Trip Generation

CEE 320
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Trip Generation

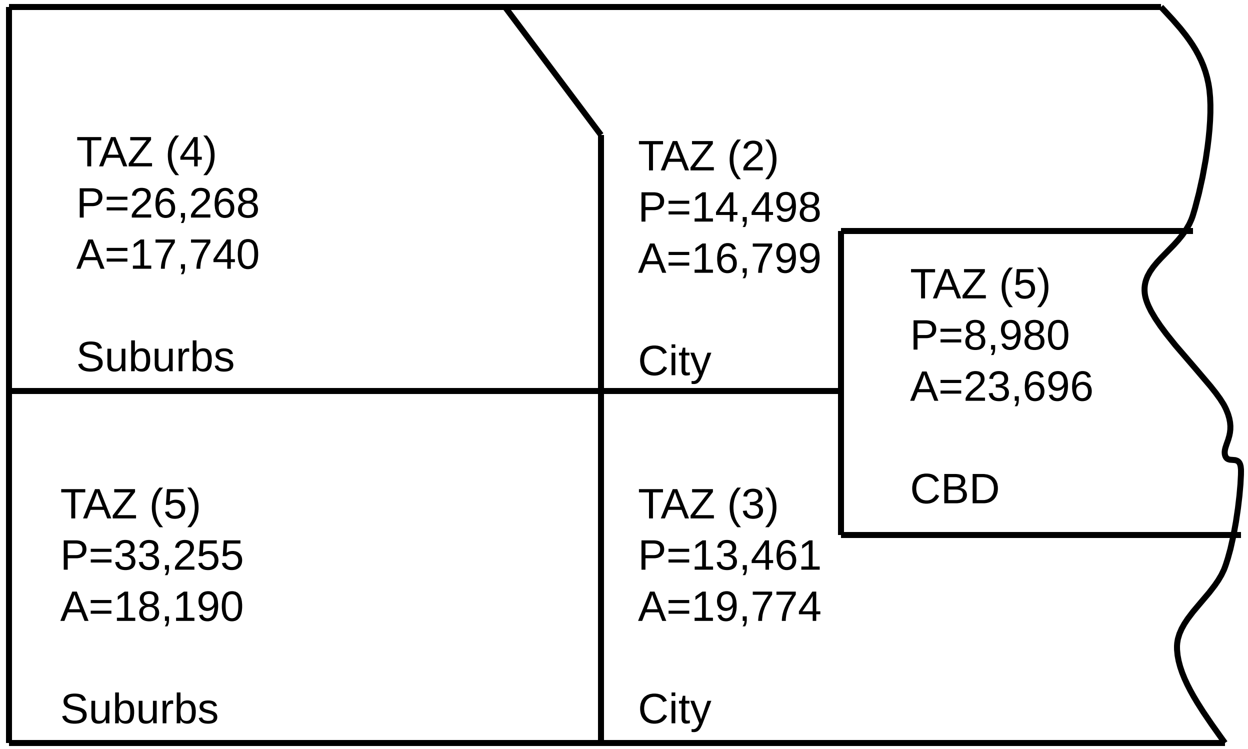
- Relates the number of trips being produced from a zone or site by time period to the land use and demographic characteristics found at that location.
- Assumptions:
  - Trip-making is a function of land use
  - Trips are made for specific purposes (work, recreation)
  - Different trip types are made at different times of the day
  - Travelers have options available to them
  - Trips are made to minimize inconvenience
  - System modeling is based on Traffic Analysis Zones and networks
- Poisson model often used

Trip Generation

- Trip productions and attractions are computed for each zone by land use
- Trip Purposes
  - HBW – Home based work trip
  - HBNW – Home based nonwork trip
  - NHB – Non-home based trip
- Usually computed using trip generation rates estimated through empirical data

Trip Generation

An example trip generation map:



P = trips produced, A = trips attracted

Trip Generation

- **Purpose**
  - **Predict how many trips will be made**
  - **Predict when a trip will be made**
- **Approach**
  - **Aggregate decision-making units (households or companies)**
  - **Categorized trip types**
  - **Aggregate trip times (e.g., AM, PM, rush hour)**
  - **Generate Model**

Truck Trip Generation

- **Use employment to estimate truck trips for a variety of landuses**
- **Any facility generates the same number of trips per metric**
- **Trips are estimated separately for light, medium, and heavy duty trucks**
- **For marine ports trips are often generated using ship arrivals or terminal acres**
- **For warehousing, trips are generated using square footage or employees**
  - Range from .02 to .5 trips per day per 1000 square feet
  - Per employee these range from 0.3 to 0.7 trips per day
  - Estimated based on empirical observation
- **Tonnage is often used instead of trips**

Motivations for Making Trips

- Lifestyle
  - Residential choice
  - Work choice
  - Recreational choice
  - Kids, marriage
  - Money
- Life stage
- Technology

Trip Generation Models

1 if married, 0 if not married

- **Linear (simple)**

$$T = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots \beta_n x_n$$

  - **Number of trips is a function of user characteristics**
  - **Estimate parameters through least squares**

Estimate a day of the week model

Trip Generation Models

- **Poisson**
  - **gives the <u>average</u> number of daily trips**
  - **can also calculate the probability of making X number of trips in a day**

$$\ln \lambda_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots \beta_n x_n$$

$$P(T) = e^{-\lambda} \left(\frac{\lambda^T}{T!} \right)$$

Poisson Distribution

- **Count distribution**
  - **Uses discrete values**
  - **Different than a continuous distribution**

$$P(n) = \frac{(\lambda t)^n e^{-\lambda t}}{n!}$$

P(n)	=	probability of exactly n trips being generated over time t
n	=	number of trips generated over time t
λ	=	average number of trips over time, t
t	=	duration of time over which trips are counted (1 day is typical)

Poisson Ideas

- Probability of exactly 4 trips being generated
  - P(n=4)
- Probability of less than 4 trips generated
  - P(n<4) = P(0) + P(1) + P(2) + P(3)
- Probability of 4 or more trips generated
  - P(n≥4) = 1 – P(n<4) = 1 – (P(0) + P(1) + P(2) + P(3))

- Amount of time between successive trips

$$\boxed{P(0) = P(h \geq t) = \frac{(\lambda t)^0 e^{-\lambda t}}{0!} = e^{-\lambda t}}$$

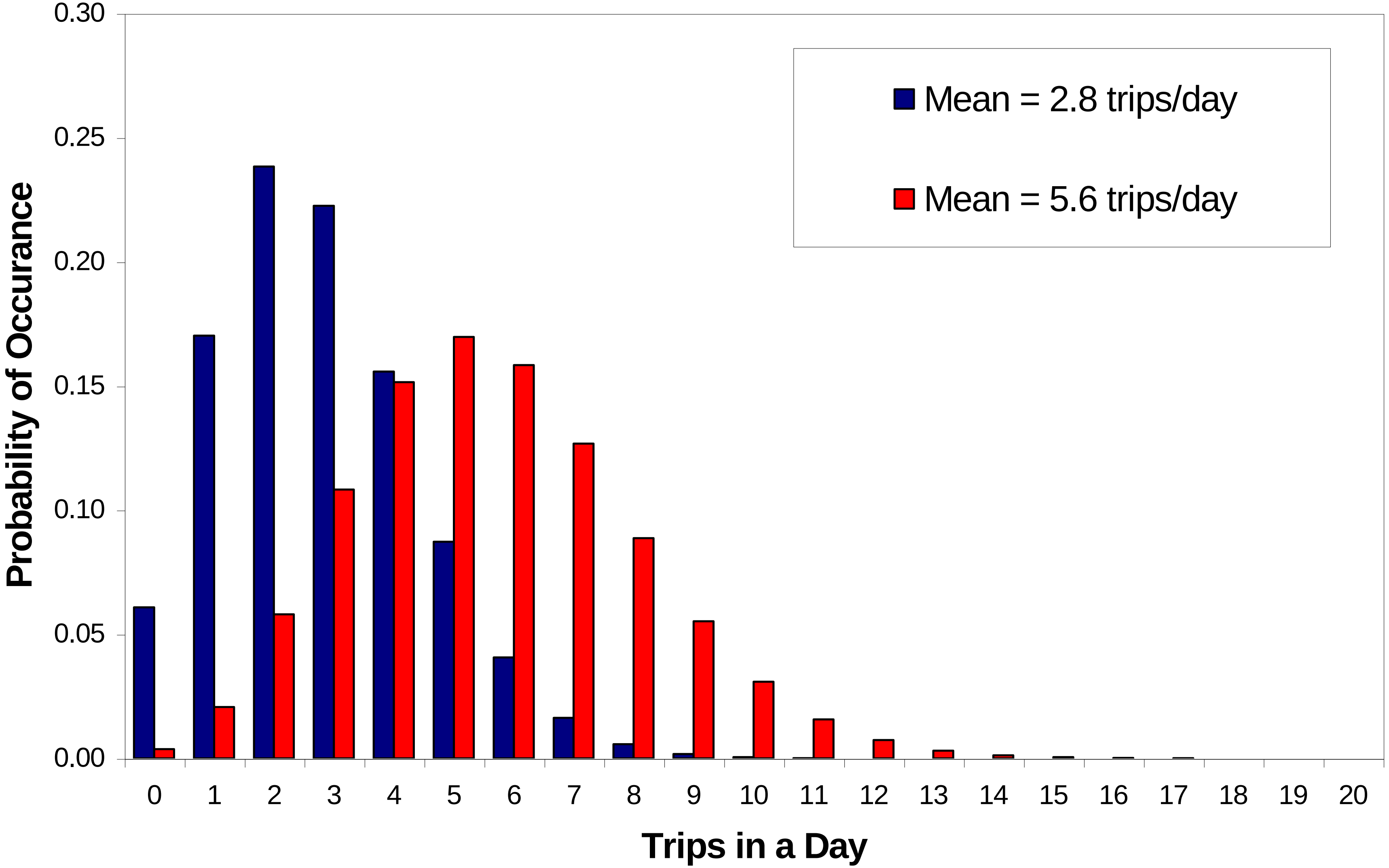
Poisson Distribution Example

Trip generation from my house is assumed Poisson distributed with an average trip generation per day of 2.8 trips. What is the probability of the following:

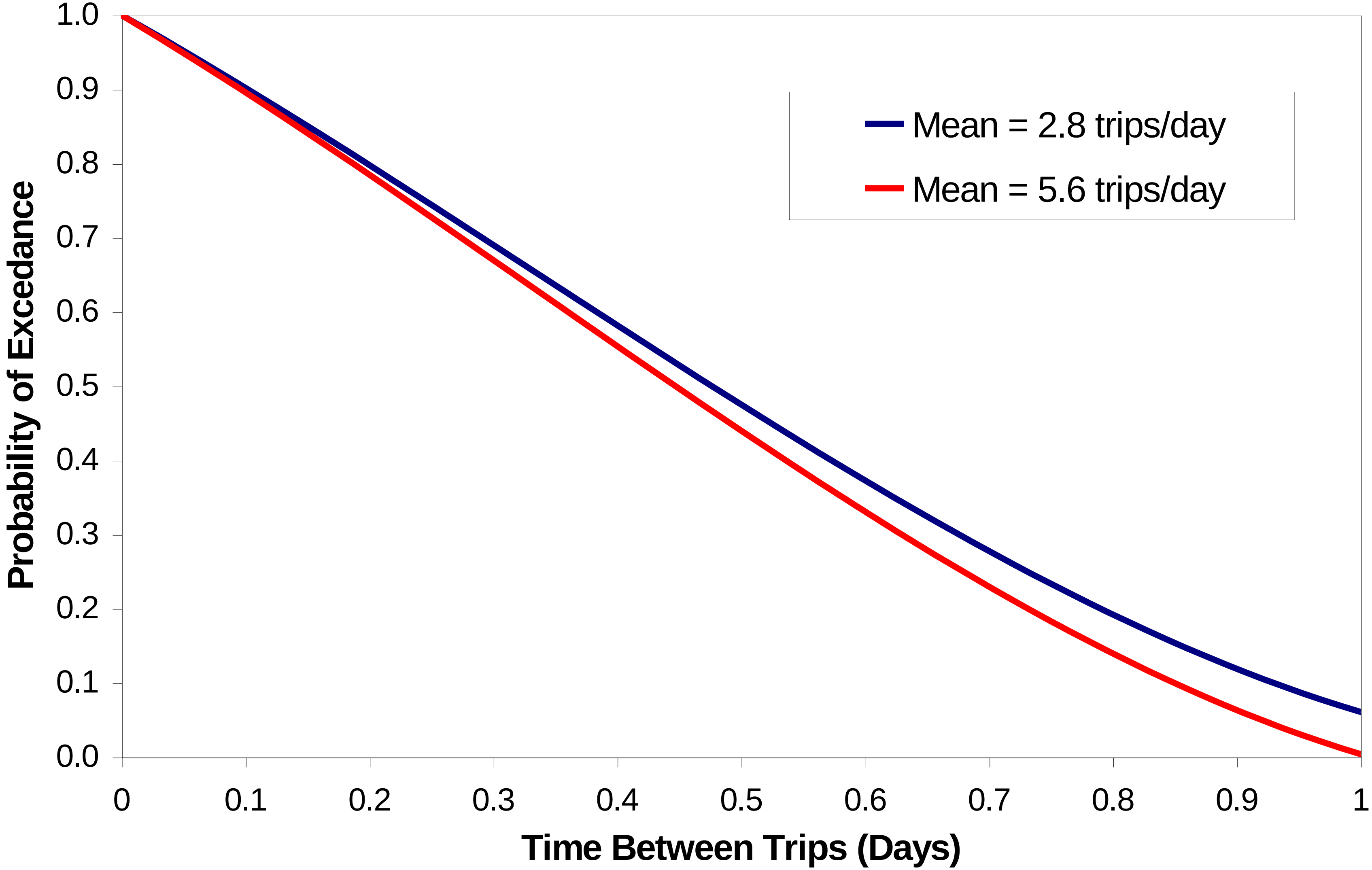
1. Exactly 2 trips in a day?
2. Less than 2 trips in a day?
3. More than 2 trips in a day?

$$P(n) = \frac{(2.8\ \text{trips/day} \times t)^n e^{-(2.8\ \text{trips/day})t}}{n!}$$

Example Graph



Example: Time Between Trips



Variable	Coefficient	Value	Product
Constant	0	1	0
Education (undergraduate degree or higher)	0.15	1	0.15
Income	0.00002	45,000	0.9
Whether or not individual owns an SUV	0.1	1	0.1
Whether or not individual owns a sports car	0.05	0	0
Whether or not individual owns a van	0.1	1	0.1
Whether or not individual owns a sedan	0.08	0	0
Whether or not individual uses a bicycle to work	0.02	0	0
Whether or not individual uses the bus to work all the time	-0.12	0	0
Number of autos owned in the last ten years	0.06	6	0.36
Gender (female)	-0.15	0	0
Age	-0.025	40	-1
Internet connection at home	-0.06	1	-0.06
Married	-0.12	1	-0.12
Number of kids	0.03	2	0.06
		Sum =	0.49

λ_i = 1.632 trips/day

Example

Recreational or pleasure trips measured by λ_i (Poisson model):

$$\ln \lambda_i = \beta_0 + \beta_1 * education + \beta_2 * income$$
$$+ \beta_{31} * suv + \beta_{32} * sports + \beta_{33} * van + \beta_{34} * sedan + \beta_{35} * bicycle$$
$$+ \beta_{36} * bus + \beta_{37} * \#autos$$
$$+ \beta_4 * gender + \beta_5 * age + \beta_6 * internet + \beta_7 * married + \beta_8 * kids$$

Example

- **Probability of exactly "n" trips using the Poisson model:**

$$P(0) = e^{-1.632}\left(\frac{1.632(0)}{0!}\right) = 0.20 \qquad P(1) = e^{-1.632}\left(\frac{1.632(1)}{1!}\right) = 0.32$$

- **Cumulative probability**
  - **Probability of one trip or less: P(0) + P(1) = <u>0.52</u>**
  - **Probability of at least two trips: 1 – (P(0) + P(1)) = <u>0.48</u>**

- **Confidence level**
  - **We are <u>52%</u> confident that no more than one recreational or pleasure trip will be made by the average individual in a day**