1. Street-Routing Problems

2. Definitions

3. Examples

4. Assignment
There are many problems that fall under the heading “Street-Routing Problems.”
We will consider five of them.
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- The Security Guard Problem
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- The Königsberg Bridge Problem
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- The Bridges of Madison County
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- The Security Guard Problem
- The Mail Carrier Problem
- The Königsberg Bridge Problem
- The Bridges of Madison County
- The Traveling Salesman Problem
The Security Guard Problem

Example (The Security Guard Problem)

A security guard must patrol every street of the neighborhood.

What route should he follow to minimize the total distance?

Must he walk some streets twice?
The Mail Carrier Problem

Example (The Mail Carrier Problem)

- A mail carrier must deliver mail to both sides of every street of the neighborhood, except the boundary.
- What route should he follow to minimize the total distance?
- Must he walk some streets twice?
The Königsberg Problem

Example (The Königsberg Problem)

- A Königsberger would like to take a stroll across the seven bridges.
- Can it be done without ever crossing the same bridge twice?
- Does it matter where the stroller starts?
A photographer wants to photograph each of the 11 bridges of Madison County.

He must cross the bridge to photograph it and each bridge has a $5 toll.

What route will minimize the total cost?
A photographer wants to photograph each of the 11 bridges of Madison County.

He must cross the bridge to photograph it and each bridge has a $5 toll.

What route will minimize the total cost?
A salesman is located in a city.

He must make a trip during which he visits each of a number of cities and return to his home city.

He knows the distance from every city to every other city.

What route will minimize the total distance traveled?
Outline

1. Street-Routing Problems
2. Definitions
3. Examples
4. Assignment
Definitions

Definition

A graph is a collection of vertices and edges. We normally draw the vertices as dots and the edges as lines. Each edge connects a pair of vertices.
We can give the vertices labels, e.g., $A$, $B$, $C$, etc. Then use those labels to identify the edges, e.g., $AB$, $AC$, etc.
Definitions

Definition (Path)

A path is a sequence of edges, each edge adjacent to the next edge. We may denote a path by listing the vertices through which it passes. (E.g., $DABC$.)
Definition (Circuit)

A circuit is a path that begins and ends at the same vertex. (E.g., ABCA.)
Definition (Weighted Graph)

A weighted graph is a graph in which every edge is assigned a value (its weight).
1. Street-Routing Problems
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In the Security Guard Problem, we want a path that traverses every edge \textit{at least once} and has the minimal total length.
In the Mail Carrier Problem, we want a path that traverses every edge \textit{at least twice} (except the boundary) and has the minimal total length.

With the duplicated edges, the Mail Carrier Problem is the same as the Security Guard Problem.
In the Bridges of Königsberg Problem, we want a circuit that traverses each edge \textit{exactly once}. 
Example (The Bridges of Königsberg Problem)

- We draw a graph that shows only the relevant parts.
In the Bridges of Madison County Problem, we want a circuit that traverses each edge at least once and has the minimal total length.

This is the same as the Security Guard Problem.
In the Traveling Salesman Problem, we want a circuit that visits each vertex \textit{at least once} and has the minimal total length.
Assignment

- Chapter 5 Exercises 2, 3, 7, 13, 15, 19, 20, 21, 22, 27.