CAP 4680/6685
Spring 2014
Semester Project

Packages-Are-Us Delivery Service of Orlando, FL has approached you to design a program that will help them schedule package pickups and deliveries across Florida. You have decided to develop this system using a knowledge-based approach using the forward reasoning inference engine provided by the CLIPS Expert System Shell.

Their current operation services the cities shown in the figure shown on the next page where the numeric values represent travel time between the various cities. As a minimum you will need to describe each city as a triple consisting of the city name, the name of a connected city, and the travel time. You may wish to make this representation more complex — that is left to your discretion.

Since each package has a specific size, a delivery truck is limited in the number of packages it can carry. Each truck could possibly be described by a 8-tuple (note: you might be able to come up with a better representation): the truck's number, the truck's current city, the city to which the truck is traveling (if it is on a delivery), its current action (idle, going to pick up a package, in route to deliver a package, or returning to base), its time of arrival, the total space of the truck, the total space occupied by packages, and the package(s) that it is carrying and each of their destinations.

For part one of your project, you should create a simulation of the operation of this company based on the following conditions. Not being real smart, the owners require that all trucks be based in Orlando. When a shipping order is received, a truck is dispatched from Orlando to pickup the package and deliver it. The truck is required to pickup and deliver only one package at a time — it is not allowed to pick up additional packages as it travels between cities or to pick up additional packages before leaving the city. This truck is required to drive the shortest route to the pickup city, pick the package up, drive the shortest route to the destination, deliver the package, then drive the shortest route back to Orlando to wait for the next shipping order.

Project: Part 1

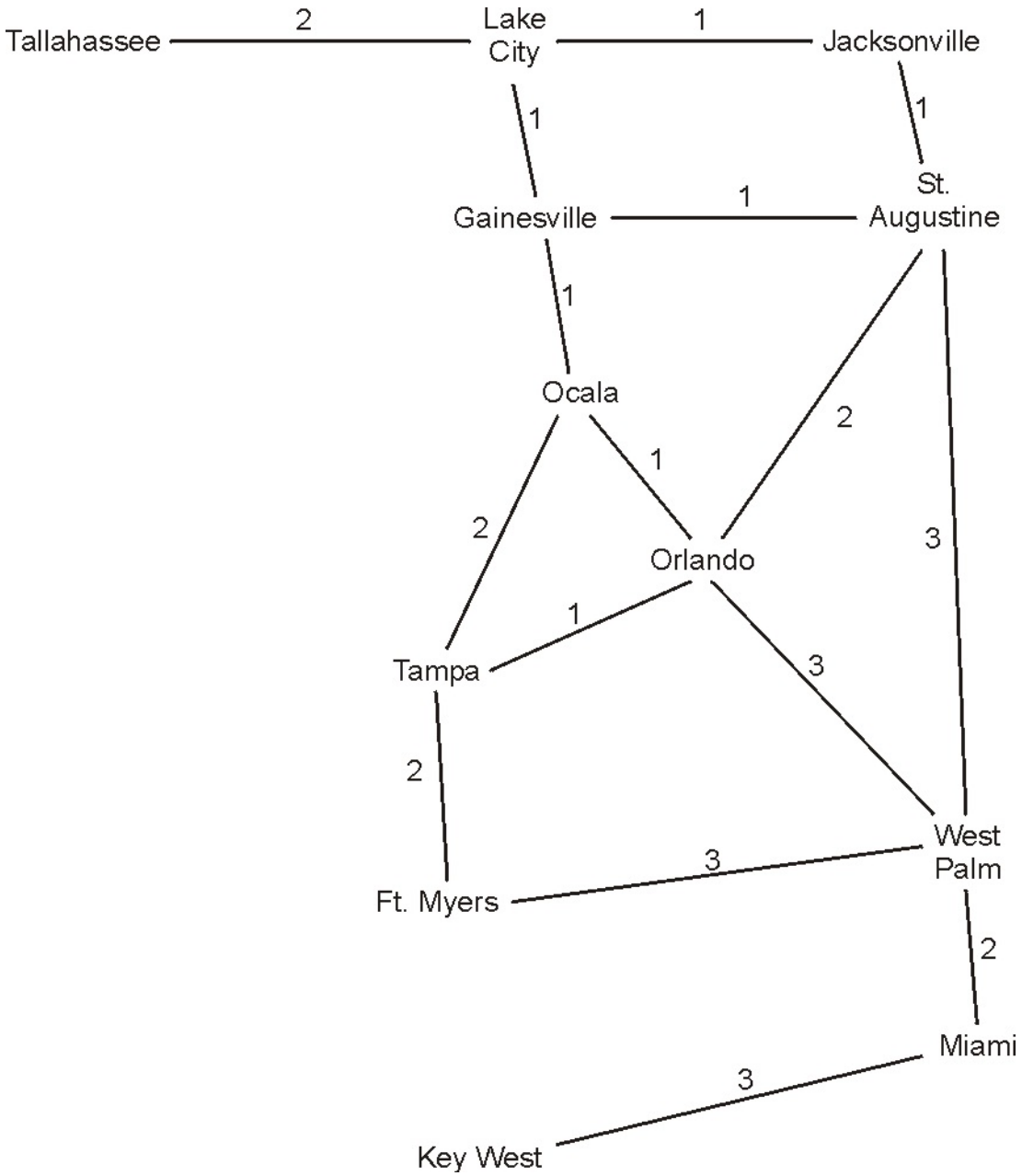
Using the above information, you are to develop a knowledge-based system in CLIPS that performs the following tasks:

1. Process the shipping orders as detailed in the example below.
2. Perform this simulation until all trucks have made their deliveries and have returned to Orlando.
3. Generate the following reports after completing the simulation:

   A. Truck Report: Total wait time (time spent in Orlando waiting to be assigned a delivery or waiting for all trucks to return at the end of the simulation), total time busy (time on the road), % of time busy, # of packages transported, average % of the truck that is occupied by a package while on the road, non-delivery travel time (this is the total time traveling from Orlando to the

city where the package is located to pick the package up plus the time traveling from the delivery city back to Orlando), and the % of busy time that is actually spent on delivering packages. Order the information in this report by ascending truck number.

B. Package Report: Wait time (the time from when the order is sent to Orlando until the package is actually picked up for delivery), the pick up time, the delivery time, whether the package was delivered on time or not, and if the package was later, how late its delivery was. Order the information in this report by ascending package number.



C. Packages Average Report: The average wait time per package, the number of packages delivered on time, the number of packages delivered late, the average lateness for late packages, and the average lateness for all packages. Note that getting a package delivered ahead of schedule does not decrease overall lateness — lateness is a measure of lateness only (by this I mean there is no bonus for being early).

You may add any additional information to these reports that you deem to be relevant.

Part 1 of this project is due Friday, March 14. You should turn in the following at that point through e-learning:

1. A complete listing of your CLIPS knowledge base and the data set,
2. A sample output of the test results, and
3. Instructions on how to execute your knowledge base.

This portion of the project will be graded on correctness, ease of use, documentation (comments) and coding style. It will count for 30% of the final project grade.

NOTE: You are strongly encouraged to develop your simulation in a manner that uses the given cities, trucks and packages descriptions as data rather than hard coding this information. The data for Part 2 of the project are not guaranteed to use the same cities, trucks or packages as Part 1!!

Project: Part 2

Using heuristics of your choice, you are to modify your CLIPS knowledge base to develop an alternative to the simple delivery algorithm used in Part 1. You may choose to improve any of the report metrics that you consider relevant, but in your final report you should identify which metric(s) you selected and why you selected it (or them). Note that in this simulation, all trucks must initially start in Orlando but are not required to return to Orlando at the conclusion of the simulation nor are they required to return to Orlando at the conclusion of delivering a package. They may also pick up additional packages when traveling between cities and may travel routes that are longer than the shortest route if you feel that will improve deliveries.

You can test your knowledge base on the data used for Part 1 or you can generate test data of your own, but do not design (rig) your knowledge base to depend on a specific set of data. (If your approach requires additional fields in the data, you should discuss this with the instructor first). As a minimum, you should generate the reports that were required for Part 1. Add any additional reports that you deem relevant.

Note: you will be given a new data set on which to run your solution to Part 2 one day before your code is due and one week before the project's final report due date.

Part 2 is due on two different dates. On April 16th, *one week before the last day of class*, you will turn in:

1. A complete listing of your code,
2. An encoding of the data set,
3. A listing of your program's output,
4. A User's Manual that, at a minimum, indicates:

    A. How to execute your system,

    B. How data is specified, and

    C. What output is generated.

Your final project report will be due on the last regularly scheduled class day. For this report you should submit the following items:

A document that, as a minimum, indicates:

A. The design philosophy used in creating your system,

B. The specific changes that you have made since Part 1,

C. Rational for the changes that you made,

D. The improvements that have resulted from these changes (both good and bad). In this you should compare the performance of your Part 1 program to the Part 2 program on the final data set, and

E. What you would do differently if you now had a chance to start all over.

Grading for Part 2 will be based on correctness, ease of use, style, improvements over the Part 1 approach, and the quality of the documentation.

Example Data/Simulation:

Package Data:

Number	Depart City	Delivery City	Size	Order Arrival Time	Expected Delivery Time
1	Key West	Jacksonville	1	2	15
2	West Palm	St. Augustine	3	4	10
3	Gainesville	Tallahassee	4	5	10
4	Jacksonville	Orlando	2	8	18
5	Ft. Myers	Key West	6	9	20
6	Orlando	Lake City	4	9	16
7	West Palm	Miami	5	9	16
8	Miami	Ocala	4	10	20
9	Gainesville	Orlando	7	11	17
10	Tampa	Tallahassee	6	12	25

Truck Data:

Number	Current Location	Destination	Space Available	Current Time	Action	Package(s)
1	Orlando	none	10	0	idle	none
2	Orlando	none	10	0	idle	none
3	Orlando	none	8	0	idle	none
4	Orlando	none	7	0	idle	none

Simulation Results:

Time	Package Number	Truck Number	Action	Arrival Location	Arrival Time
2	"for 1"	1	dispatched	Key West	10
4	"for 2"	2	dispatched	West Palm	7
5	“for 3”	3	dispatched	Gainesville	7
7	2	2	delivering	St. Augustine	10
7	3	3	delivering	Tallahassee	10
8	“for 4”	4	dispatched	Jacksonville	11
10	1	1	delivering	Jacksonville	19
10	-	2	return	Orlando	12
10	-	3	return	Orlando	15

Data Set for Part 1

Package Data:

Number	Depart City	Delivery City	Size	Order Arrival Time	Expected Delivery Time
1	Orlando	Jacksonville	4	1	15
2	Tampa	St. Augustine	4	4	10
3	Key West	Miami	3	8	25
4	Miami	Orlando	5	20	30
5	Ocala	Orlando	7	30	40
6	Orlando	Lake City	6	40	45
7	Jacksonville	Tallahassee	8	65	80
8	Tallahassee	Gainesville	4	80	100
9	St. Augustine	Tallahassee	5	90	110
10	West Palm	Ft. Myers	1	110	120
11	Ocala	Ft. Myers	1	110	120
12	Jacksonville	Key West	2	120	150
13	Miami	Ocala	2	150	155
14	Miami	Gainesville	5	150	160
15	Miami	Tallahassee	2	150	170
16	Tallahassee	Lake City	2	200	210
17	Lake City	Tallahassee	7	220	240
18	Tallahassee	Key West	9	240	300
19	St. Augustine	Gainesville	8	250	260
20	Tampa	Jacksonville	1	250	270

Truck Data:

Number	Current Location	Destination	Available Space	Current Time	Action	Package
1	Orlando	none	10	0	idle	none
2	Orlando	none	8	0	idle	none
3	Orlando	none	6	0	idle	none
4	Orlando	none	10	0	idle	none
5	Orlando	none	12	0	idle	none
6	Orlando	none	6	0	idle	none