# Introduction to AI
# Lab-1, Writeup

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**Terrain Cost Considerationos:**

1. FOOTPATH: 1
2. ROAD: 1.3

   ⇒ Footpaths and roads seemed to be easier to go across.
3. OPEN LAND: 1.5

   ⇒ If roads or paths are not available, open land would be preferred.
4. EASY MOVEMENT FOREST: 1.55
5. SLOW RUN FOREST: 1.7
6. WALK FOREST: 2
7. ROUGH MEADOW: 2.5
8. LAKE: 15
9. IMPASSIBLE VEG: 20

   ⇒ Imappible vegetation seemed particularly difficult to navigate, thus, it is only ever chosen for when all other paths are out of bounds. Even Lakes and water are preferred over it, since you could still potentially swim.
10. OUT OF BOUNDS: 100

    ⇒ It is not meant to be navigatable at all.

    Note: For some reason, mt implementation of the A* algorithm acts very strangely for the normal-brown trail testcase.

**<u>Cost & Heursitics:</u>**

`Euclidean Distance without the Tobler Function (without consts)`

$$\sqrt{x^2 + y^2}$$

`Euclidean Distance with the Tobler Function (without consts)`

$$\sqrt{x^2 + y^2} * e^{-|y/x|}$$

`Manhattan/Taxicab Distance`

$$|\Delta x| + |\Delta y|$$

The cost of movement is calculated by taking the euclidean distance between the start position and the end position ($pixel \rightarrow neighbor$), then, this distance is multiplied by the tobler function, which goes from 0 to 1 based on the steepness, making steeper hills to climb harder. This is then finally multiplied by a constant value `terrain-cost` which represents the maneuverability of the terrain. This allows the A* algorithm to give preferential treatment to the paths that have better terrain maneuverability over those that don't.

For the heuristic function $h(\vec{x})$, I went with the Manhattan distance, since it is much cheaper to compute and scales, more or less, just as well as euclidean distance for dimensionality.

It can be seen in the figures which will follow this paragraph, that the cost function never less than the heuristics, both, the euclidean and manhattan distance heuristics. To make sure that the Manhattan distance heuristic is admissable, and does not grow larger than the actual cost, in the code, it is multiplied byb a constant of 0.95 so as to limit the potential of the function becoming inadmissible.

$$h(\vec{v}) \leq optimal\ cost(\vec{v})$$

The figures that follow represent the two dimensional analogs of their corresponding 3-dimensional functions, so that they could be graphed.

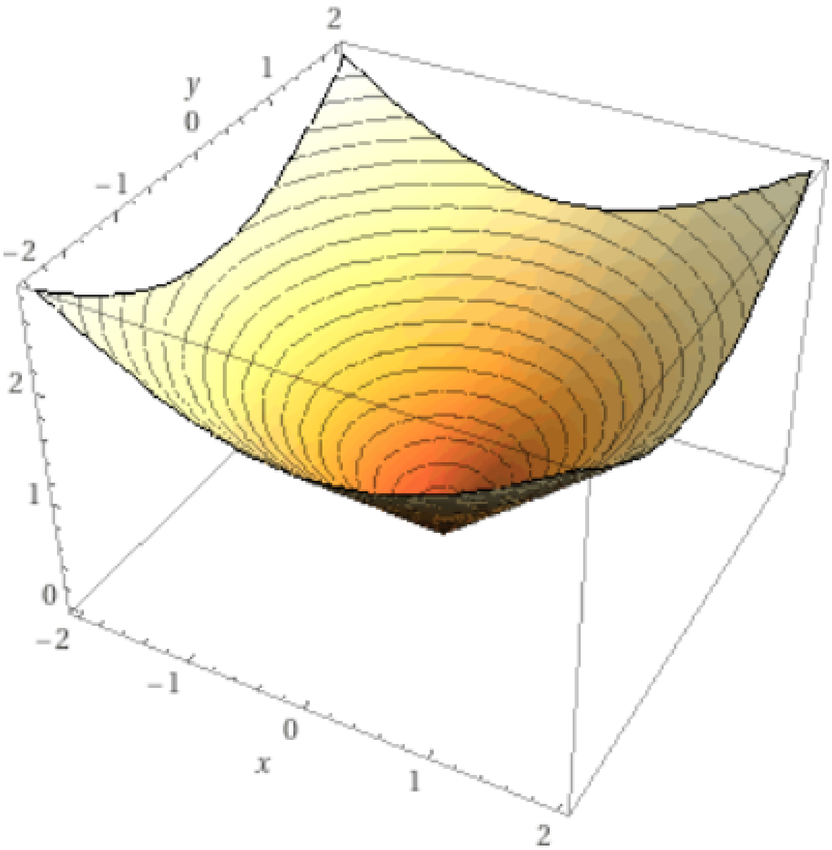


Figure 1: Euclidean Distance

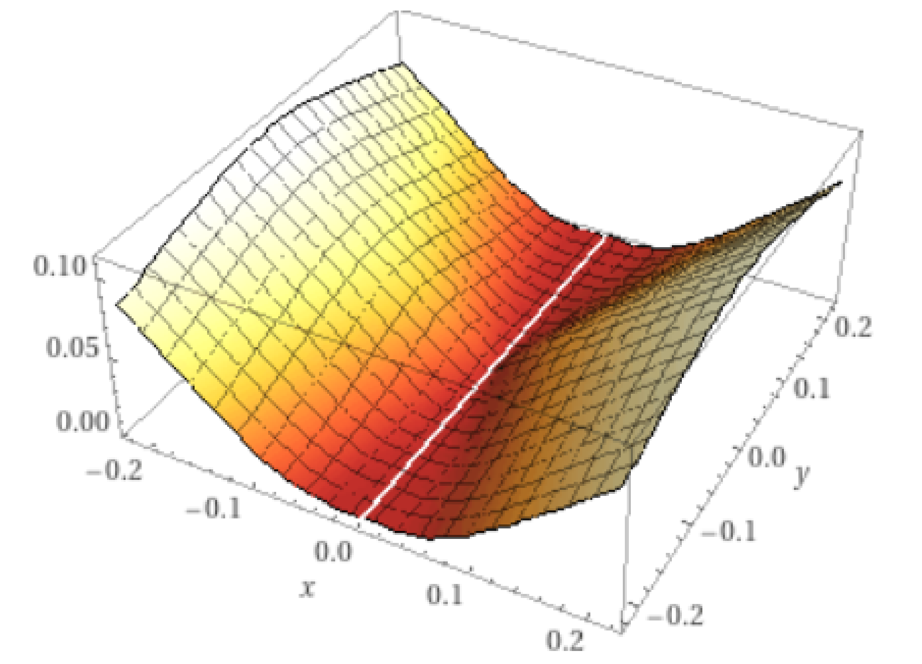


Figure 2: Manhattan Distance (with steepness accounted for)

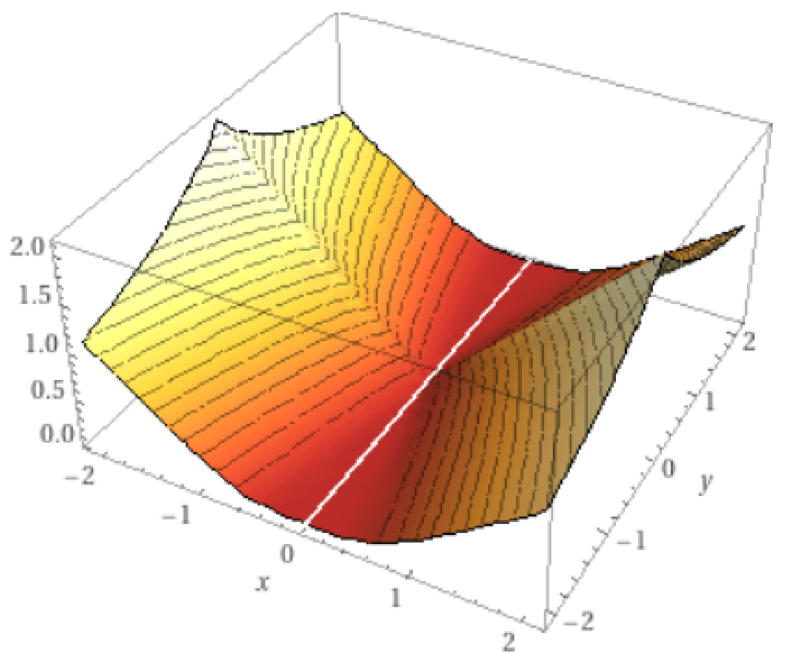


Figure 3: Euclidean Distance with the Tobler function

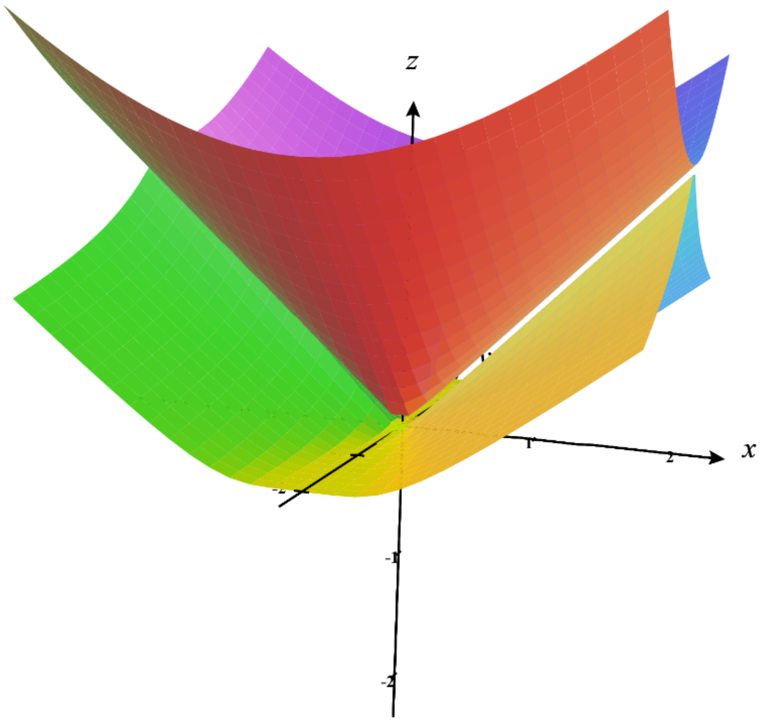


Figure 4: Euclidean Distance compared with Euclidean Distance with the Tobler function to check for overlaps, so as to ensure admissibility.

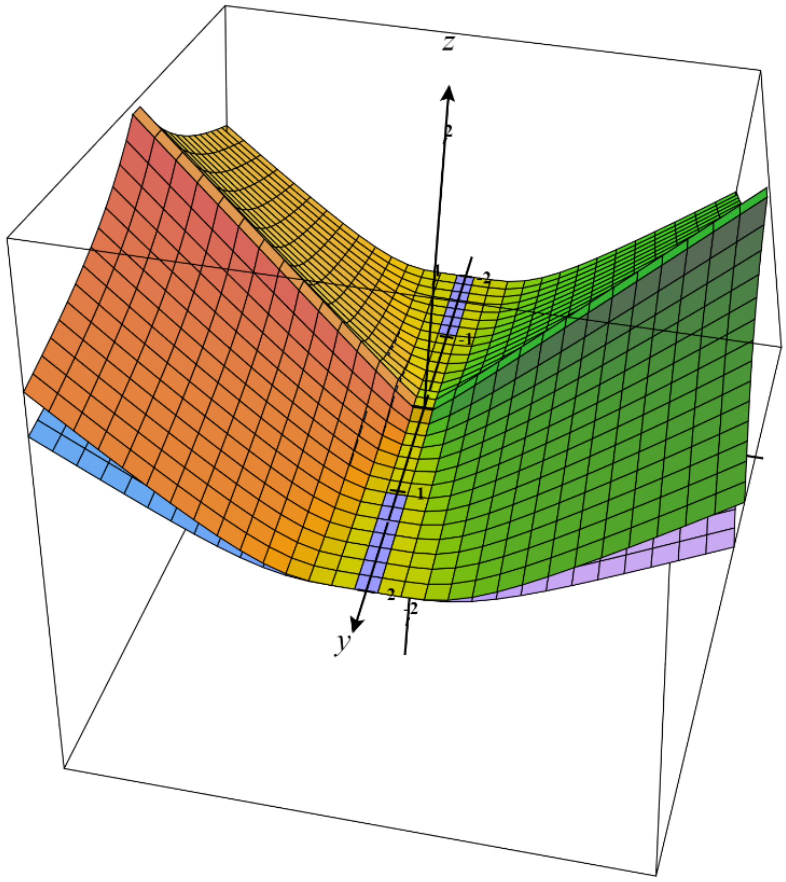


Figure 5: Manhattan Distance compared with Euclidean Distance with the Tobler function to check for overlaps, so as to ensure admissibility.