING TOPICS RAPIDLY GAINING INTEREST…

- Increased working from home
- E-commerce and delivery
- Long-term effects of COVID-19 pandemic

DEALING WITH MODEL UNCERTAINTY

- There are many areas of uncertainty that cannot be removed from models

  - Data used in model development
  - Data used in model validation
  - Model input data
  - Model parameters
  - Land use/demographic forecasts
  - Changes in behavior over time
  - New transportation modes
  - New technologies

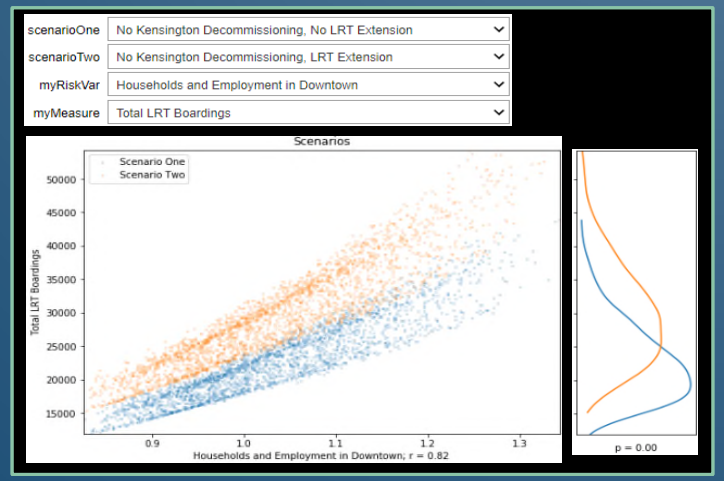
DEALING WITH MODEL UNCERTAINTY

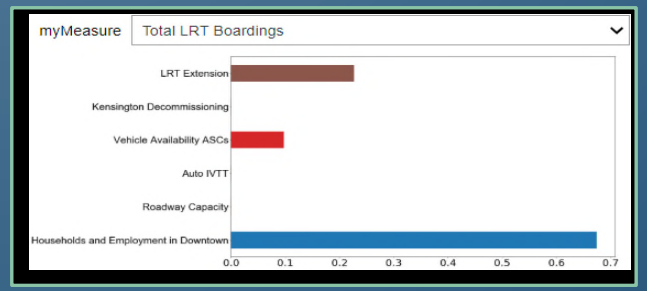
- Scenario analysis
  - Create scenarios with different values for input data, parameters, etc. about which the analyst is uncertain
  - But when there are many uncertainties, the number of scenarios to represent them can be enormous

UNCERTAINTY SPACE

DEALING WITH MODEL UNCERTAINTY

- Exploratory modeling analysis
  - Identify risk variables and measures of interest
  - Develop meta-models that run quickly to relate measures to variables
  - FHWA has developed an open-source tool (TMIP-EMAT) to run with an existing model to produce probabilities of goals being met and other outputs





SUMMARY

- We covered:
  - Emerging trends in modeling
    - Activity-based modeling
    - Advanced toll modeling procedures
    - Dynamic traffic assignment
  - Emerging mobility options
  - Dealing with uncertainty

FSUTMS MODELING TRAINING SERIES

Key Takeaways

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IMPORTANT THINGS TO REMEMBER

- Models are effective analytic tools for planners to produce information to help inform planning decisions
  - But they are not crystal balls, and they don't provide "the answer" to planning questions
  - Choose the right tool for your situation
- There is a lot going on "under the hood" to try to simulate travel demand as accurately as possible
- Model validation is critical to ensure that the results are reliable
- Modeling procedures have evolved a lot in recent years and continue to evolve rapidly due to new planning needs and the changing planning environment
- There is much uncertainty associated with models, but when used in the best possible way, we can learn from the uncertainty

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Questions and Discussion

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