



Matrices and Trip Distribution
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- **Summary-**
 - Learning to model trip distribution given trip generation with multi-relationships.
 - Students will learn to utilize matrices to represent these concepts.
- **Engineering Connection-**
 - Understanding how people move about a given area is fundamental to transportation planning. We can gauge where people are moving and why they are moving to those destinations.
- **Audience-**
9-12th grade
- **Lesson Objectives-**
 - What is traffic modeling?
 - What is a directed graph?
 - How can mathematics be used for real engineering problems?
- **Educational Standards-**
 - Thinking Like a Mathematician
 - Applying functional reasoning to model real world situations
- **Material List-**
 - Pencil
 - Paper
 - Slideshow
 - Handouts of relevant data
- **Introduction-**
To expose students to mathematical modeling of multi-way relationships and finding equilibrium solutions to problems with graph structures. They will use basic graph theory to model free flow traffic on arbitrary road networks

represented as graphs. They will learn a general path-finding algorithm. They will use an iterative approximation method to refine their equilibrium solution. They will gain relevant problem-solving experience with questions regarding infrastructure networks. They will develop a deeper understanding of urban planning problems and civil engineering. They will abstract away from individual agents in a system focusing on large scale population dynamics.

Procedure-

- Background knowledge
 - Directed graphs/graph theory
 - Algebra 2
 - Geometry
 - Linear Programming
- Before the activity
 - Make copious amounts of diagrams/graphs/tables
 - Maps
 - Prepare walk-through examples for Dijkstra's
- During the activity
 - Students will construct an origin/destination table
 - Students will conduct trip distribution calculations of data given to them
 - Students will conduct shortest path calculations on the network
- After the activity
 - Ask students for other example problem settings they can think of to apply graphs/traffic modeling
- **Assessment-**
 - When they can confidently explain what each calculation is for and why we perform them in the grand scheme of the method.
 - When they can explain what each quantity involved in our method represents
- **Wrap-up-**
 - Students will be shown real world examples of these computational techniques, so they know when to apply them.
 - Students can be asked to apply concepts from what they just learned to attempt to model hallway traffic between classes. They will be asked to point out fundamental differences in that scenario vs. road traffic.