Allocating Disaggregated Freight Analysis Framework Truck-Rail Data

presented to

The 3rd Innovations in Travel Modeling Conference

presented by

Roshan Kumar, University of Texas at Austin
Krishnan Viswanathan, Cambridge Systematics, Inc.

Co-authors

Daniel Beagan, Cambridge Systematics, Inc.
Vidya Mysore, Florida DOT
S. Travis Waller, University of Texas at Austin

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STATE OF FLORIDA · DEPARTMENT OF TRANSPORTATION

Presentation Outline

- Motivations
- Disaggregation Methodology
- Allocation Methodology
- Summary and Future Work

Why Disaggregate FAF2 Data

- Freight capacity expansion not keeping up with demand
- Rail as an attractive mode
  - » Helps mitigate congestion
  - » Reduces Greenhouse gas emissions
  - » Price competitive
- The Freight Analysis Framework Version 2 (FAF2) valuable data source
- Serves two audiences
  - » MPO and DOT Planners
  - » MPO and DOT Modelers

Florida FAF2 Data

	2002						2035					
Mode	Within State		From State		To State		Within State		From State		To State	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Truck	487	85	50	68	85	42	928	88	67	72	300	56
Rail	60	11	17	23	37	18	56	5	14	15	113	21
Water (Domestic only)	<0.1	<1	1	<1	37	18	<0.1	<1	0	<1	18	3
Air, air & truck (Domestic only)	<0.1	<1	0	<1	0	<1	<0.1	<1	0	<1	1	<1
Truck & rail	<0.1	<1	0	<1	1	<1	0	<1	0	<1	3	<1
Other intermodal	0	<1	1	1	5	3	1	<1	1	1	17	3
Pipeline & unknown	27	5	5	7	36	18	64	6	10	10	85	16
Total	575	100	74	100	202	100	1049	100	94	100	538	100

The Methodology

- Develop relationships between commodity and employment and population data
  - » Rationale is commodities end up in zones that produce or consume them
- Use relationships to develop factors for each commodity for freight flow disaggregation
- Apply share of county tonnage or value to FAF^2 regional tonnage or value to obtain disaggregated FAF^2 O-D database

Development of 3 Digit NAICS Employment

- County Business Patterns (CBP) data
- 3 digit most complete at MSA level
- PUMS data used for allocation
- Census 2000 stratification used for government and self employed workers

Development of Production and Attraction Equations

- Regression used to establish relationships between commodities and employment
- Number of observations is 114 (domestic FAF2 regions)
- Data from 3 digit NAICS county data aggregated to FAF regions
- Data from USDA National Agricultural Statistical Services used for farm and livestock related commodities
- Data from USDOE National Energy Technology Lab used for coal consumption

Development of Production and Attraction Equations

- Input-Output data used to determine initial commodity - employment relationship
- Multiple revisions done to equations before settling on a final form
- Some of relationships have either low R^2 values or the t-stats are very poor
  - » Kept it because we felt that those employment categories reflected the true nature of the commodity production or attraction

Inclusion of Import Data

- FAF2 includes domestic travel portion of international shipments
- Regressions are used only for the domestic end of the international shipments
- Critical to understand the flows from/to the Port of Entry/Exit (POE)
- Allocate each POE share by mode in each FAF region using data from BTS, US Army Corp of Engineers, and STAT-USA
- Add the POE commodity by tons and value to the disaggregated county commodity tonnage & value

The Disaggregation Process

- Estimate the annual tonnage of commodity produced $P_c(i)$ or attracted $A_c(j)$ for each County
- Aggregate the county productions $P_c(i)$ and attractions $A_c(j)$ to their associated FAF^2 regions to create $P_{FAF2}(i)$ and $A_{FAF2}(j)$
- Expand the FAF^2 Regions matrix, $FAF^2(k,l)$, to counties matrix, County (i,j)

The Disaggregation Process

- If origin *i* and destination *j* are in Florida then $County(i,j)=[FAF^2(k,l)*P_c(i)/P_{FAF2}(i)* A_c(j)/ A_{FAF2}(j)]$
- If origin *i* is in Florida and destination *l*, is outside Florida then $County(i,l)=[FAF^2(k,l)*P_c(i)/P_{FAF2}(i)]$
- If origin *k* is outside Florida and destination *j* is in Florida then $County(k,j)=[FAF^2(k,l)*A_c(j)/A_{FAF2}(j)]$

The Disaggregation Process

- **Paper or Paperboard Articles (SCTG 28)**

- ***Production Equation***
  - **0.101 *(10.78)* x Paper Manufacturing (NAICS 322) + 0.038 *(4.82)* x Printing or related activities (NAICS 323) ; $R^2 = 0.81$**

- ***Attraction Equation***
  - **0.006 *(2.49)* x Food Manufacturing (NAICS 311) + 0.033 *(5.10)* x Paper Manufacturing (NAICS 322) + 0.048 *(6.97)* x Printing or related activities (NAICS 323) + *0.00009 (4.77)* x Population2000 ; $R^2 = 0.93$**

The Disaggregation Process

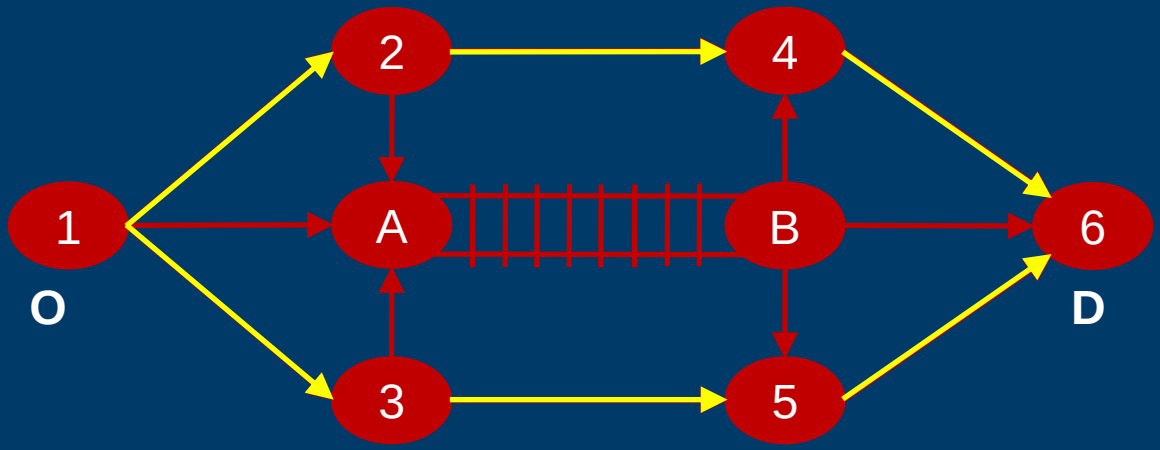
			Paper 2002 (thousands of tons)
Origin	Destination	County	FAF Zone
Disaggregation of Florida origins to Florida destinations			
FAF2 Miami (20)	FAF2 Jacksonville (19)	#NA	16.57
Miami Dade County	Baker County	0.00	#NA
Miami Dade County	Clay County	0.12	#NA
Miami Dade County	Duval County	7.89	#NA
Miami Dade County	Nassau County	3.54	#NA
Miami Dade County	St. Johns County	0.07	#NA
Palm Beach County	Baker County	0.00	#NA
Palm Beach County	Clay County	0.01	#NA
Palm Beach County	Duval County	0.44	#NA
Palm Beach County	Nassau County	0.20	#NA
Palm Beach County	St. Johns County	0.00	#NA
Broward County	Baker County	0.00	#NA
Broward County	Clay County	0.04	#NA
Broward County	Duval County	2.71	#NA
Broward County	Nassau County	1.22	#NA
Broward County	St. Johns County	0.03	#NA
Diaggregation of Florida origins to other US destinations			
FAF2 Miami (20)	GA Rem (25)	#NA	6.64
Miami Dade County	GA Rem	0.27	#NA
Palm Beach County	GA Rem	4.74	#NA
Broward County	GA Rem	1.63	#NA
Diaggregation of other US origins to Florida Destinations			
GA Rem (25)	FAF2 Miami (20)	#NA	199.63
GA Rem	Miami Dade County	113.05	#NA
GA Rem	Palm Beach County	26.11	#NA
GA Rem	Broward County	60.47	#NA

Disaggregation Issues

- Methodology presented thus far works for truck mode
  - » Truck network is ubiquitous
- Methodology needs to be enhanced to account for rail and truck-rail modes since intermodal centers are not in every county
- This calls for a new allocation methodology of truck-rail flows

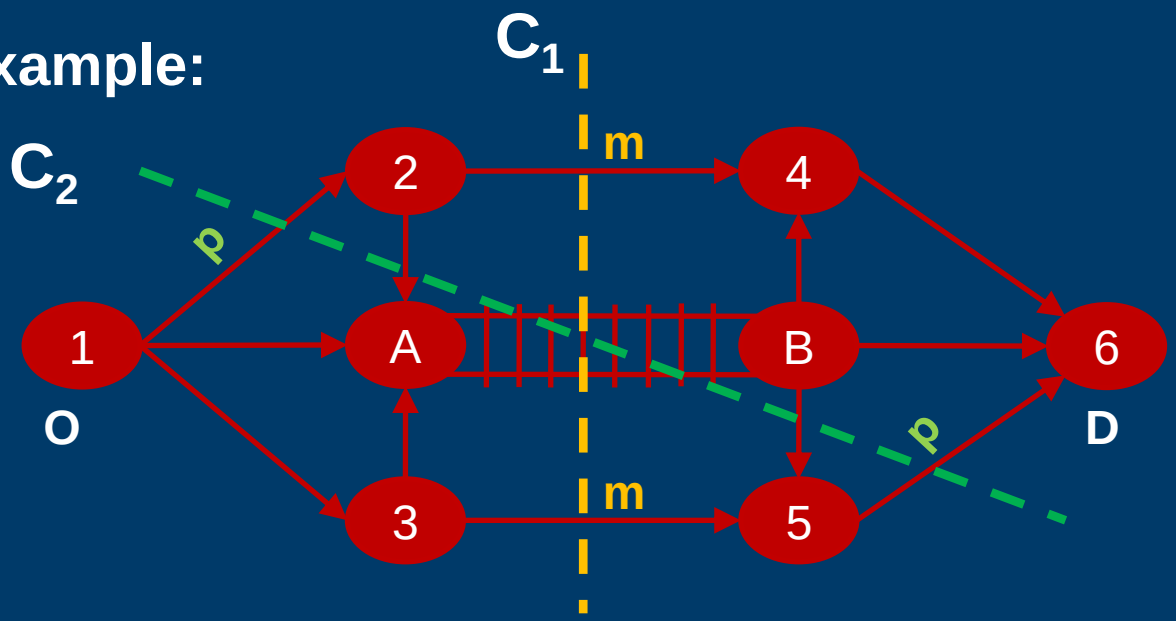
Assignment of Truck-Rail Flows on Links (Issues)

- Assignment should use both truck and rail links
- Assignment of flows from O to D will not ensure this
- Example:



Assignment of Truck-Rail Flows on Links (Issues)

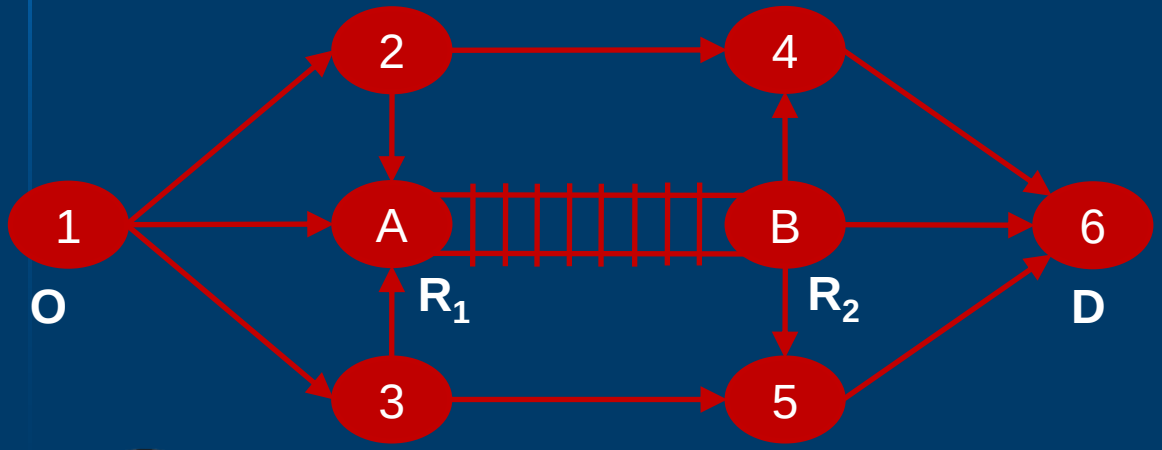
- Removal of links such that rail link gets loaded *suitably* is not feasible
- Example:



- Have to remove links marked **m** and not **p**. How to choose correct cut ? Very time consuming (exponential)

Assignment of Truck-Rail Flows on Links

- Given a suitable assignment technique
- Transform O-D matrix as follows:
  - » Split O-D flow. From origin to rail access center. From rail egress center to destination
  - » Given O-D, convert to O → R_1 and R_2 → D

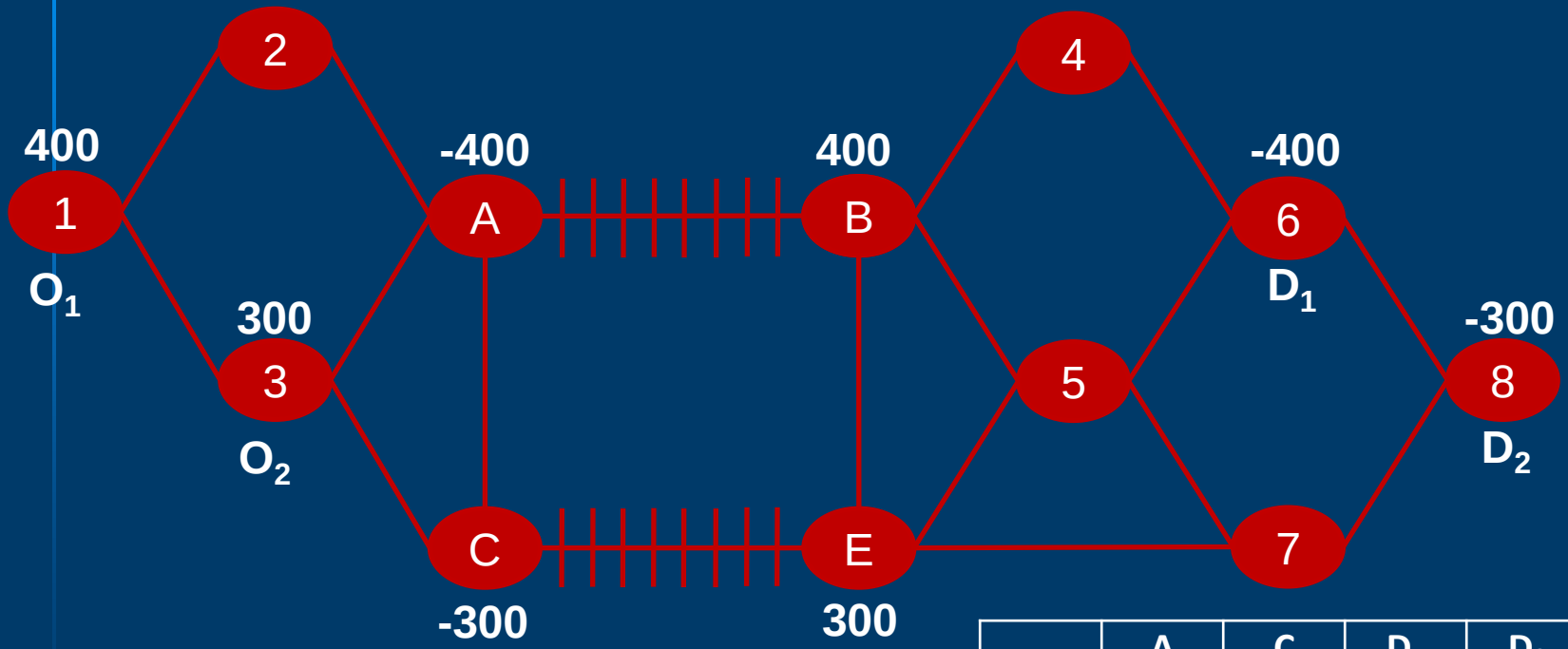


	D
O	100

	R1	D
O	100	0
R2	0	100

Truck-Rail Path Flows from Link Flows

- **Step 0:** Transform O-D Matrix; perform assignment

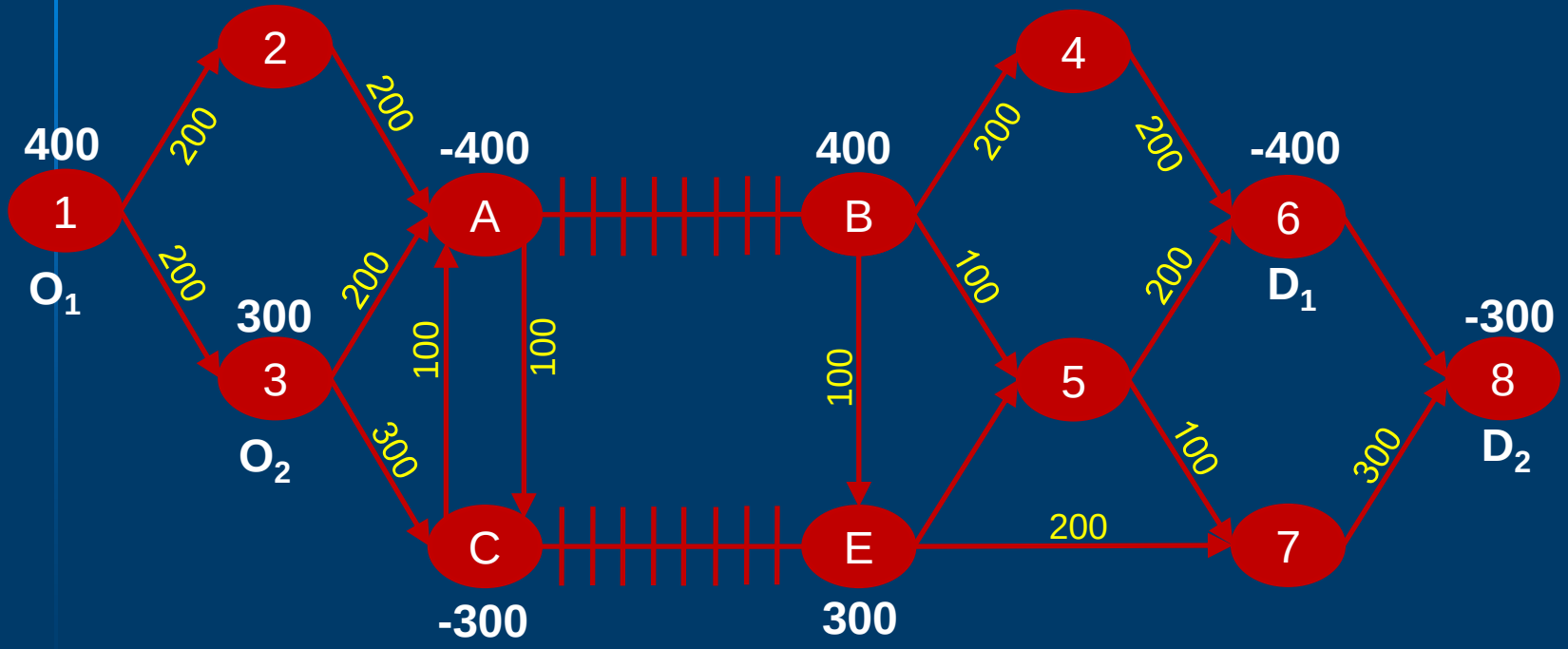


	D_1	D_2
O_1	400	0
O_2	0	300

	A	C	D_1	D_2
O_1	400	0	0	0
O_2	0	300	0	0
B	0	0	400	0
E	0	0	0	300

Truck-Rail Path Flows from Link Flows

- **Step 1:** Perform equilibrium assignment using modified trip table

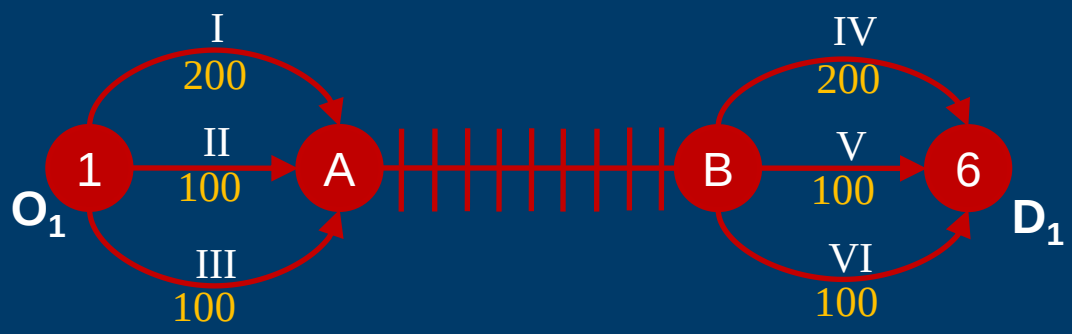


Truck-Rail Path Flows from Link Flows

- **Step 2:** Find all paths connecting Origin to rail access; and paths connecting rail egress to Destination
  - » This step is usually unnecessary as all paths are tracked during assignment procedure
- Else, one can use a modified shortest path algorithm to find all shortest paths
  - » Not a fast technique. Not recommended
- **Step 3:** Store all the paths and set flow on the path equal to flow of the link on the path that constricts the flow

Truck-Rail Path Flows from Link Flows

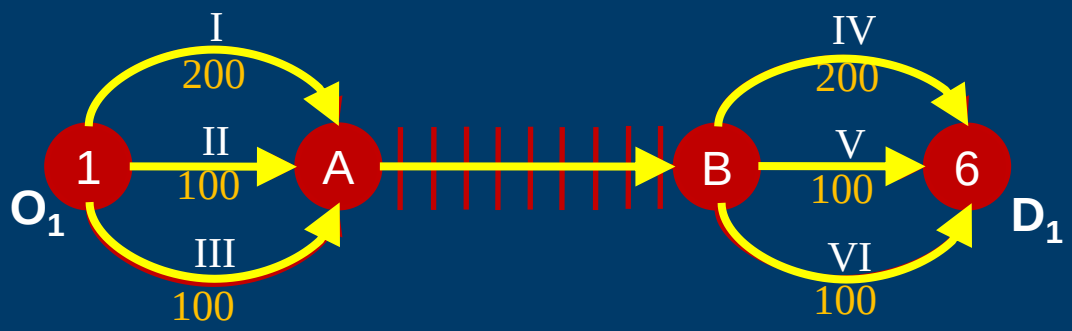
- **Steps 2 and 3 for first O-D pair:**



LIST	
Path	Flow
I	200
II	100
III	100
IV	200
V	100
VI	100

Truck-Rail Path Flows from Link Flows

- **Step 4:** Flow Decomposition Algorithm. For the first O-D pair



Paths	Flows
I - A - B- IV	200
II - A - B- V	100
III - A - B- VI	100

LIST	
Path	Flow
I	200
II	100
III	100
IV	200
V	100
VI	100

- **Step5:** Repeat for all O-D pairs

Summary and Future Work

- The methodology allows us to determine which O-D pairs are practical and which are not for disaggregation
  - » Prevents inclusion of O-D pairs that should not be included
  - » Helps reduce model run times
  - » For every link we get disaggregated O-D flows
- Apply methodology to Florida FAF2 database
- Develop validation methods
  - » ODME to understand truck portion of movements

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