Introduction to Artificial Intelligence
Lab 1 Write-Up

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Search:

To find the most optimal path through the map, the program runs an A* search between each progressive destination. Location nodes are added to the frontier when they are adjacent to the current node being checked. The heuristic for any particular location on the map is:

$$f(x_i, y_i) = f(x_{i-1}, y_{i-1}) + \frac{\sqrt{\left(10.29(x_i - x_n)\right)^2 + \left(7.55(y_i - y_n)\right)^2 + \left(z(x_i, y_i) - z(x_n, y_n)\right)^2}}{s\left(t(x_i, y_i)\right)}$$

where x is the x-coordinate, y is the y-coordinate, i is the number of steps from the start, n indicates the final location, $z(x, y)$ returns the elevation at (x, y), $t(x, y)$ returns the terrain at (x, y), and $s(t)$ returns the speed on terrain t. The constants are required to account for the meters per pixel in each direction. Essentially, the heuristic is the three-dimensional distance away from the end divided by the speed of moving on that terrain, plus the previous location's heuristic.

The elevation function returns the elevation from a two-dimensional array. This is loaded with values from the given elevation file at the start of the program. These actions are taken to avoid constantly opening and closing the elevation file for every elevation check.

The terrain function technically returns a 4-tuple representing the color on the map at that position, but this is also effectively the terrain, as the color differs for each terrain type. At the top of the program, all of the possible colors in a properly formatted summer map are listed as constants.

The speed function is actually implemented as a dictionary, 4-tuple for the terrain and returning the speed of travel compared to maximum speed (1).

In the A* algorithm, the next node to check is that which has the smallest value for its heuristic.

Seasonal Differences:

The provided map shows the conditions during the summer, so no map modifications must be made for summer searches.

For fall searches, the leaves that drop from trees decrease the speed in all pixels adjacent to forests. This is done by changing the terrain at the location (i.e. color on the map) to a new leafier terrain. Leafy terrains allow for 90% the speed of the original one. Since the differences in edges between terrain types would be virtually imperceptible anyway, the alpha channel value of the leafy pixel is instead decreased by 1 for distinction only by the program. This conversion is implemented by a dictionary, taking the old terrain and returning the new leafier terrain.

For winter searches, the water near to (7 or less spaces from) any land freezes to walkable ice. This is done by changing the pixels with water that are 7 or less square steps away from non-water into a new ice terrain. Walking on ice is much faster than swimming through water.

For spring searches, the land near to (15 or less spaces from) any water becomes submerged in water or muddy. This is done by changing the land pixels that are 15 or less square steps from the water and at an elevation 1 meter or less above the water into a new soaked terrain. Soaked terrains allow for 50% the speed of the original one. The color of the soaked terrains are marginally redder or darker than their dry counterparts. This conversion is implemented by a dictionary, taking the old terrain and returning the new soaked terrain.

Output:

During execution of the program, the step being worked on is printed to the console. If the season requires modification, that is printed first. Then, the program indicates that it's finding the path. Finally, the program prints out the distance of the optimal path in meters and displays an image of the modified map, with the seasonal modifications, the path in red, and the destinations in maroon.

Terrain Speeds:

Terrain	Default Speed (100%)	Leafy Speed (90%)	Muddy Speed (50%)
Open Land	0.950	0.855	0.475
Rough Meadow	0.500	0.450	0.250
Easy Movement Forest	0.800	0.720	0.400
Slow Run Forest	0.700	0.630	0.350
Walk Forest	0.600	0.540	0.300
Impassible Vegetation	0.100	0.090	0.050
Lake/Swamp/Marsh	0.050	0.045	-*
Paved Road	1.000	0.900	0.500
Footpath	0.900	0.810	0.450
Out of Bounds	0.001**	-*	-*
Ice	0.400	-*	-*

* - this type of modification cannot be made

** - for the heuristic calculation, this must exist, but as it is so low, it is effectively always avoided