

The Evolution of Transport Planning



From Macros to Modeller



From Macros to Modeller
Toronto May 16, 2011



Overview

- Comparison of Macros and Modeller
 - Matrix Calculation
 - Traffic Assignment
 - Iterating within a procedure
- Model Conversion: Washoe County RTC (Reno, Nevada)
 - Some Details of the Conversion
 - Run-time Comparison
- Modeller Logbook Examples

Example 1: Matrix Calculation

Emme Macro

```
3.21
1
y
mfetoi27
n
mf"etoi07"*
((1+0.02)**20)
```

```
y
150,170
```

```
1,149
```

```
2
q
```

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Toronto May 16, 2011

Emme Modeller

```
matrix_calc = Modeller.tool(
'intro.emme.standard.matrix_calculation.
matrix_calculator')

spec = {
  'type': 'MATRIX_CALCULATION',
  'result': 'mfetoi27',
  'expression':
    'mfetoi07*((1+0.02)**20)',
  'constraint': {
    'by_zone':
      {
        'origins': '150,170',
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}

report = matrix_calc(spec)
```



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```
report = matrix_calc(spec)
```



Example 1: Matrix Calculation

Use reports, when available, to check results of a procedure

All procedure tools return a report which can be examined to determine the results of the procedure, logged, or displayed.

```
>>> report = matrix_calc(spec)
>>> report
{ 'average': 0.56,
  'expression_type': 'FULL',
  'maximum': 357.33,
  'maximum_at': {'destination': 11, 'origin': 150},
  'minimum': 0.0,
  'minimum_at': {'destination': 121, 'origin': 150},
  'num_evaluations': 2958,
  'result_type': 'FULL',
  'sum': 1656.48 }
```

E.g. to get the sum of the result matrix, simply look it up in the report:

```
>>> sum_of_mfeto27 = report['sum']
```

No need for a second matrix calculation!

Example 2: Traffic Assignment

Emme Macro

```
5.11
1
~?q=2
2
1
2
mfvehi01

mfaus30
n
50
0.01,0
0.001
5.22
3
2
2
```

Emme Modeller

```
traffic_assign = Modeller.tool(
'intro.emme.standard.traffic_assignment.
standard_traffic_assignment')
```

```
report = traffic_assign(spec)
```

Example 2: Traffic Assignment

Emme Macro

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2
1
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50
0.01,0
0.001
5.22
3
2
2
```

Emme Modeller

```
spec = {
  'type': 'STANDARD_TRAFFIC_ASSIGNMENT',
  'background_traffic': {
    'add_transit_vehicles': True  },
  'classes': [{
    'mode': 'a',
    'demand': 'mfvehi01',
    'results': {
      'od_travel_times':{
        'shortest_paths': 'mfaus30' },
    }],
  },
  'stopping_criteria':
  {
    'max_iterations': 50,
    'best_relative_gap': 0.01,
    'normalized_gap': 0.001,
    'relative_gap': 0          },
  'performance_settings':{
    'number_of_processors': 2},
}
```

Example 2: Traffic Assignment

Use “View Spec” in the standard tools to generate specifications

The Emme Standard Traffic Assignment. Run traffic assignments with multiple classes, generalized cost, or path analysis.

C:/Emme/Modeller/specifications/basic_sta.ems

Load Spec... Save Spec As... View Spec

Background Traffic

On links:

No link component

On turns:

No turn component

Add transit vehicles

Traffic classes

Class 1

Mode:

c car AUTO

Demand:

mf1 - auds - AM auto demand from survey (veh

Results

O-D travel times

Shortest paths:

None

Save link volumes:

None

Save turn volumes:

None

Use generalized cost

Analysis

Add a class

View specification source

```
{
  "type": "STANDARD_TRAFFIC_ASSIGNMENT",
  "background_traffic": {
    "add_transit_vehicles": true,
    "link_component": null,
    "turn_component": null
  },
  "path_analysis": null,
  "classes": [
    {
      "mode": "c",
      "demand": "mf1",
      "generalized_cost": null,
      "results": {
        "od_travel_times": {
          "shortest_paths": null
        }
      },
      "link_volumes": null
    }
  ]
}
```

Close

Example 2: Traffic Assignment

Open saved specifications from a file

Emme Modeller

```
file_name = 'C:/Program Files (x86)/INRO/Emme/Emme 3.3  
/specifications/basic_sta.ems'
```

```
f = open(file_name, 'r')
```

```
spec = f.read()
```

```
report = traffic_assign(spec)
```

```
f.close()
```

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```

Example 3: Procedure Iteration

From Congested Transit Assignment (contras.mac)

Emme Macro

```
~:nextiter
~x=%ms90%
~?x=%1%
~$alldone
~x+1
~/=== Iteration %x% ===
3.21
~+|1|y|ms90|n|ms90+1
...
~# ms87 is normalized gap
~x=%ms87%
~?x<%2%
~$nextiter
~:alldone
```

Emme Modeller

```
for i in range(1, max_iterations):
    ...
    if norm_gap < min_norm_gap:
        break
```

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~x=%ms87%
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```

Emme Modeller

```
for i in range(1, max_iterations):
    ...
    if norm_gap < min_norm_gap:
        break
```

Example 3: Procedure Iteration

Use Python variables in place of registers and Scalar matrices

In Python:

- Practically no limits on number or type of variables
- Can use informative names
- Can specify mathematical expression directly
- Can test conditions of arbitrary complexity

Important Detail:

The macro parameter substitution, %1%, %2%, etc. becomes the named arguments to a Python function:

```
def congested_transit(max_iterations,  
                      min_norm_gap, ...):
```

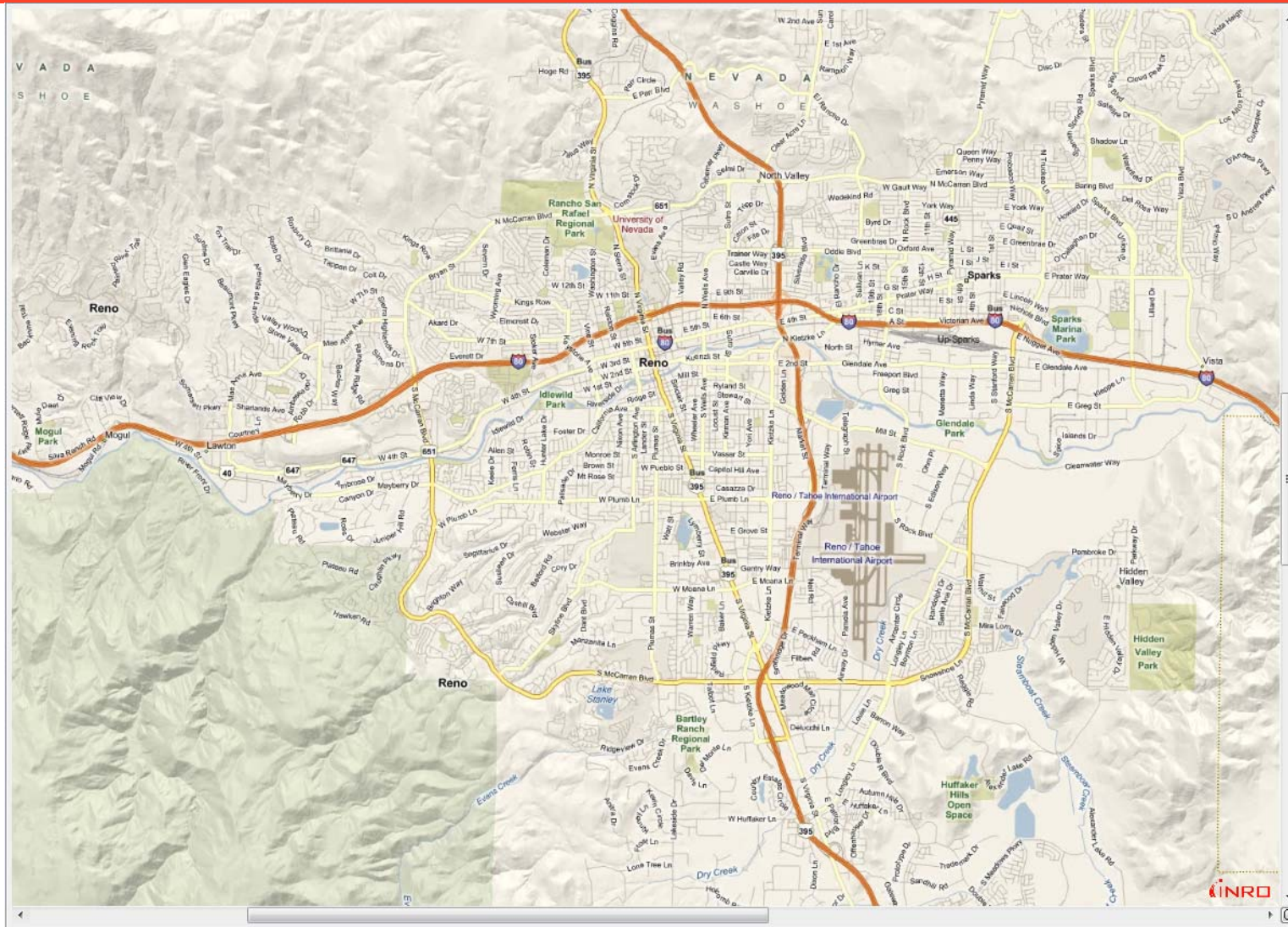
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 - Flow-of-control
- Model Conversion: Washoe County RTC (Reno, Nevada)
 - Some Details of the Conversion
 - Run-time Comparison
- Modeller Logbook Examples

Conversion of Washoe RTC Model

- Model for Regional Transportation Commission of Washoe County, Nevada
 - Planning and implementation of regional roads, rails and public transit
 - Most well-known city is Reno
- Last Updated in 2006
- Implemented using macros and DOS batch files
- Reimplemented exclusively using the new Modeller framework

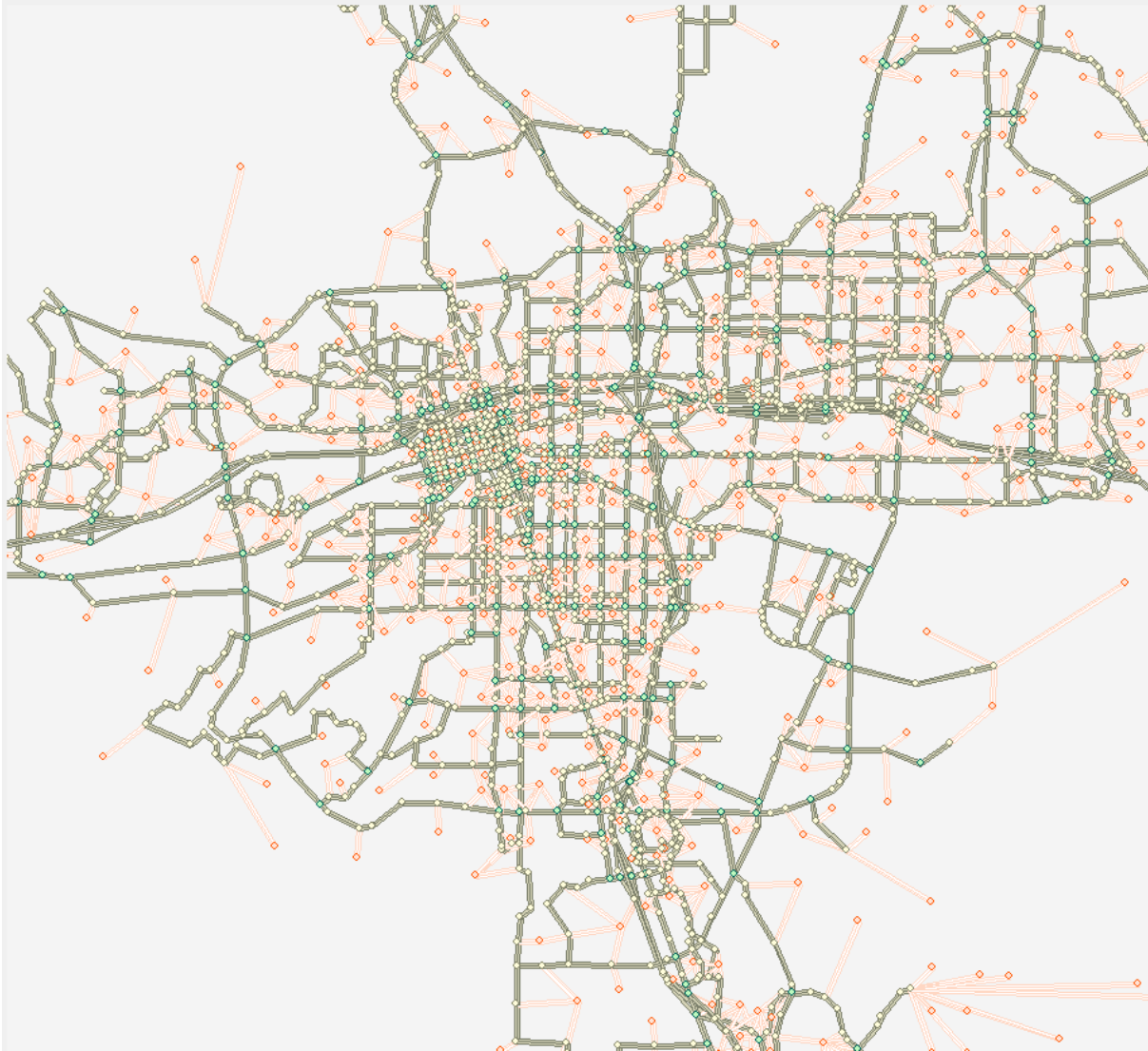
Conversion of Washoe RTC Model



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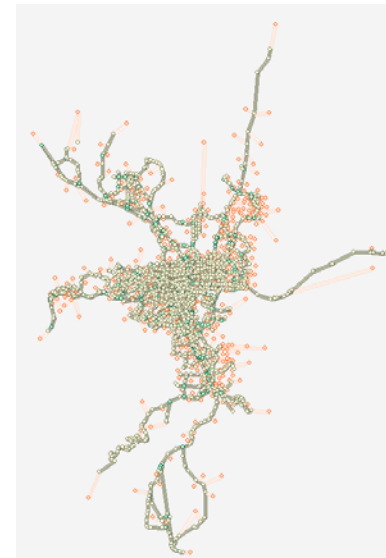


Conversion of Washoe RTC Model



Network size:

- 746 zones
- 3071 nodes
- 12048 links
- 8723 turns



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Some Details of the Conversion

- The model uses Method of Successive Averages (MSA) on link flows
- At the beginning of each iteration, the travel times are updated according to the MSA link flows
- The volume-delay functions (VDF) are modified so that the auto skims can be calculated
- The VDFs are changed back for the multi-class assignment

Update volume-delay functions:

VDF for traffic assignment:

$$fd1 = (\text{length} * 60 / ul3) * (1 + .15 * (\text{volau} * el1 / (\text{lanes} * ul1)) ^4)$$

VDF for auto skims:

$$fd1 = (\text{length} * 60 / ul3) * (1 + .15 * (el2 * el1 / (\text{lanes} * ul1)) ^4)$$

Some Details of the Conversion

Macro for the purpose:

```
~#create function file d411sk.in for
auto skims
~!del d411tp.in
~!del d411sk.in
batchout=?
~+;4.14;3;y;d411tp.in;q
~<<d411tp.in
~:NextLine
~t0=~@
~?e
~$>End-Read
~t8=%1%
~?t8=c
~+;~>>d411sk.in;~"%t0%;~>>;~$NextLin
e
~?t8=t
```

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```
~+;~>>d411sk.in;~"%t0%;~>>;~$NextLine
~?t8=
~+;~>>d411sk.in;~"%t0%;~>>;~$NextLine
~#check if there is "v" in the line
~+;~x=1;~t8=%t0%
~+;~t7=%%t8.1%%;~t8=%%t8.-1%%;~?
t7=v;~$>Found;~?t8=;~$>nFound;~x+1;~$
~:Found
~x-1
~+;~>>d411sk.in;~"%%t0.%x%% e12
%t8.-5%;~>>;~$NextLine
~:nFound
~+;~>>d411sk.in;~"%t0%;~>>;~$NextLine
~$NextLine
~:End-Read
```



Some Details of the Conversion

Modeller Version:

```
change_function = Modeller.tool(  
    'intro.emme.standard.data.function.change_function')  
for f in emmebank.functions():  
    if f.type == 'VOLUME_DELAY':  
        if f.expression.find('volau'):  
            expression = f.expression.replace('volau', 'el2')  
            change_function(f, expression)
```

Run time comparison

Step	Macro	Modeller
	Running Time in Seconds	
Initialization & Iteration Control	2	3
Auto skims	12	33
Transit skims	60	76
Resident Trip Generation	117	46
Resident Trip Distribution	6	22
Resident Mode Choice	202	86
Visitor trip generation	5	1
Visitor Mode Choice	187	176
Time-of-day model	20	24
Park-and-ride Model	4	8
Auto Assignment	60	47
Total	675	522
Total (minutes)	11.3	8.7

Summary of Findings

- Modeller specifications are more explicit and less error-prone
- Modeller enables easier iteration and conditional logic
- A 1-1 translation of Macros to Modeller scripts is possible but not optimal (a good place to start)
- Integrated structure using namespaces allows easy “bootstrapping”

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Modeller Logbook



- [-] Sequential model
 - [-] Sequential model run
 - [+] Init zonal data
 - [-] Assignment and skims
 - [+] Create matrix ms1 - zero - for 0 demand traffic assignment
 - [+] Create matrix mf3 - auskim - auto skim
 - [+] Standard traffic assignment
 - [+] Create matrix mf4 - trskim - transit skim
 - [+] Standard transit assignment
 - [+] Traffic conditions
 - [-] Trip generation
 - [+] Productions for residential zones
 - [+] Productions for non-residential zones
 - [+] Total productions
 - [+] Attractions for low employment zones
 - [+] Attractions for high employment zones
 - [+] Total attractions
 - [+] Attractions normalized to total productions
 - [+] Productions and Attractions by District
 - [-] Trip distribution
 - [+] Entropy input matrix
 - [+] 2-D balancing
 - [+] Trip distribution vs survey
 - [-] Mode choice
 - [+] Demand for cars
 - [+] Demand for transit
 - [+] Aggregate demand to prod/attr
 - [+] Transit and Car Trips
 - [-] Assignment and skims
 - [+] Standard traffic assignment
 - [+] Standard transit assignment
 - [+] Traffic conditions

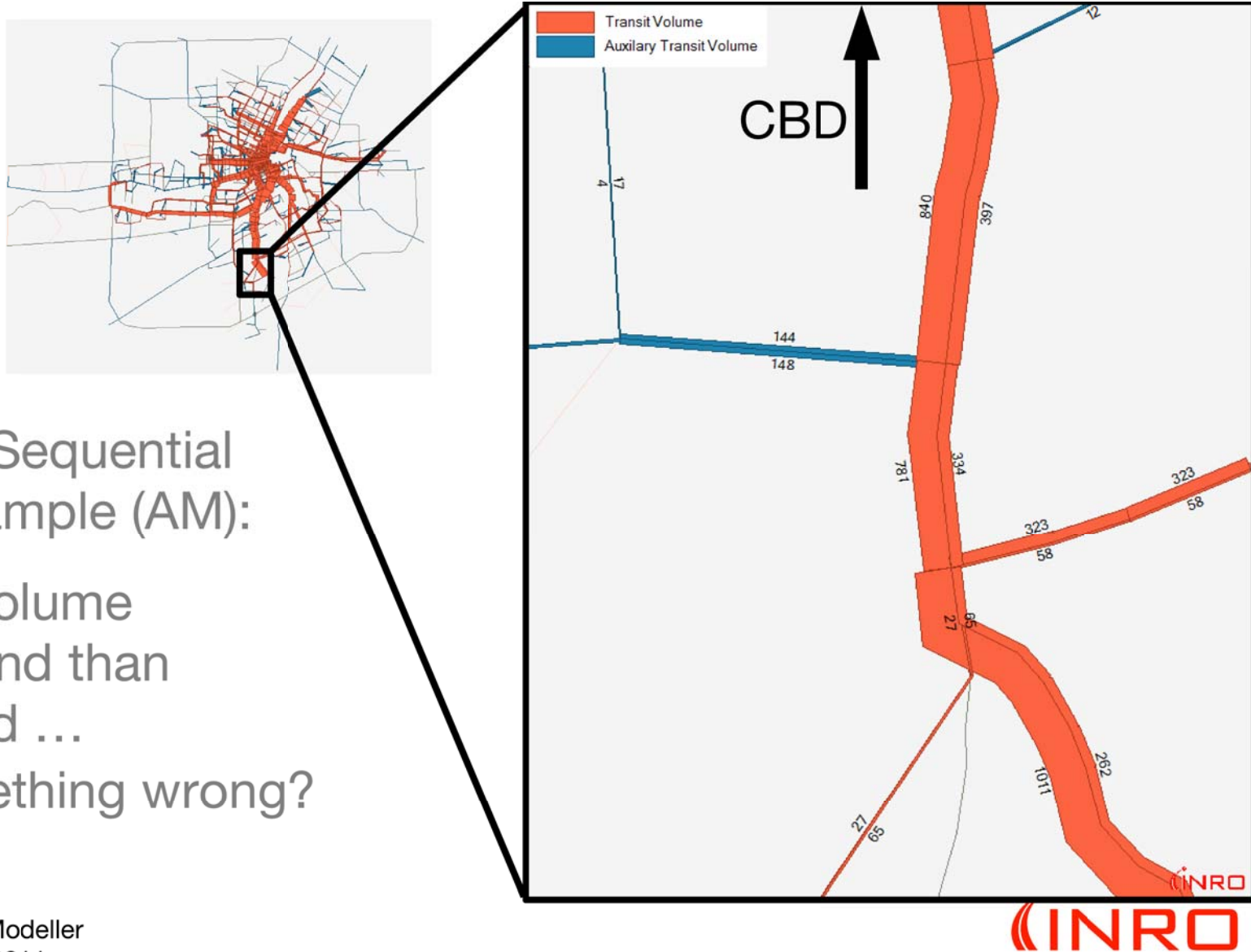
Use Logbook for:

- Trace of Model run
 - Record of Model run
 - Debugging model during development
- Unveiling the Black Box
 - Logbook clearly illustrates model structure
 - Documentation of model for new users

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Example 4: Logbook – Run Record

































Winnipeg Sequential Model Example (AM):

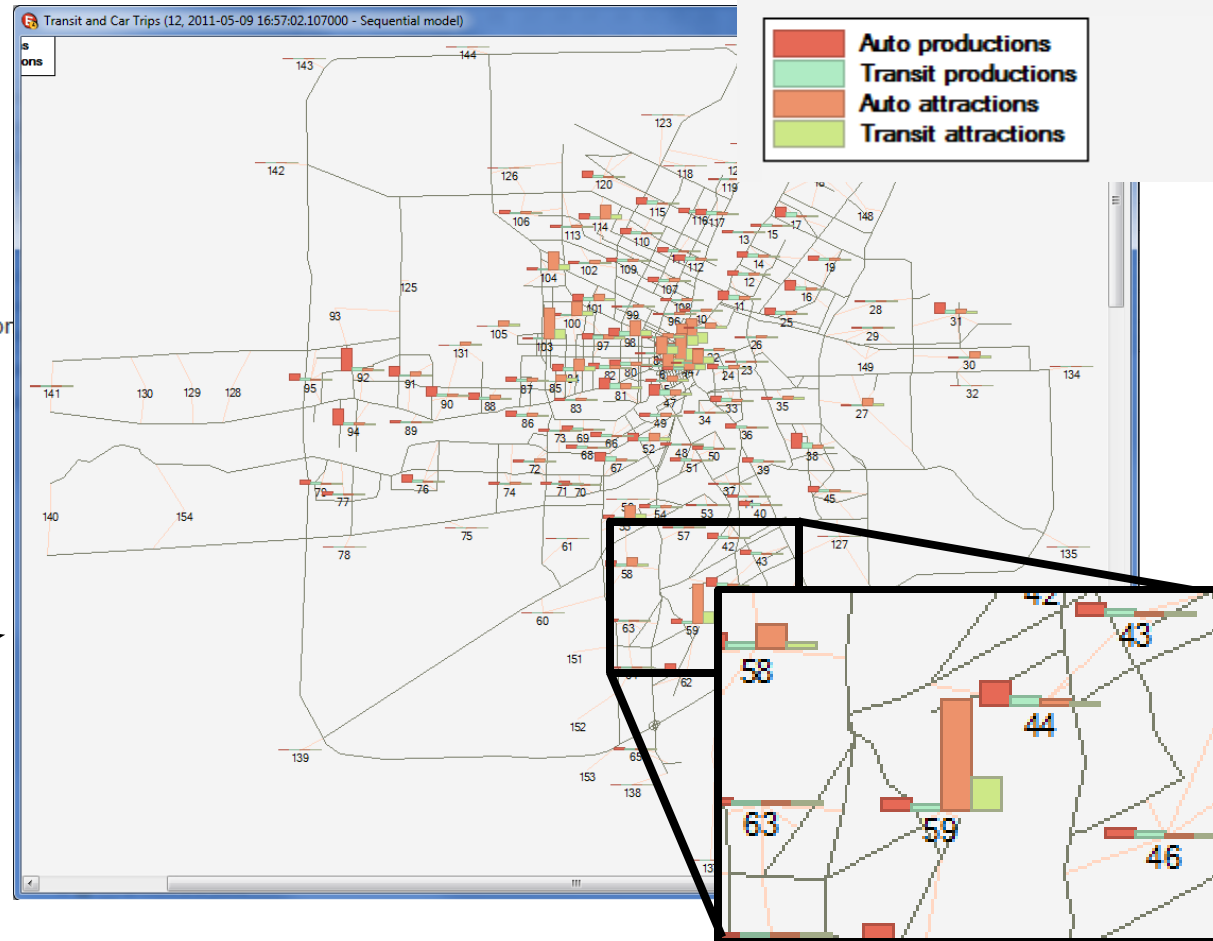
- More volume outbound than inbound ...
- Is something wrong?

Example 4: Logbook – Run Record

16:57:02 Sequential model 

- [-]  Sequential model
 - [-]  Sequential model run
 - [-]  Init zonal data
 - [-]  Assignment and skims
 - [-]  Trip generation
 - [-]  Productions for residential zones
 - [-]  Productions for non-residential zones
 - [-]  Total productions
 - [-]  Attractions for low employment zones
 - [-]  Attractions for high employment zones
 - [-]  Total attractions
 - [-]  Attractions normalized to total production
 -  Productions and Attractions by District
 - [-]  Trip distribution
 - [-]  Entropy input matrix
 - [-]  2-D balancing
 -  Trip distribution vs survey
 - [-]  Mode choice
 - [-]  Demand for cars
 - [-]  Demand for transit
 - [-]  Aggregate demand to prod/attr
 -  Transit and Car Trips
 - [-]  Assignment and skims
 - [-]  Standard traffic assignment
 -  Convergence Chart
 -  Report
 - [-]  Standard transit assignment
 -  Transit Assignment Summary
 -  Report
 -  Traffic conditions

Transit and Car Demand



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Example 4: Logbook – Run Record



Mystery is solved:

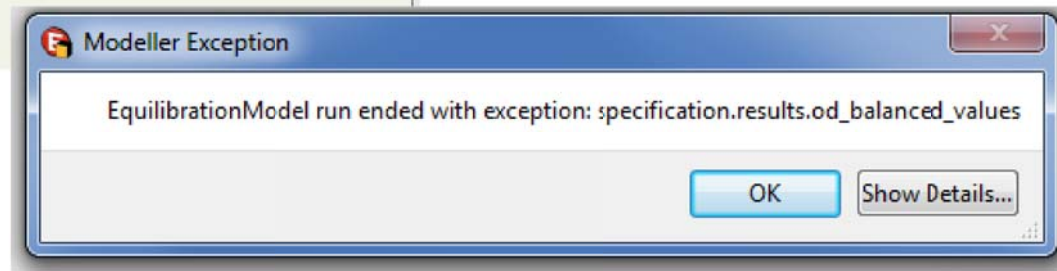
- University of Manitoba is attracting a large numbers of trips

Example 5: Logbook – Debugging

The screenshot shows the INRO Winnipeg software interface. At the top, there is a red header with the INRO logo and the text "Winnipeg". Below this, the main content area is titled "Simple travel demand model with equilibration." and contains the text "Runs standard 4-step sequential model with equilibration feedback to trip distribution." There are two input fields: "Feedback iterations" set to "10" and "Log worksheets" which is checked. A "Stop tool" button is visible. Below the main content, there is a "Recent history" section and a "Tool Context" section with the following text: "Database Title: Emme Standard Demonstration and Course Database", "Database Path: E:\Modeller_tests\Winnipeg\Database\emmebank", and "Current Scenario: 3001 – Unprotected Copy of Scenario 3000". At the bottom, there is a footer with the INRO logo and "© 2011 INRO. All rights reserved."

There is an error during a model run

- What is wrong?
- How do we fix it?

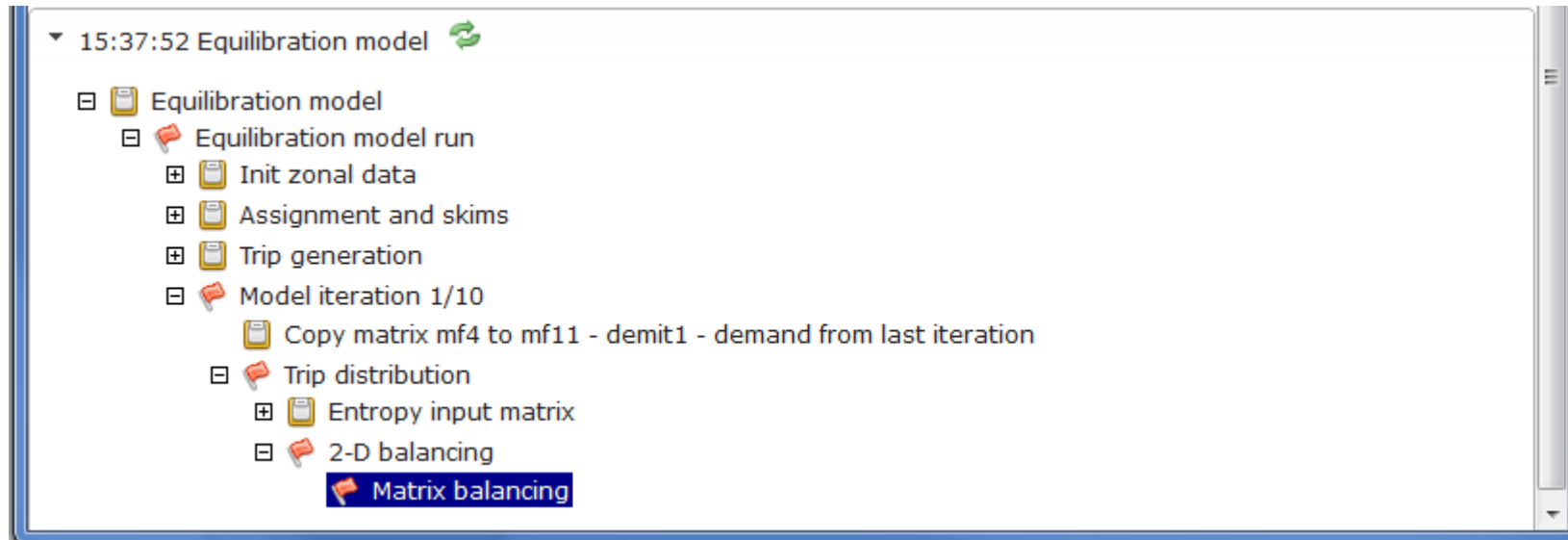


Example 5: Logbook – Debugging



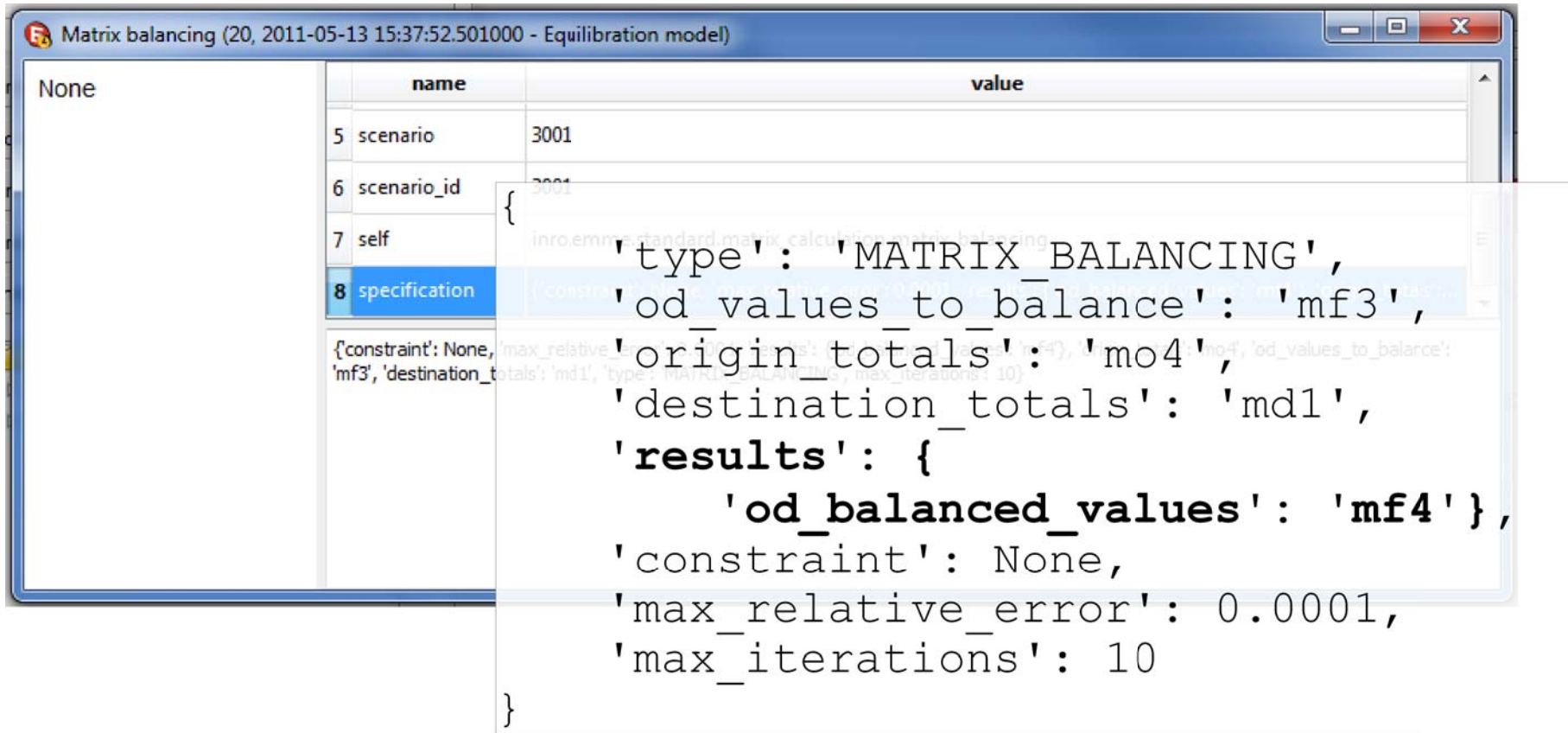
- The error message **specification.results.od_balanced_values** indicates the problem is with a specification, and states which value caused the problem:
 - The **od_balanced_values** in the results
- Click “View in the logbook” to find out more

Example 5: Logbook – Debugging



- Error happened during a Matrix balancing, in the Trip distribution procedure, during the first iteration
- Open the “Matrix balancing” record to find out more

Example 5: Logbook – Debugging



	name	value
5	scenario	3001
6	scenario_id	3001
7	self	{
8	specification	{ 'type': 'MATRIX_BALANCING', 'od_values_to_balance': 'mf3', 'origin_totals': 'mo4', 'destination_totals': 'md1', 'results': { 'od_balanced_values': 'mf4'}, 'constraint': None, 'max_relative_error': 0.0001, 'max_iterations': 10 }

```
{  
  'type': 'MATRIX_BALANCING',  
  'od_values_to_balance': 'mf3',  
  'origin_totals': 'mo4',  
  'destination_totals': 'md1',  
  'results': {  
    'od_balanced_values': 'mf4'},  
  'constraint': None,  
  'max_relative_error': 0.0001,  
  'max_iterations': 10  
}
```

- Select specification and check the 'od_balanced_values'
- Is something wrong with mf4?

Example 5: Logbook – Debugging

- Check out mf4 in Change matrix properties tool

Change matrix properties

Changes the name, description and protection flags of a matrix, as well as the storage type for a full matrix.

Matrix:
mf4 - demand - demand obtained from balancing (entropy) ▼
Properties will be changed for this matrix.

Name:
demand
Name for the matrix. 6 characters or less.

Description:
demand obtained from balancing (entropy)
Description for the matrix . 40 characters or less.

Protect matrix against write and delete operations

- Read-only protection was accidentally set on mf4

About Python

- There are many resources available online:
 - Python's website: python.org
 - Tutorial: Dive Into Python: diveintopython.org
- A quick Google search answers most questions
- For Emme-specific information, see the Emme API reference, Modeller Guide, and the other Emme manuals

Conclusions

- Modeller provides a complete alternative to Emme Macros
- Python is a very powerful scripting language, using clear modern syntax
- Modeller logbook provides extremely valuable debugging and auditing services

Emme Modeller

- **Prepare** and **run** model procedures easier than ever
- Rapidly **build** and **deploy** complete travel demand models
- **Develop** your own model procedures and utilities
 - Hundreds of new **APIs** and services
- **Integrate** any procedure into your model
- **Visualize** Emme models like never before



Thank you!



From Macros to Modeller
Toronto May 16, 2011

