

OA 4202, Homework 3.1 : The Drug Lord

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Due Thu. Oct 13 at the beginning of class

In this sequence homework assignments, we will help the Arizona state police capture an escaping drug lord.

Background. The Arizona state police have for years been gathering intelligence and building a case against a drug lord, Tihomir Anastazov, operating out of Flagstaff, Arizona. Just today, the police were finally ready to raid the drug lord's offices, take down his operation, and arrest him.

The raids were carried out in the morning, gathering plenty of evidence to convict Tihomir. However, Tihomir's network of informants is vast, and somehow, he received a tip-off about the upcomming raids. Now, Tihomir is on the run, trying to escape Arizona before getting arrested.

Assignment. In this first assignment, we will model Tihomir's movements as he attempts to escape.

We know that Tihomir is trying to leave the state as quickly as he can, to escape capture. We also know that he is starting from Flagstaff. Figure 1 is a map of the Arizona state highway system.

The first step in modeling Tihomir's movements is to abstract the real network of roads and highways, into a network we can work with. We have many choices on exactly how to do this. In particular, our abstraction can be of fine-granularity (where we include every side-street, on-ramp, byroad etc.) or coarser (where we model most cities or highway intersections as nodes, and the major roads connecting them as edges). *Write a paragraph or two of discussion on the advantages and disadvantages fine-granularity models vs. coarse-granularity models.*

We have decided to abstract the Arizona state highway system to the graph in Figure 2. We know that Tihomir's starting point in this network is Flagstaff, and that his goal is to leave the state as quickly as possible. To compute Tihomir's escape route, as discussed in class, we must give him a destination node. We could do this by connecting a single node called "Escape" to each of the edges coming out of Arizona. However, anticipating that Tihomir may prefer to escape to Mexico, instead of simply another US state, we will create three extra nodes: "Mexico," "Other US State," and "Escape." Figure 3 pictures the final abstract network, including the three extra nodes.

Ok, now we are ready to actually compute Tihomir's escape routes. This is your homework assignment.

Go to the course webpage and download the archive **3-1-files.zip**. Unzipping the archive will give you access to the following files:

1. **arizona-state.jpg** – The Arizona highway map.
2. **arizona-escape-nodes.pdf** – An overlay of our abstract network over the highway map.
3. **arizona_nodes.csv** – A listing of all the nodes in our abstract network
4. **arizona_arcs_set.csv** – A listing of all the arcs in our abstract network

5. `arizona_arcs_data.csv` – The data for our network’s arcs. In particular, each arc’s distance is given in *abstract-map units*, simply derived from the coordinates of the nodes in the abstract map.
6. `shortestpath.gms` – A GAMS file to help you start your homework.

For homework do the following:

1. Write the one or two paragraphs of discussion mentioned in this writeup.
2. Program a shortest path LP in GAMS, using `shortestpath.gms` as a starting point.
3. Using your GAMS code, compute and give Tihomir’s best escape route when there are no road blocks.
4. Use the distance from Yuma to Gila Bend to derive a conversion from abstract-map units to miles. Assuming that traffic moves at 65 miles per hour, and that a roadblock adds 30 minutes of wait time, compute an appropriate value to the parameter `delay` that is given in the GAMS code.
5. Using the `delay` parameter from the previous problem, re-solve your GAMS shortest path LP, but this time placing a roadblock from Tuba City to Marble Canyon. You should be able to do this *without* touching the data in `arizona_arcs_data.csv`, simply by setting `xbar('TubaCity', 'MarbleCanyon')` to 1. If Tihomir knows that this single road block is in place, what is Tihomir’s new best escape route?

In addition to a hard copy of the homework assignment questions, also turn in a hard copy your working GAMS file. Underline or highlight the lines of GAMS you edited.

ARIZONA HIGHWAYS

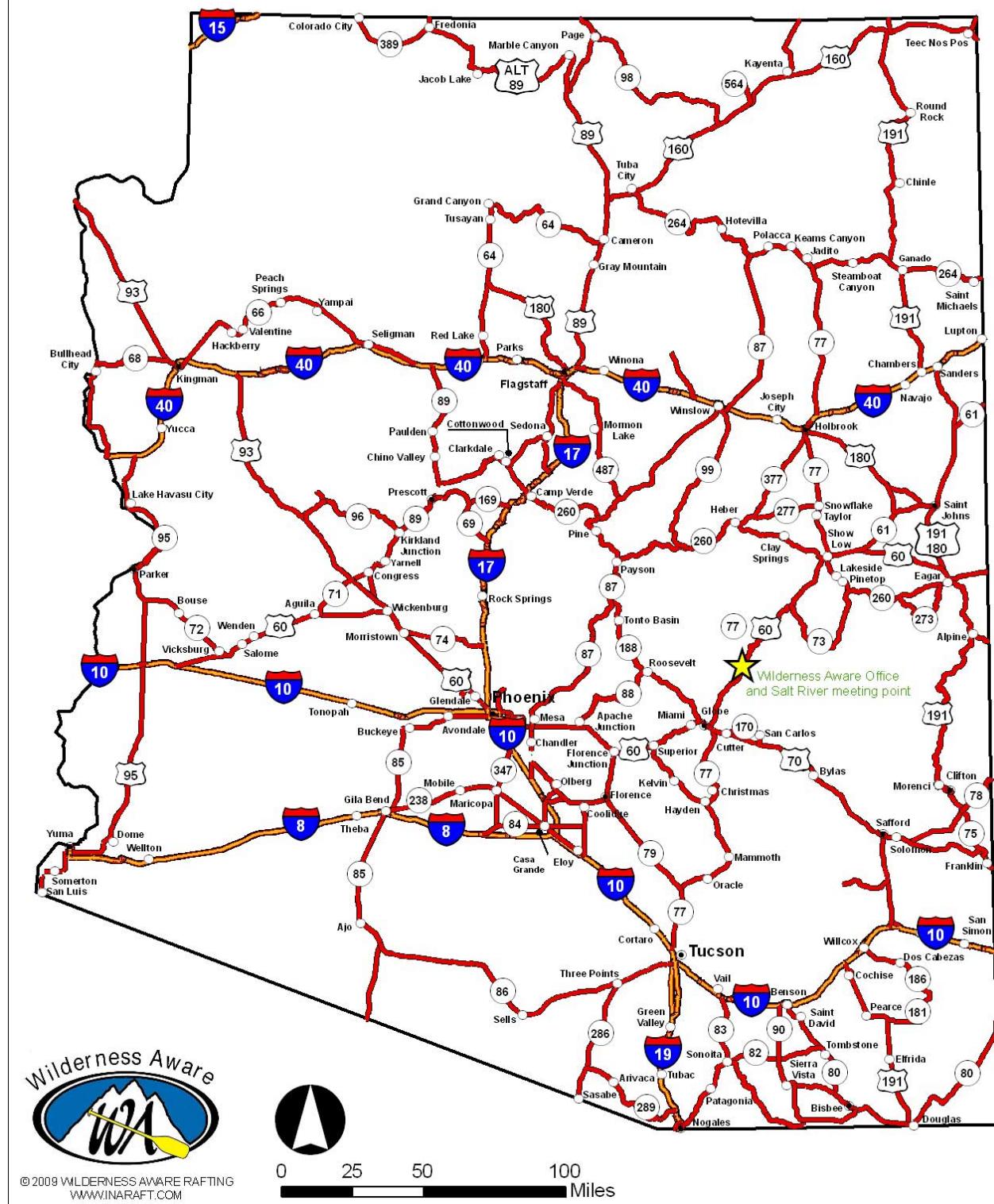


Figure 1: A map of the Arizona state highway system.

ARIZONA HIGHWAYS

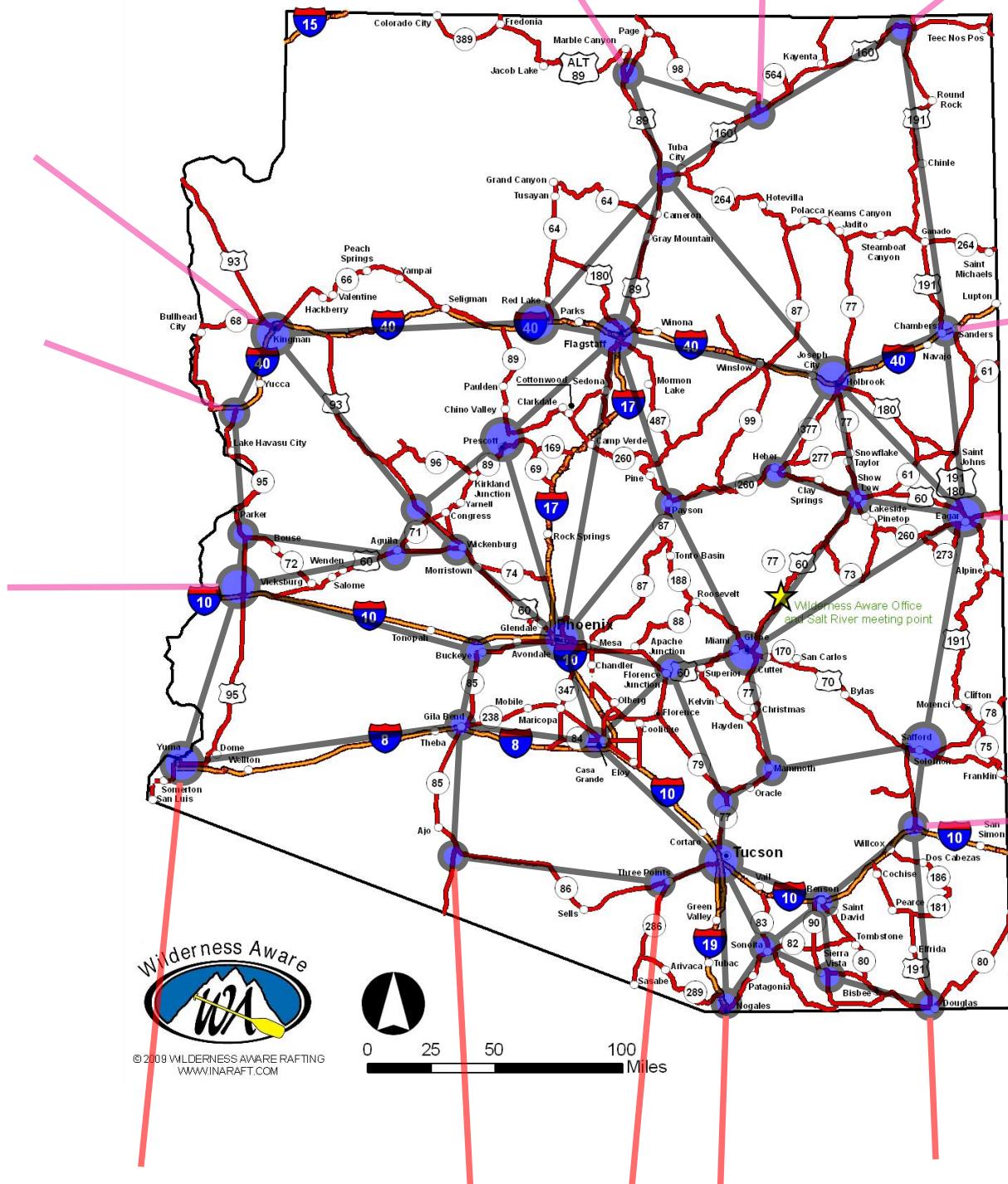
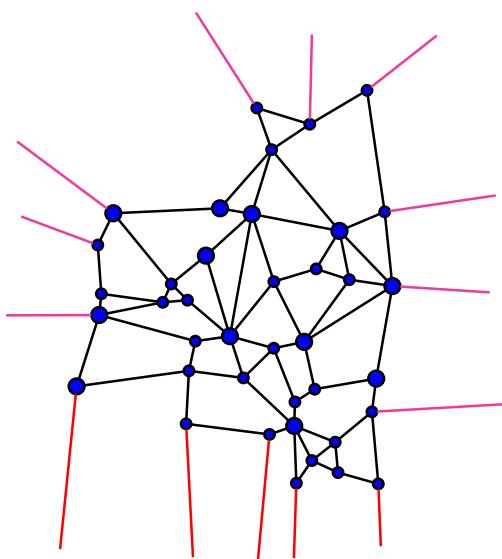
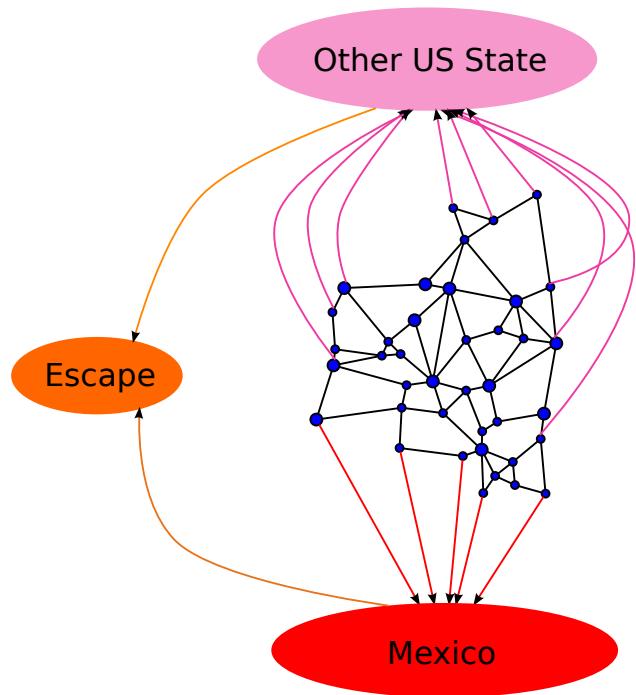


Figure 2: An abstract network created from the Arizona highway system.



(a) Abstract network.



(b) Abstract network with destination nodes.

Figure 3: The final abstract network.