GROUP 06

LAND ROVER ON MARS

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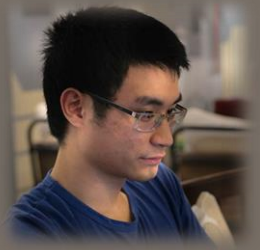

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1. PROBLEM DESCRIPTION

The land rover can move in only 4 directions: forward, backward, left, right

It can go up or down with an inclination of $\theta \leq 10^\circ$ (this value can be computed by the formula: $\tan(\theta) = |h1 - h2| / dist(P1, P2)$)

2. RESEARCH METHODOLOGY

ALGORITHM

Astar, UCS, Greedy BFS

FRONTIER'S DATA STRUCTURE

Priority Queue (with heapsort) & List (with timsort)

HEURISTIC FUNCTIONS

Manhattan distance, Tie-Breaking High g-cost and its variance, Tie-Breaking Low g-cost and its variance

WAYS TO FIND NEIGHBORS

Find first before run & Find while running

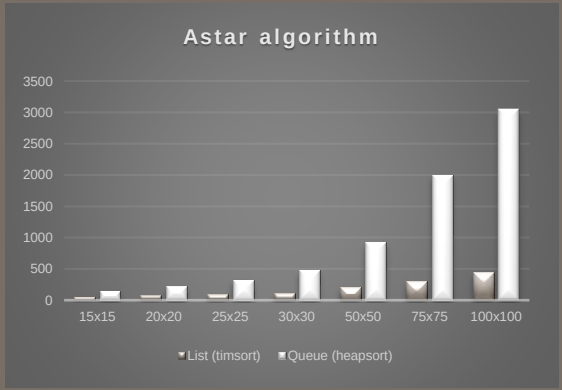
3. Code implementation

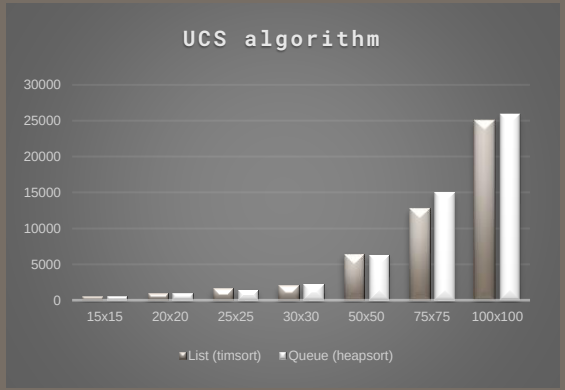
Difficulty when testing algorithm:
+ Many aspects affect our result.
+ Long time to choose an appropriate image that meet our expectations and requirements.
+ The image size is too big that took the long time to test the algorithm.

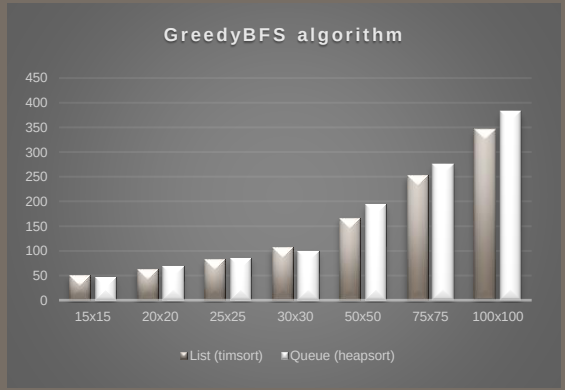
Our decision:
+ Consider 7 image sizes **(15x15, 20x20, 25x25, 30x30, 50x50, 75x75, 100x100)**, for each size, we take **100 images** taken from **16** different **bins** of standard deviation.
+ Run the algorithms with **100 random pairs** of points.

4. RESULTS DISCUSSION

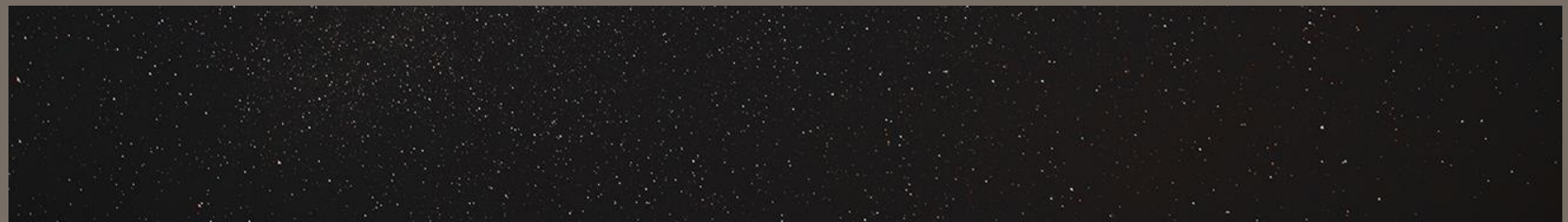
4.1 Comparison of frontier definitions (steps count)







→ We choose **list (with timsort)** as the frontier's data structure



4. RESULTS DISCUSSION

4.2 Algorithm comparison (steps count)

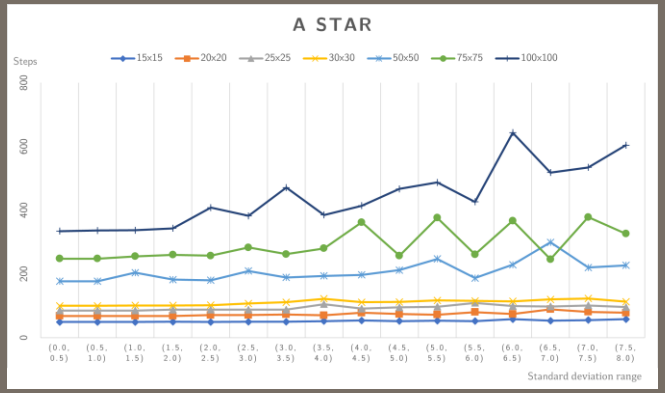
Size	UCS	A-star	GreedyBFS
15	496.19	52.06	49.88
20	922.69	73.94	63.44
25	1641.63	93.63	82.69
30	2050.56	110.56	106.94
50	6412.50	208.13	166.87
75	12798.10	297.88	253.06
100	25046.38	443.06	346.31

CONCLUSION: GreedyBFS < Astar < UCS

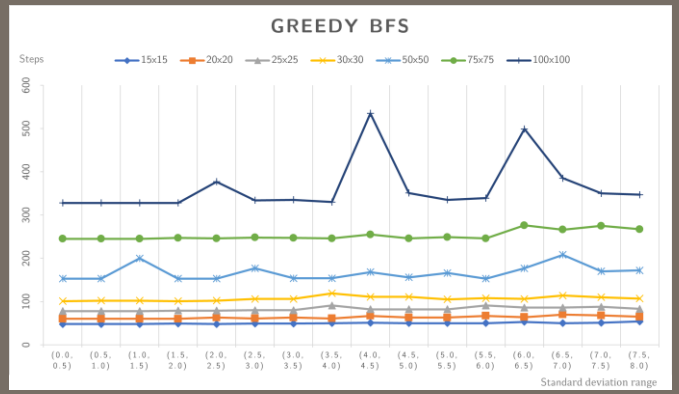
4. RESULTS DISCUSSION

4.3 Influence of standard deviation to the running time

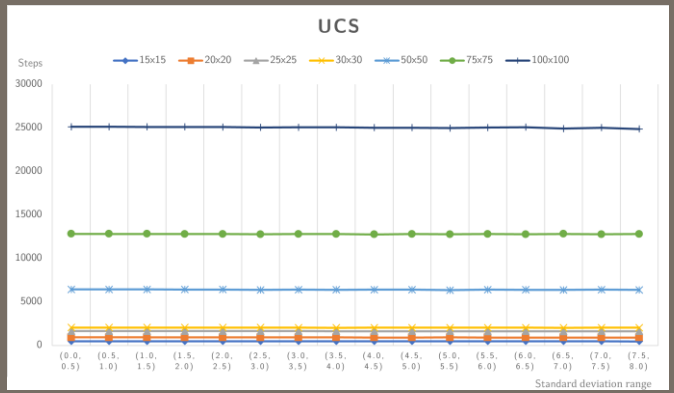
The more variety the altitudes of points in the image is,



the larger the number of steps the land rover need to do become!



But not for the case of UCS



4. RESULTS DISCUSSION

4.4 Heuristic functions

Bin	MHT	THg	v-THg	TLg	v-TLg
0.0-0.5	162	162	162	162	162
0.5-1.0	162	162	162	162	162
1.0-1.5	162	162	162	162	162
1.5-2.0	163	163	163	163	163
2.0-2.5	166	166	166	166	166
2.5-3.0	170	170	170	170	170
3.0-3.5	171	171	171	171	171
3.5-4.0	176	176	176	176	176
4.0-4.5	174	174	174	174	174
4.5-5.0	177	177	177	177	177
5.0-5.5	182	182	182	182	182
5.5-6.0	168	168	168	168	168
6.0-6.5	174	174	174	174	174
6.5-7.0	171	171	171	171	171
7.0-7.5	184	184	184	184	184
7.5-8.0	189	189	189	189	189

Table 3: Image of size 50 - Astar

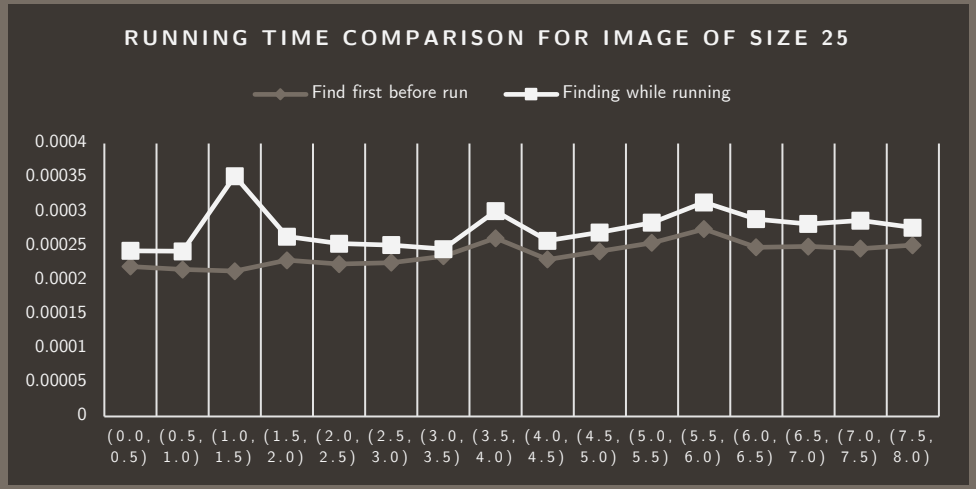
Bin	$\delta = 0.01$	$\delta = 0.1$	$\delta = 0.5$	$\delta = 1$
0.0-0.5	148(1.0)	148(0.9999)	148(0.9994)	148(0.9994)
0.5-1.0	148(1.0)	148(0.9998)	148(0.9986)	148(0.9984)
1.0-1.5	151(1.0)	151(0.9992)	150(0.9939)	150(0.9920)
1.5-2.0	152(1.0)	152(0.9984)	151(0.9936)	151(0.9919)
2.0-2.5	154(1.0)	153(0.9981)	152(0.9903)	152(0.9889)
2.5-3.0	179(1.0)	178(0.9971)	173(0.9826)	171(0.9779)
3.0-3.5	164(1.0)	162(0.9963)	157(0.9809)	155(0.9759)
3.5-4.0	167(1.0)	165(0.9967)	159(0.9734)	156(0.9676)
4.0-4.5	169(1.0)	166(0.9952)	159(0.9711)	157(0.9644)
4.5-5.0	161(1.0)	160(0.9961)	155(0.9753)	153(0.9675)
5.0-5.5	157(1.0)	156(0.9975)	153(0.9831)	152(0.9804)
5.5-6.0	234(1.0)	230(0.9955)	221(0.9712)	218(0.9638)
6.0-6.5	187(1.0)	183(0.9956)	174(0.9673)	169(0.9585)
6.5-7.0	187(1.0)	185(0.9940)	177(0.9687)	174(0.9610)
7.0-7.5	192(1.0)	189(0.9964)	181(0.9714)	178(0.9633)
7.5-8.0	184(1.0)	181(0.9955)	173(0.9689)	171(0.9590)

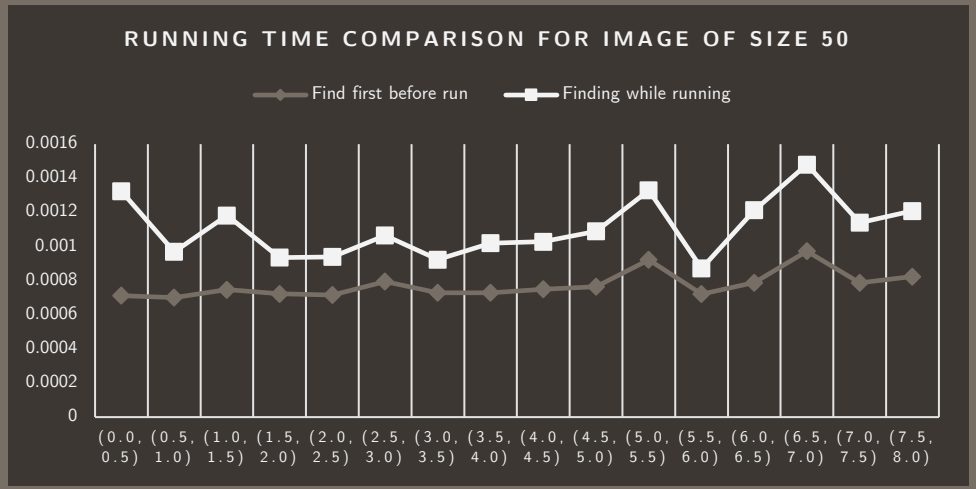
Table 4: Tie-breaking High g-cost

- Manhattan distance is an admissible heuristic which gives us a good result.
- Tie-breaking high g-cost and its variance give a slightly better result then Manhattan distance but if we ignored the optimality a little bit, A* search would run much more faster.
- Tie-breaking low g-cost is the worst heuristic function as.
- Variance of Tie-breaking Low g-cost improves the original heuristic function significantly.

4. RESULTS DISCUSSIONTIONS

4.5 Find neighbors comparison





CONCLUSION: The running time is less if we find the neighbors first and run the search algorithm after

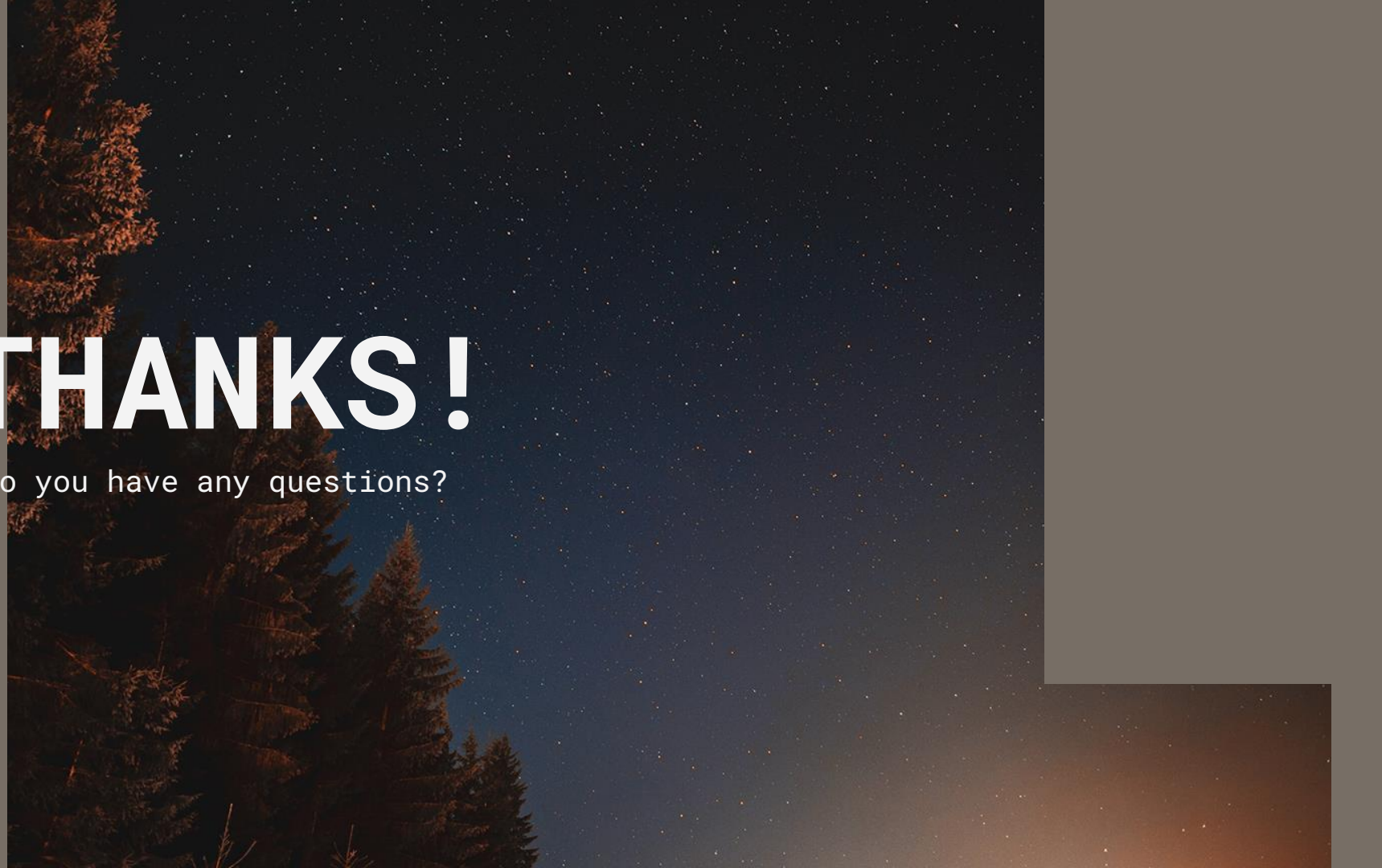
5. CONCLUSION AND FUTURE RESEARCH DIRECTIONS

4 main factors

- Heuristic function
- Frontier's data structure
- How to determine neighbor points
- Image's standard deviation

Future research directions

- δ in Tie-breaking heuristic functions
- Trade-off between the optimality and the running time of the search algorithm



THANKS!

Do you have any questions?