Introduction
CSCI 338

True or False?

Finding shortest paths in a distance-weighted graph can be done easily (i.e. in polynomial time).

True or False?

Finding shortest paths in ~~~~~~~ ghted graph can be done ~~~~ polynomial time).

TRUE – Dijkstra's Algorithm

True or False?

That cost at most 20   **and cost**

Finding shortest paths in a distance-weighted graph can be done easily (i.e. in polynomial time).

True or False?

That cost at most 20 **, and cost**

Finding shortest paths in weighted graph can be done in polynomial time).

UNKNOWN!!!

True or False?

Can you build a program that will answer the question:
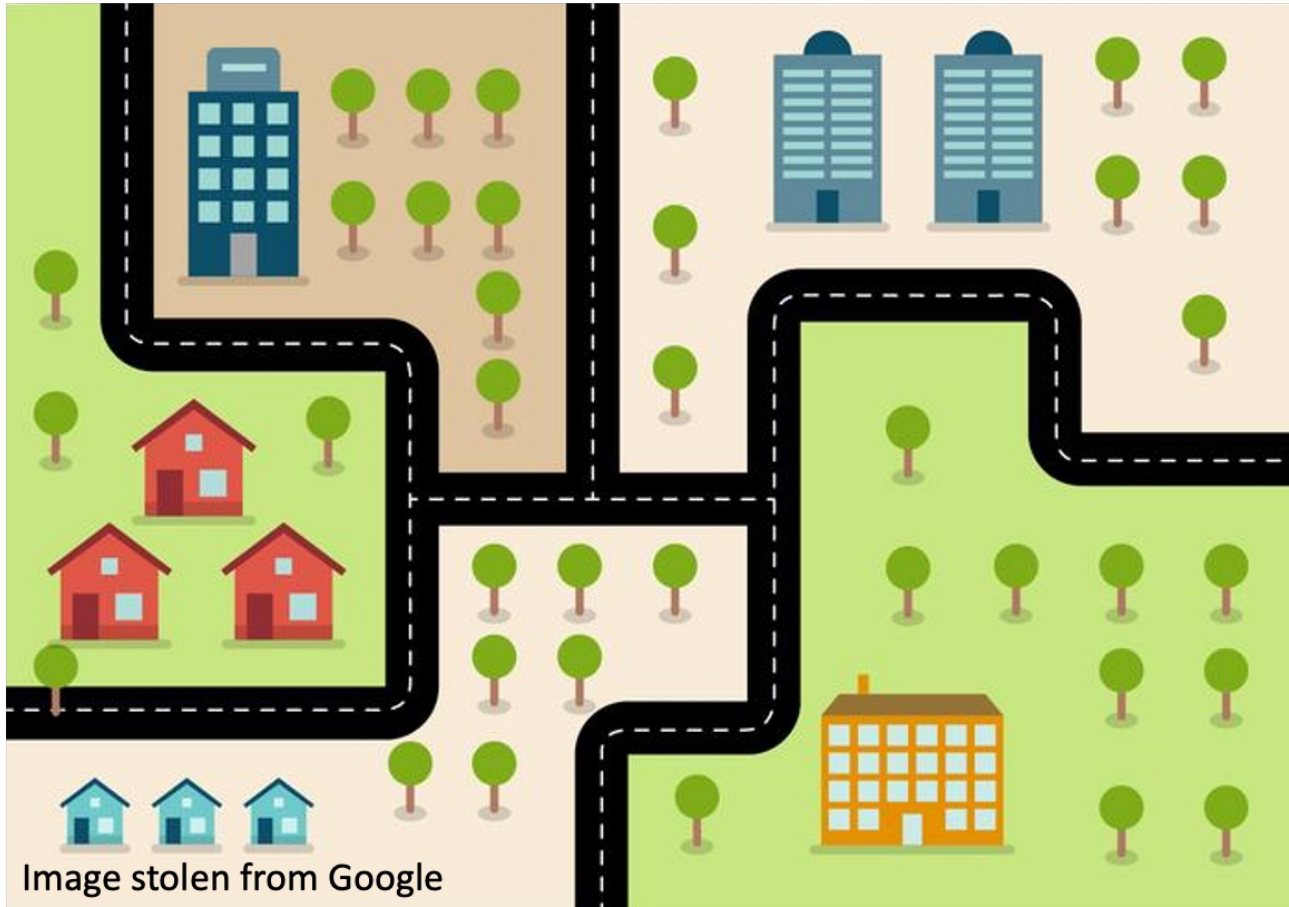"Will this input code terminate eventually?"

True or False?

Can you build a pro~~gram~~ ~~tion:~~
"Will th~~e~~ ~~tually?"~~

FALSE – Unsolvable problems exist, regardless of the computer!

Mathematical Model
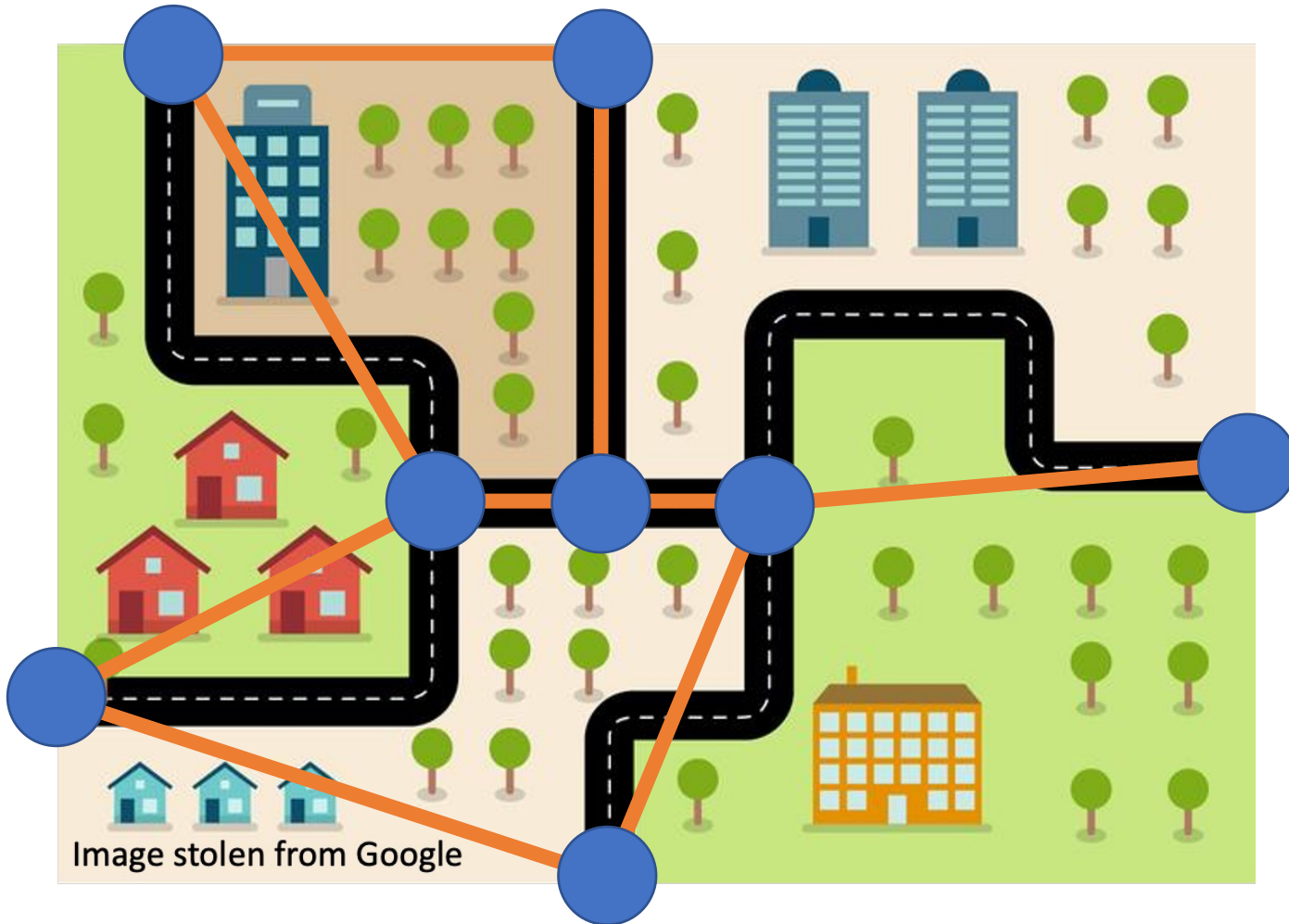

Image stolen from Google

Mathematical Model:
- A rigorous mathematical formulation of reality.
- Used to make predictions.

Can we represent a road network as a mathematical model?

Mathematical Model

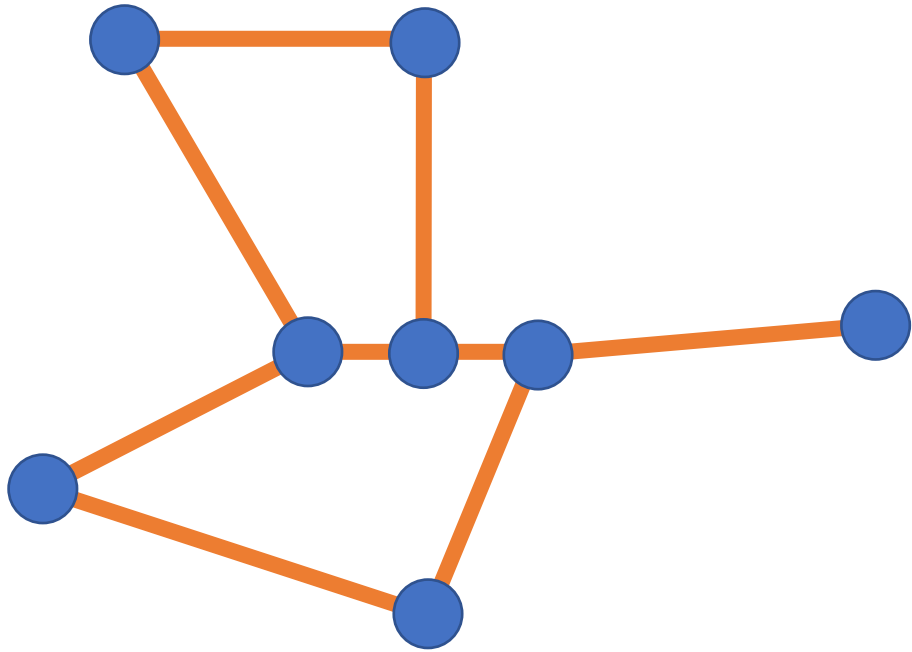

Image stolen from Google

Mathematical Model:
- A rigorous mathematical formulation of reality.
- Used to make predictions.

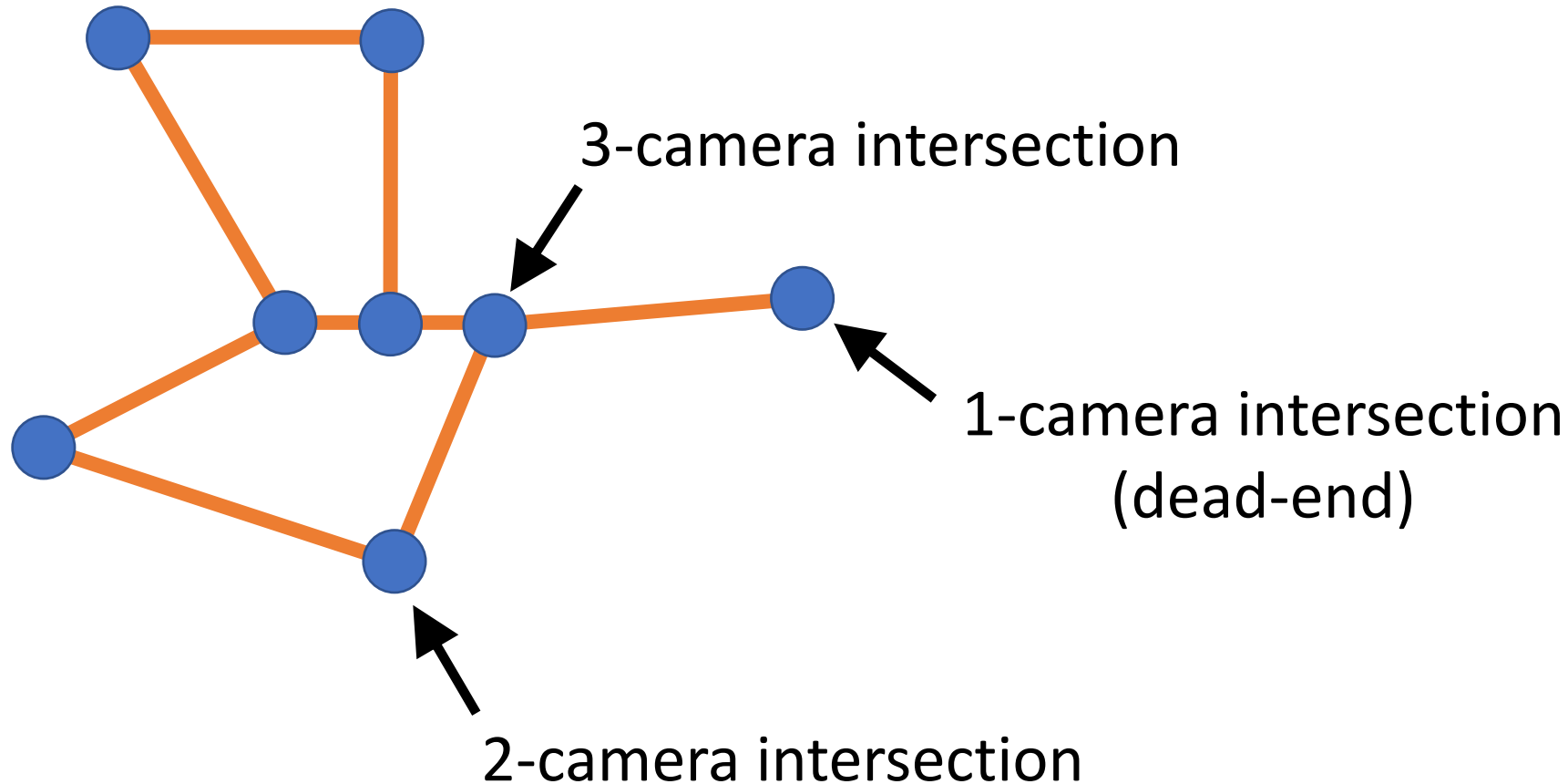Can we represent a road network as a mathematical model?

Graph? Nodes/Edges

Mathematical Model

Let's use our mathematical model of a road network to answer some questions.
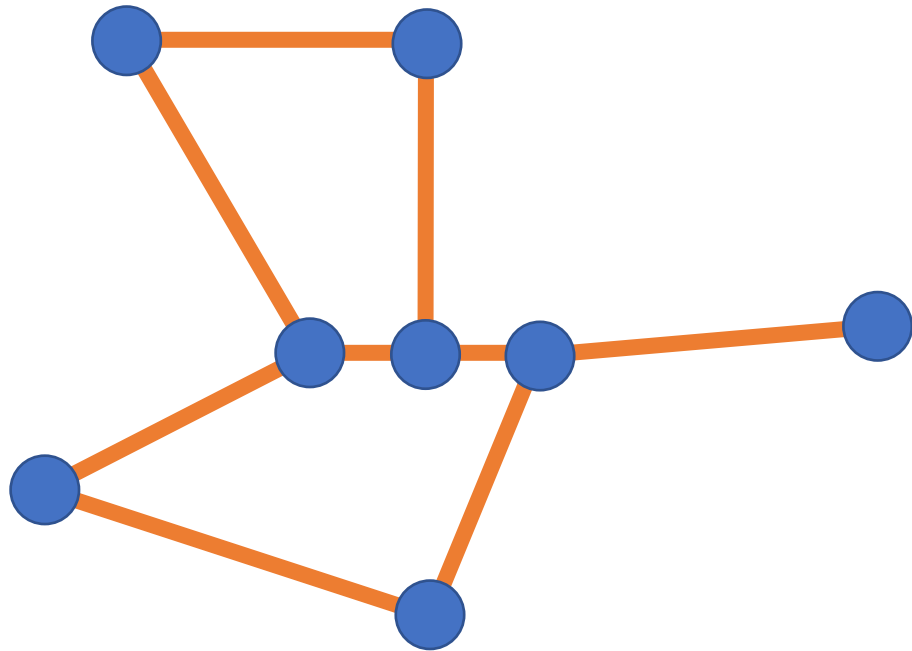
Mathematical Model

Each intersection requires a camera to monitor each road segment.

3-camera intersection

1-camera intersection
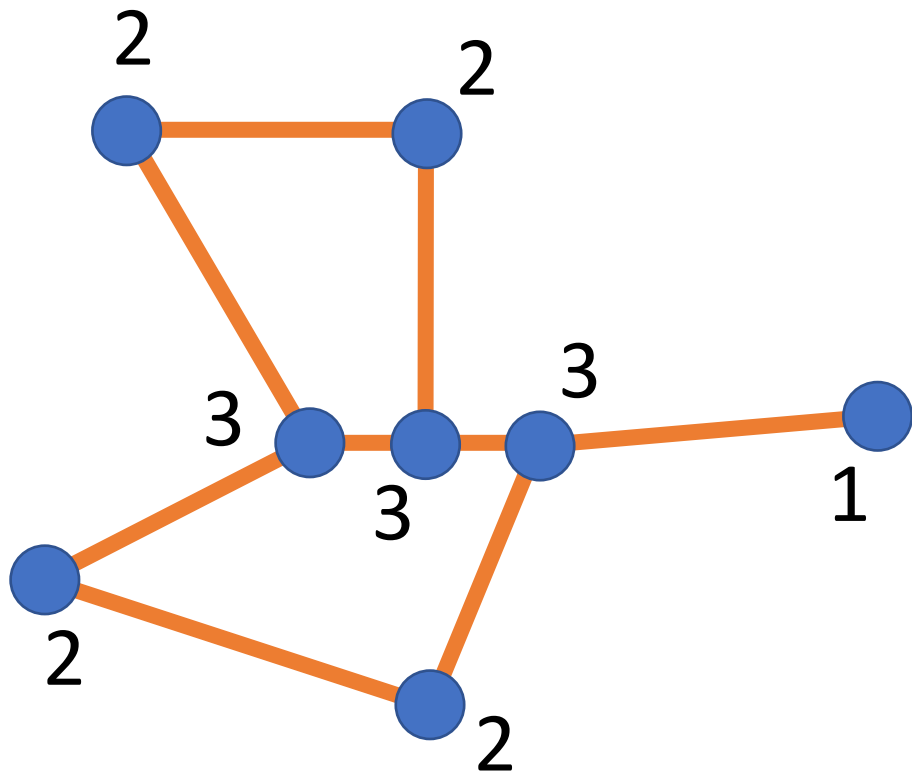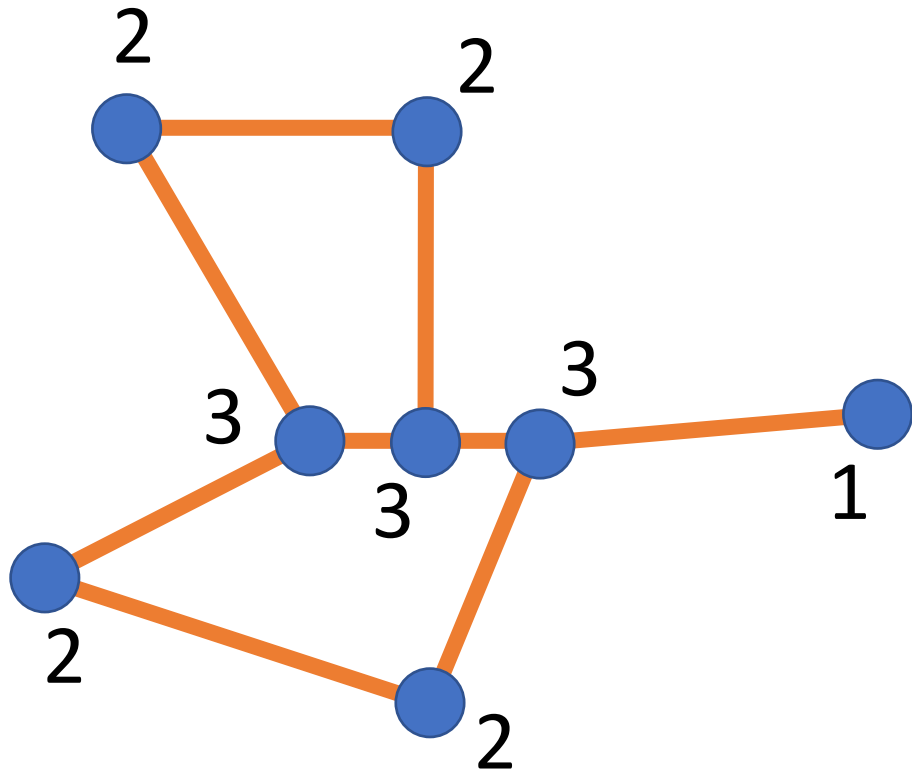(dead-end)

2-camera intersection

Mathematical Model

Each intersection requires a camera to monitor each road segment.

Can we build a road network so that the number of cameras we need is odd?

Mathematical Model

Each intersection requires a camera to monitor each road segment.

Can we build a road network so that the number of cameras we need is odd?

Mathematical Model
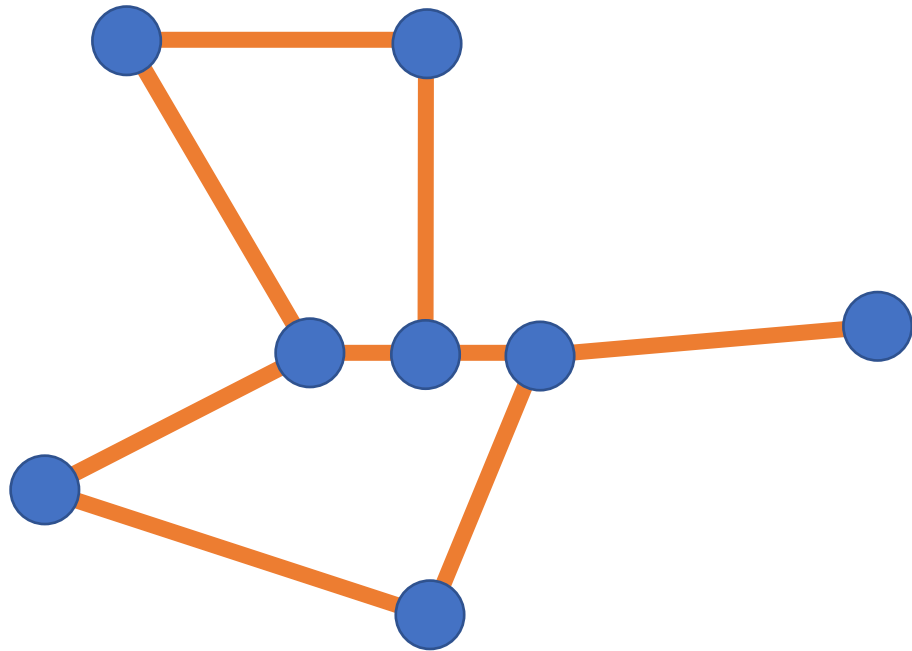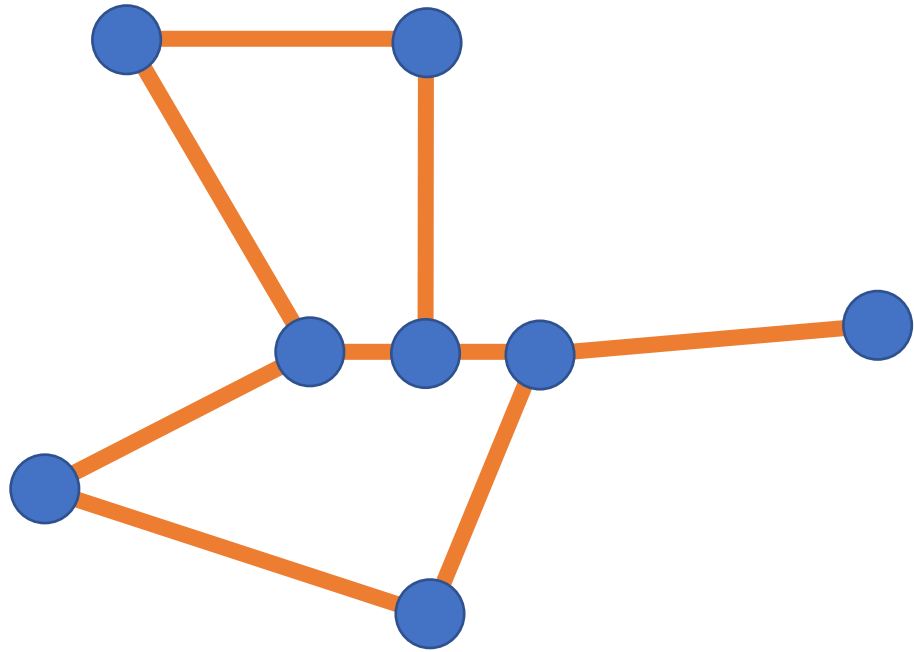

Each intersection requires a camera to monitor each road segment.

Can we build a road network so that the number of cameras we need is odd?

2+2+3+3+3+2+2+1 = 18, which is even.

Mathematical Model

Each intersection requires a camera to monitor each road segment.

Can we build a road network so that the number of cameras we need is odd?
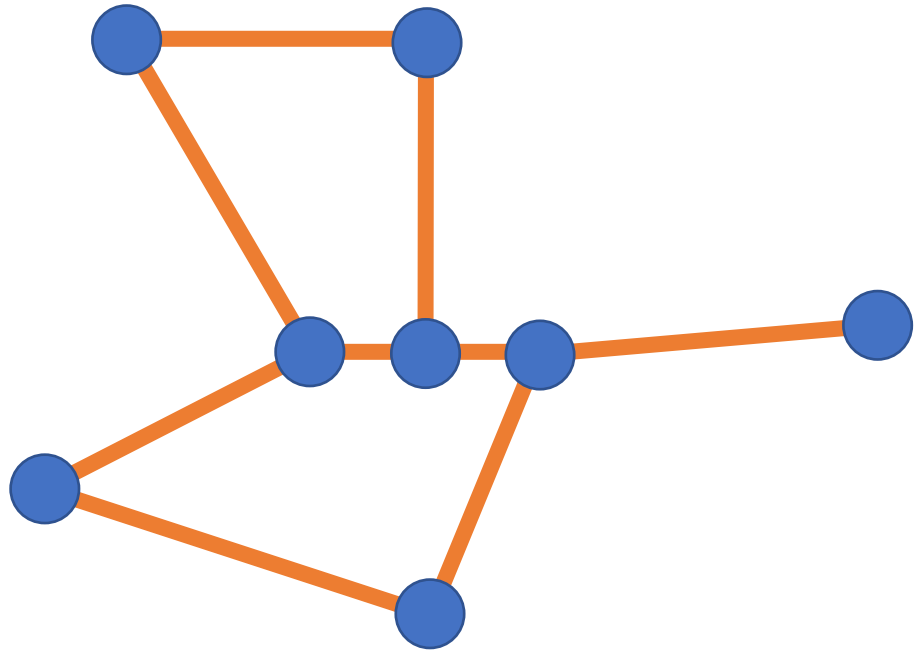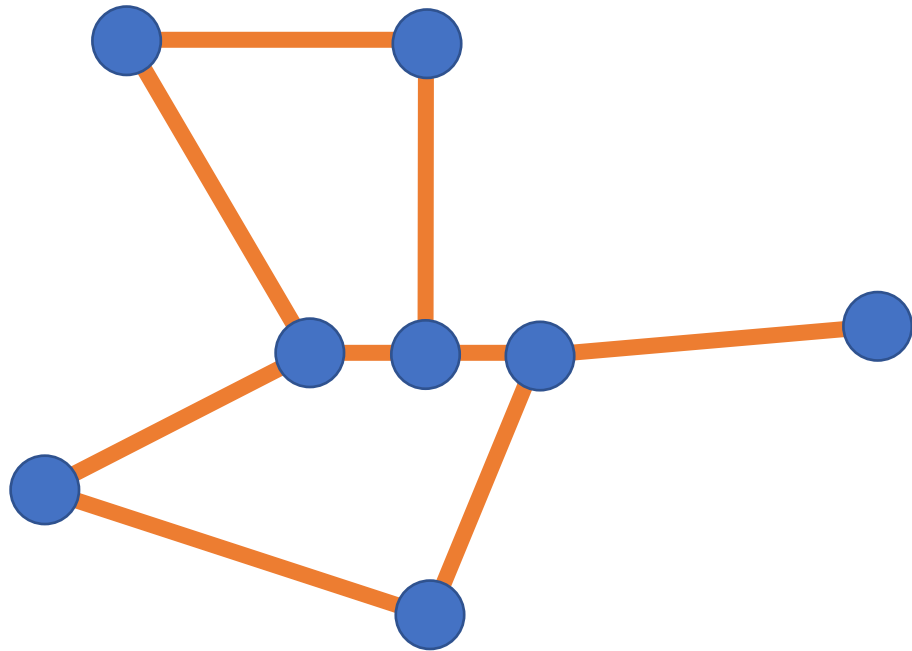
Mathematical Model

Each intersection requires a camera to monitor each road segment.

Can we build a road network so that the number of cameras we need is odd?

Each road (edge) adds ???? to the number of required cameras.
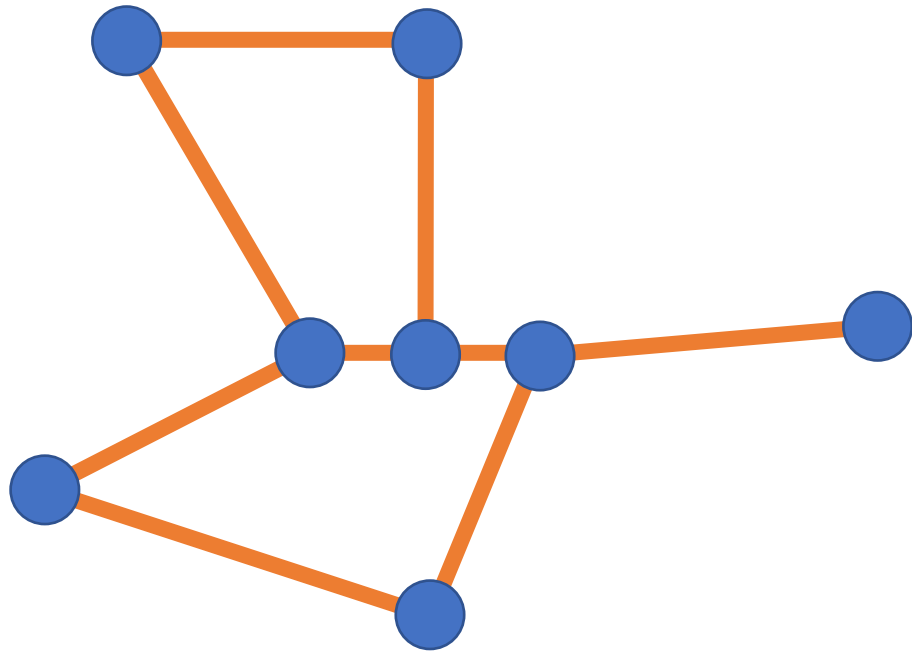
Mathematical Model

Each intersection requires a camera to monitor each road segment.

Can we build a road network so that the number of cameras we need is odd?

Each road (edge) adds two to the number of required cameras.

Mathematical Model

Each intersection requires a camera to monitor each road segment.

Can we build a road network so that the number of cameras we need is odd?

Each road (edge) adds two to the number of required cameras. So, if the road network (graph) has r roads (edges), the number of required cameras is ??
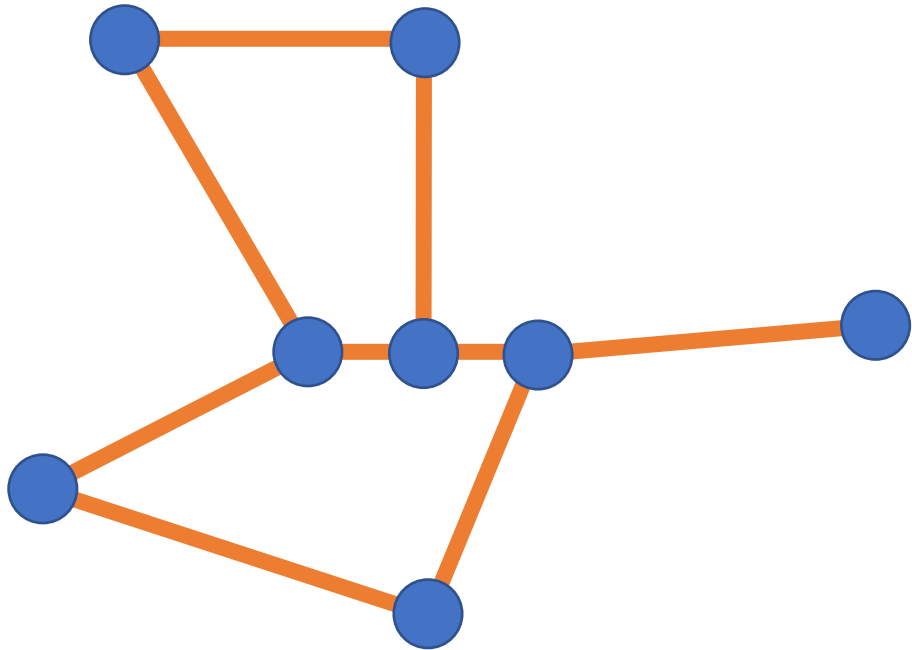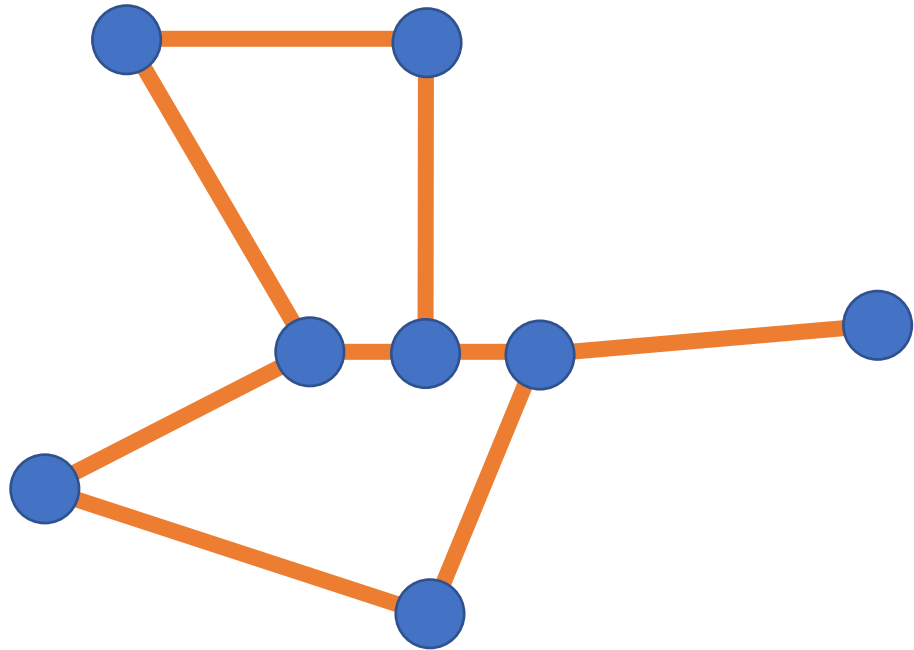
Mathematical Model

Each intersection requires a camera to monitor each road segment.

Can we build a road network so that the number of cameras we need is odd?

Each road (edge) adds two to the number of required cameras. So, if the road network (graph) has r roads (edges), the number of required cameras is $2r$.
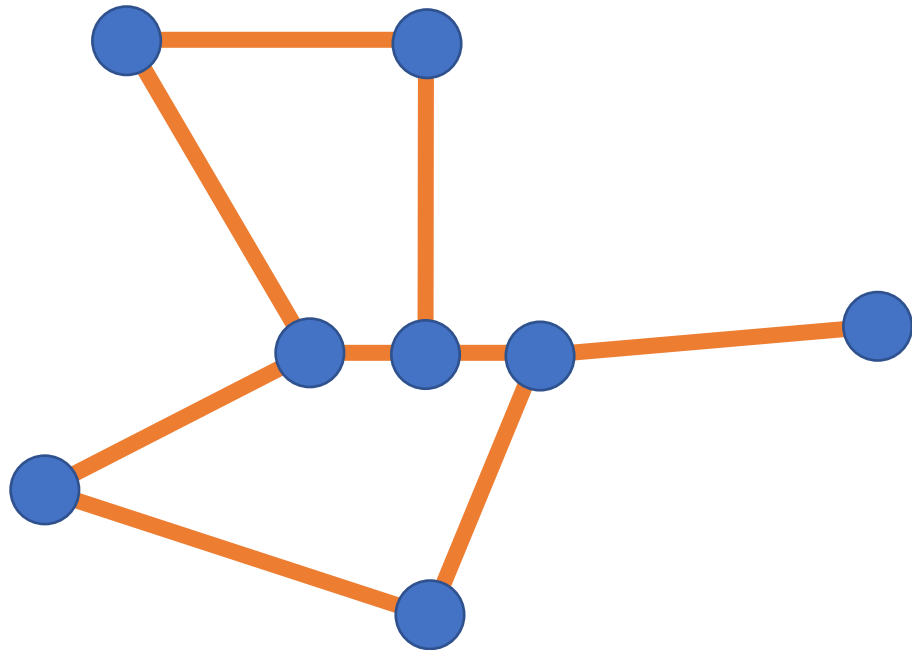
Mathematical Model

Each intersection requires a camera to monitor each road segment.

Can we build a road network so that the number of cameras we need is odd?

Each road (edge) adds two to the number of required cameras. So, if the road network (graph) has r roads (edges), the number of required cameras is $2r$, which is ???

Mathematical Model

Each intersection requires a camera to monitor each road segment.

Can we build a road network so that the number of cameras we need is odd?

Each road (edge) adds two to the number of required cameras. So, if the road network (graph) has r roads (edges), the number of required cameras is $2r$, which is even.

Mathematical Model

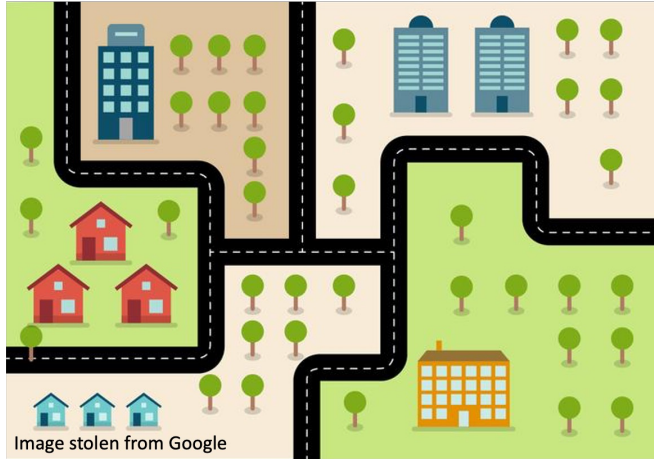Each intersection requires a camera to monitor each road segment.

Can we build a road network so that the number of cameras we need is odd?

NO!

Each road (edge) adds two to the number of required cameras. So, if the road network (graph) has r roads (edges), the number of required cameras is $2r$, which is even.
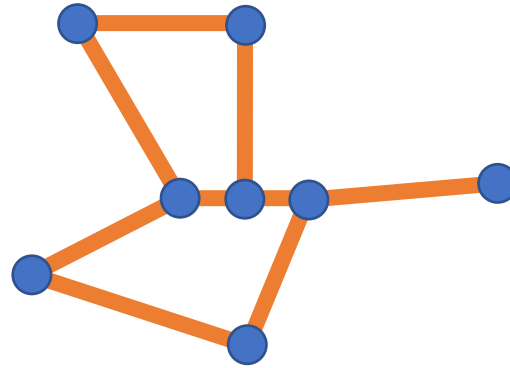
What Did We Do?

What Did We Do?
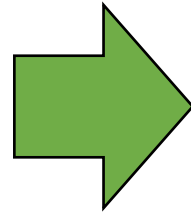

Image stolen from Google

Step 1: Considered an ill-defined, abstract, "thing".

What Did We Do?

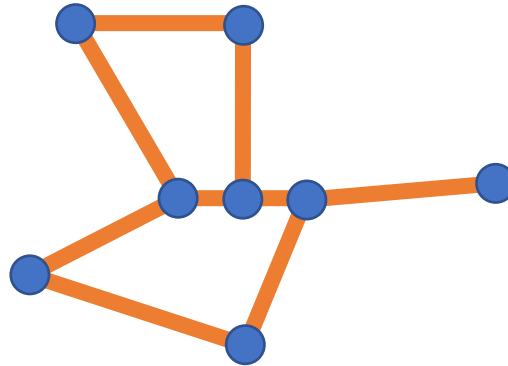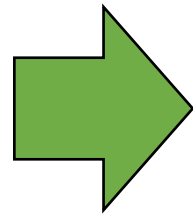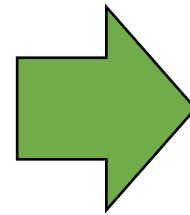Step 1: Considered an ill-defined, abstract, "thing".

Step 2: Built a formal model of it.

What Did We Do?

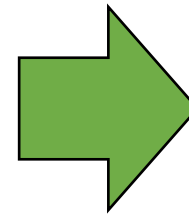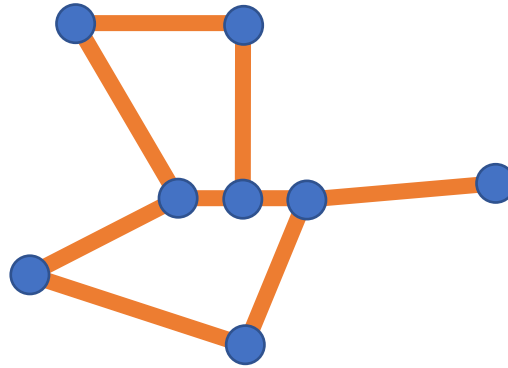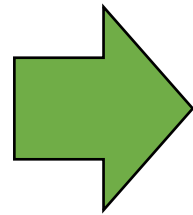Step 1: Considered an ill-defined, abstract, "thing".

Step 2: Built a formal model of it.

Impossible to build road network requiring an odd number of camera?

Step 3: Found limitations of the model, which translated to limitations of the "thing".

What Did We Do?

Image stolen from Google

Impossible to build road network requiring an odd number of camera?
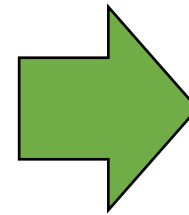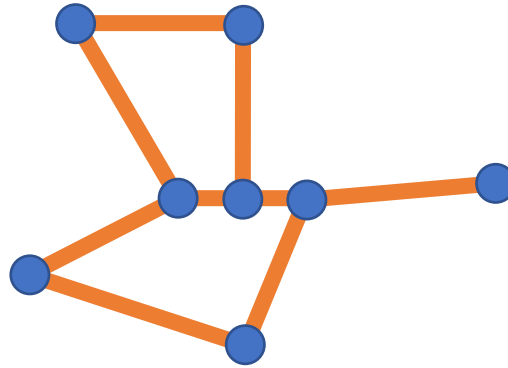
St _____ ns
an _____
ab _____ s

CSCI 338:

Step 1: Consider a computer.

Step 2: Build mathematical model of a computer.

Step 3: Find limitations of model, which translate to limitations of computers.

What Did We Do?

Impossible to build road network requiring an odd number of camera?

St..ns

an..

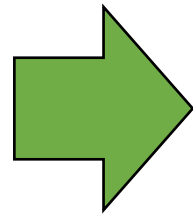ab..s

CSCI 338:

Step 1: Consider a computer.

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