Dobler, C. (2014) Integration of Activity-Based with Agent-Based Models: An Example from Tel-Aviv Model and MATSim, presentation at a seminar of Ayalon Highways Ltd., Ramat Gan, April 2014.
Integration of Activity-Based with Agent-Based Models: An Example from Tel-Aviv Model and MATSim

Christoph Dobler
Senozon
April 2014
Work conducted can be divided into four tasks.

- Update of the existing MATSim Model of Tel Aviv (see Bekhor, Dobler and Axhausen, 2011).
- Add new features to the model: road pricing and destination choice.
- Re-run and re-calibrate the model.
- Analyze the outcomes.
Motivation

Most activity-based models have:
• a detailed activity and trip chains for each modeled person, but
• the supply side is generally modeled using aggregate methods.

This study explores the possibility combining best features of both frameworks:
• The disaggregate demand representation of the activity-based model.
• The disaggregate supply representation of an agent-based simulation model.
Overall Activity-Based Model Application Structure

**INPUT**
 Individual and zonal data
 Networks and level of service data

Activity Based Model

**OUTPUT**
 Individual trips and activities
 OD trip matrices

Highway and Transit Assignments
*(typically aggregated – to be replaced!)*
New Assignment Unit: The MATSim Agent-Based Toolkit

Highway and Transit Assignments

Initial Demand

Execution (mobility simulation)

Scoring (plan evaluation)

Strategy / Re-planning (route, departure time, location)

Analysis
Consistent Implementation of Destination Choice

\[ U = \beta x + \varepsilon \]

- Constant and dynamic attributes
- Iteration-stable randomness
- Estimated DC utility function
- MATSim scoring function
- DC scoring function
- Execution (mobsim)
Modeling Framework – Past vs. Present

**Past**
- **INPUT**
  - Individual and zonal data
  - Networks, level of service data
- **Activity Based Models**
- **OUTPUT**
  - Individual trips and activities
  - MATSim toolkit:
    - Departure time and route choice
    - Traffic flow simulation

**(Near) present**
- **INPUT**
  - Individual and zonal data
  - Networks, level of service data
- **Activity Based Model**
  - fully integrated in MATSim toolkit
- **OUTPUT**
  - Individual trips and activities in all detail
  - Traffic flow simulation
Steps Performed to Prepare the Initial Demand

Departure Time Disaggregation
• From time periods to hourly demand

Traffic Analysis Zones Disaggregation
• From traffic zones to links and facilities

Network Conversion
• Representation of turning restrictions
• Assignment of links to zones
Project Area

1,219 zones
About 1,500 km²
3.3 million habitants
Road Network

9,474 nodes
18,570 links
Road Pricing

Tolled links marked yellow
Counted Links

137 links with traffic count data available marked red
Trip Length Distributions
Calibration and Outcomes

Calibration of the simulation model
• Traffic flow dynamics (flow and storage capacity)
• Destination choice
• Road toll

Analysis of the outcomes
• Trip length distributions
• Road pricing
• Traffic counts
Destination Choice Calibration

Three step approach

• Conduct parameter study for various $\varepsilon$ values
• Find optimal $\varepsilon$ for each trip purpose
• Apply optimal $\varepsilon$ to a setup with bad initial location choices
Leisure Trip Calibration

![Graph showing the relationship between Share and Travelled distance [km]. The graph includes multiple curves representing different values of \( \varepsilon \): Reference, \( \varepsilon = 1.0 \), \( \varepsilon = 2.0 \), \( \varepsilon = 3.0 \), \( \varepsilon = 4.0 \), \( \varepsilon = 5.0 \), \( \varepsilon = 6.0 \), \( \varepsilon = 7.0 \), \( \varepsilon = 8.0 \), \( \varepsilon = 9.0 \), and \( \varepsilon = 10.0 \). The graph illustrates how the Share decreases as the Travelled distance increases.]
Optimal $\varepsilon$ for Leisure Trips

![Graph showing travelled distance vs share for reference and $\varepsilon = 7.0$]
Leisure Trips with Altered Initial Locations

- altered initial locations, $\varepsilon = 7.0$
- original initial locations, $\varepsilon = 7.0$

**Share** as a function of **Travelled distance [km]**

The chart illustrates the distribution of travel distances for leisure trips with altered initial locations compared to original initial locations, indicating a notable difference in the share of trips across different distance categories.
Trip Length Distributions – Shopping Trip Calibration

![Graph showing trip length distributions with various epsilon values.](image)

- **Share** vs. **Travelled distance [km]**
- Different curves represent various epsilon values (e.g., e = 1.0, e = 2.0, etc.).
Optimal $\epsilon$ for Shopping Trips
Shopping Trips with Altered Initial Locations

![Graph showing the distribution of travelled distances with and without altered initial locations.]
Road Pricing

Adding road tolls slightly improves the model fit. Only small influence since...

• Only a few tolled links.
• Only 16 of 137 count stations are on tolled roads, i.e. effects are hard to measure.
• No count stations next to tolled roads to measure how many agents switch to non-tolled roads.

Checking the number of vehicles per period shows...
• too many vehicles in the OP period.
• too few vehicles in the AM and PM period.
Traffic Counts Analysis

Three data sources to compare
• Real world traffic count data (15 minute time bins)
• Outcomes of the EMME/2 model (3 time periods)
• Outcomes of the MATSim model (1 hour time bins)

Therefore, compare...
• peak values of all three sources for the three time periods.
• accumulated real world and MATSim values for the three time periods.
• real world and MATSim values for each hour.
Traffic Count Analysis – AM Period

RMSE: EMME/2 – 1552
     MATSim – 1240
Traffic Count Analysis – OP Period

RMSE: EMME/2 – 903
      MATSim – 975
Traffic Count Analysis – PM Period

RMSE:  
EMME/2 – 1502  
MATSim – 873
Real World vs. MATSim Traffic Flows for each Hour

**Link 5408, Iteration: 0**

Details from 07 o'clock to 08 o'clock

Count Value: 2196.0
MATSim Value: 2298.0
Relative Error: 4.694333928332
Route: Marhin - Yehud

Volumes 7:00 - 8:00, Iteration: 0

- Mean real error
- Mean abs bias

28
Summary and Outlook

The (already very good) outcomes from the previous MATSim model were further improved.

- Model input data was updated.
- Destination Choice was fully integrated into the model.
- Analyzing traffic counts shows a better fit than the EMME/2 model.

To further improve the model...

- additional parts of the activity-based model could be implemented.
- additional data sources could be used for the calibration, e.g.
  - trip length distributions from travel surveys.
  - toll related information (origin and destination of tolled vehicles; travelled distance on tolled roads; ...)
References


Thank you for your Attention! Questions?