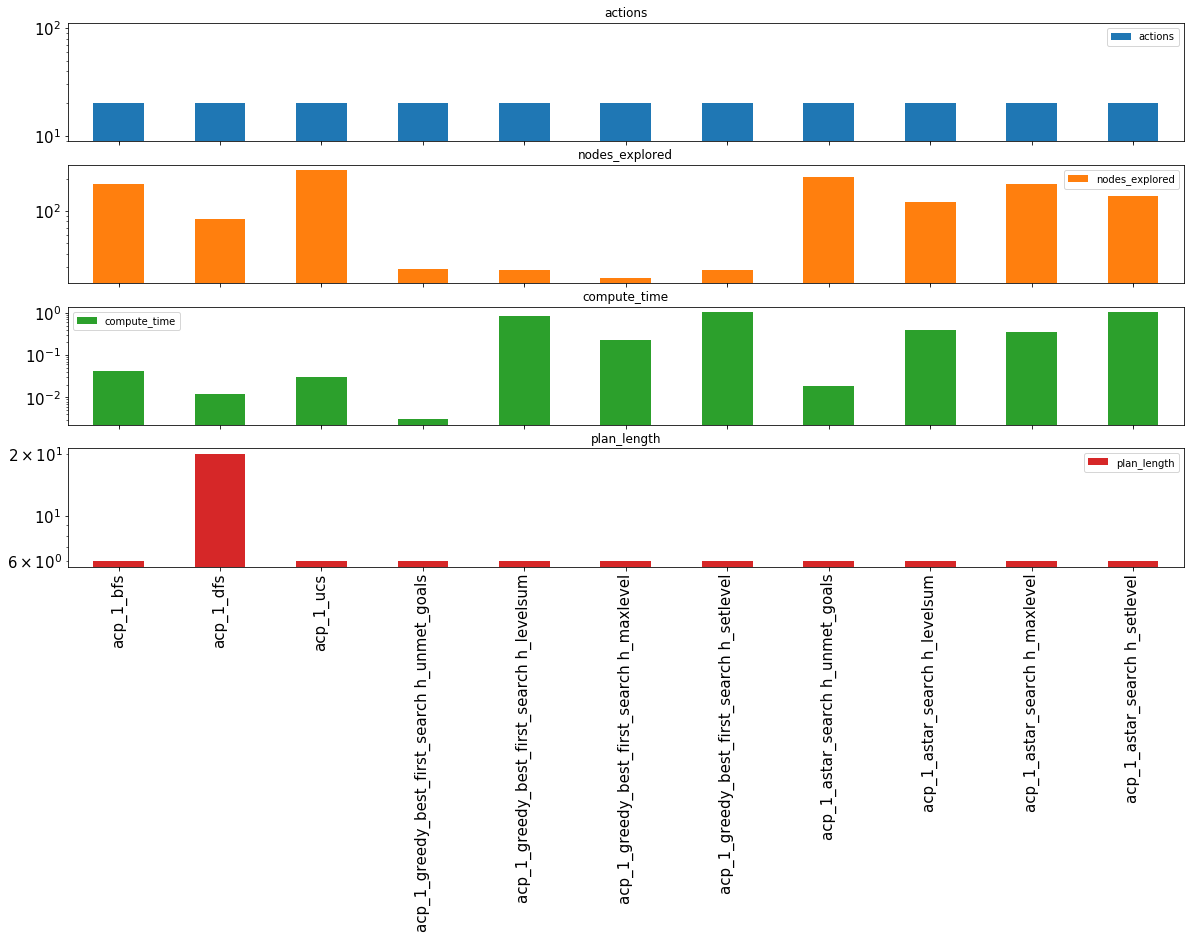
*Kyle Topasna*

*Udacity Project 2*

Classical Planning

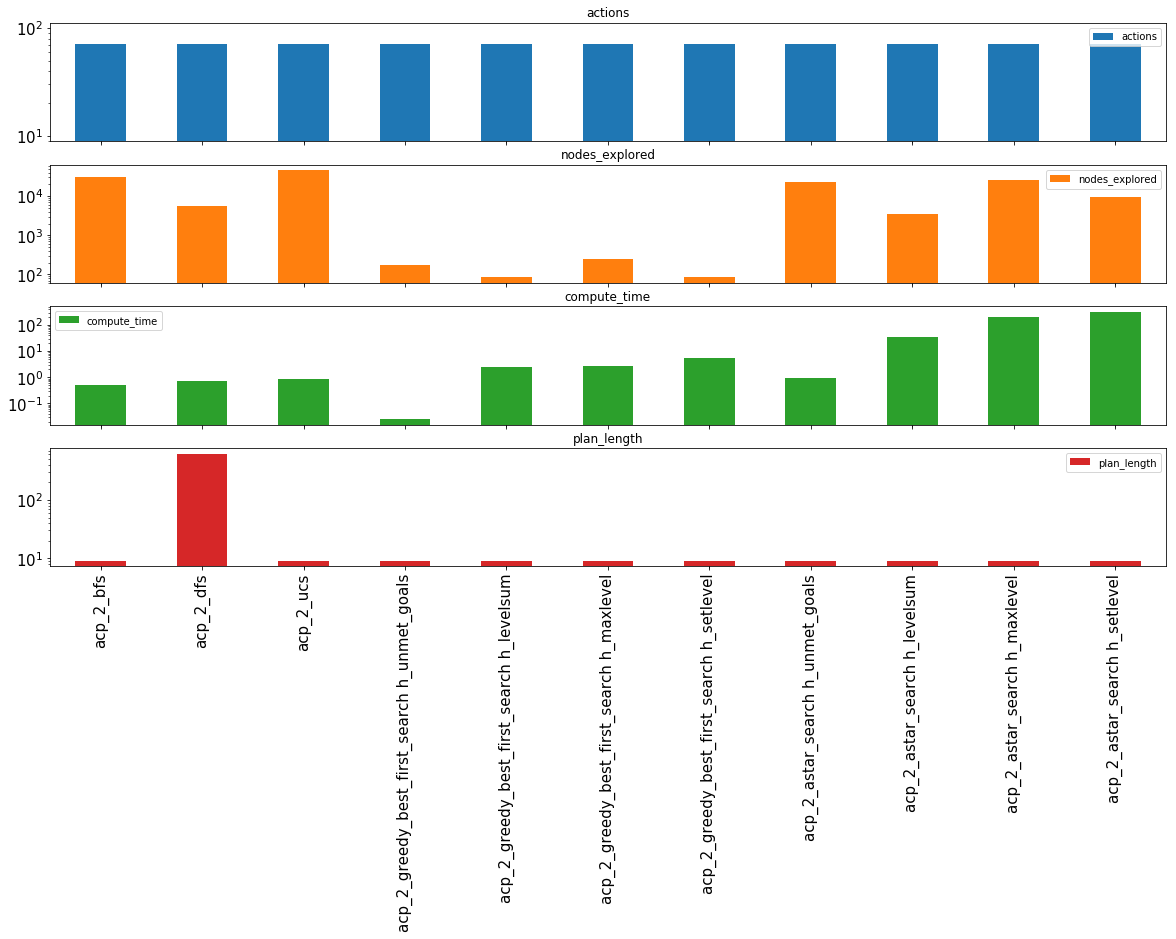
Air Cargo Problem 1:

|  | **actions** | **compute\_time** | **graph\_expansions** | **nodes\_explored** | **plan\_length** |
| --- | --- | --- | --- | --- | --- |
| **acp\_1\_bfs** | 20 | 0.042688 | 43 | 178 | 6 |
| **acp\_1\_dfs** | 20 | 0.012300 | 21 | 84 | 20 |
| **acp\_1\_ucs** | 20 | 0.030821 | 60 | 240 | 6 |
| **acp\_1\_greedy\_best\_first\_search h\_unmet\_goals** | 20 | 0.003025 | 7 | 29 | 6 |
| **acp\_1\_greedy\_best\_first\_search h\_levelsum** | 20 | 0.826779 | 6 | 28 | 6 |
| **acp\_1\_greedy\_best\_first\_search h\_maxlevel** | 20 | 0.230910 | 6 | 24 | 6 |
| **acp\_1\_greedy\_best\_first\_search h\_setlevel** | 20 | 1.028256 | 6 | 28 | 6 |
| **acp\_1\_astar\_search h\_unmet\_goals** | 20 | 0.019108 | 50 | 206 | 6 |
| **acp\_1\_astar\_search h\_levelsum** | 20 | 0.394338 | 28 | 122 | 6 |
| **acp\_1\_astar\_search h\_maxlevel** | 20 | 0.347104 | 43 | 180 | 6 |
| **acp\_1\_astar\_search h\_setlevel** | 20 | 1.048690 | 33 | 138 | 6 |



Air Cargo Problem 2:

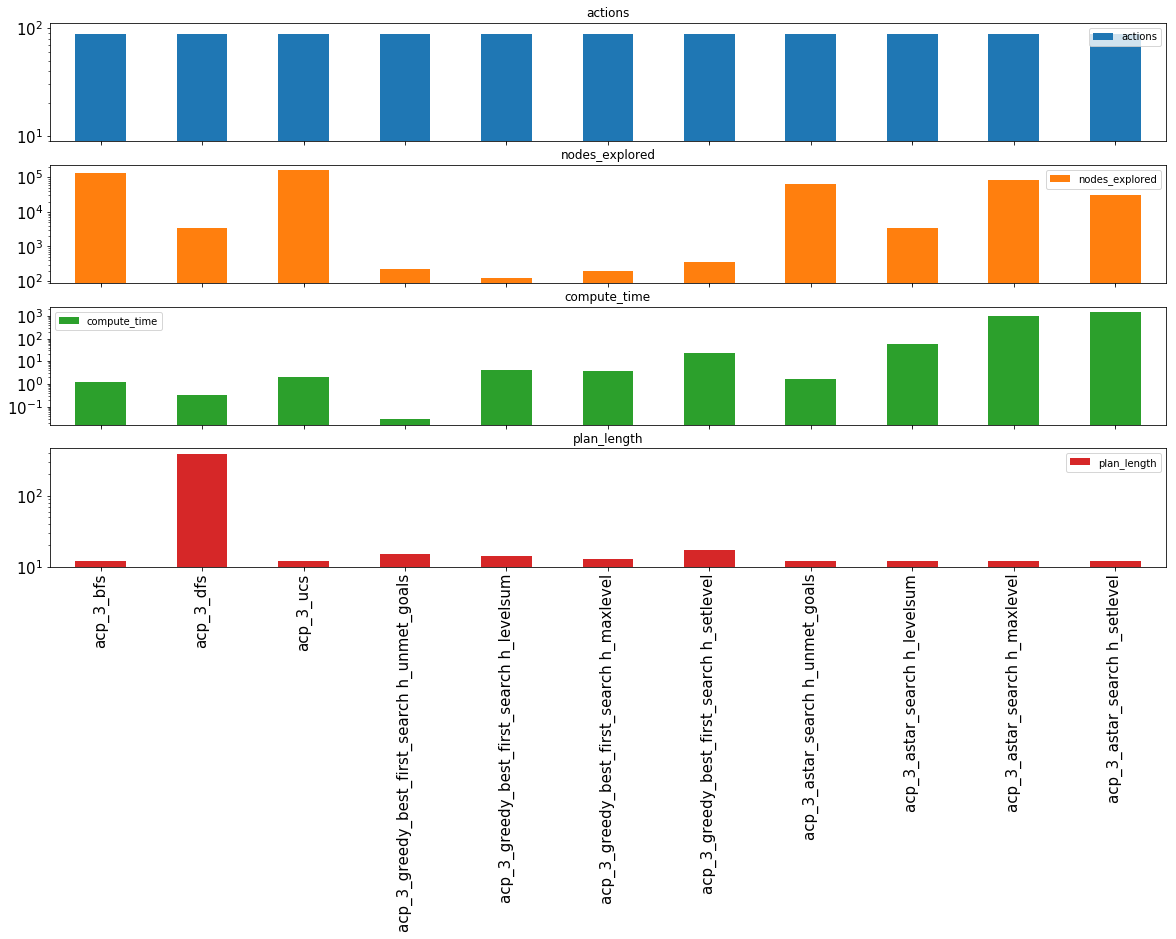
|  | **actions** | **compute\_time** | **graph\_expansions** | **nodes\_explored** | **plan\_length** |
| --- | --- | --- | --- | --- | --- |
| **acp\_2\_bfs** | 72 | 0.504165 | 3343 | 30503 | 9 |
| **acp\_2\_dfs** | 72 | 0.713412 | 624 | 5602 | 619 |
| **acp\_2\_ucs** | 72 | 0.893246 | 5154 | 46618 | 9 |
| **acp\_2\_greedy\_best\_first\_search h\_unmet\_goals** | 72 | 0.024852 | 17 | 170 | 9 |
| **acp\_2\_greedy\_best\_first\_search h\_levelsum** | 72 | 2.571643 | 9 | 86 | 9 |
| **acp\_2\_greedy\_best\_first\_search h\_maxlevel** | 72 | 2.742849 | 27 | 249 | 9 |
| **acp\_2\_greedy\_best\_first\_search h\_setlevel** | 72 | 5.399611 | 9 | 84 | 9 |
| **acp\_2\_astar\_search h\_unmet\_goals** | 72 | 0.957883 | 2467 | 22522 | 9 |
| **acp\_2\_astar\_search h\_levelsum** | 72 | 35.475223 | 357 | 3426 | 9 |
| **acp\_2\_astar\_search h\_maxlevel** | 72 | 202.709443 | 2887 | 26594 | 9 |
| **acp\_2\_astar\_search h\_setlevel** | 72 | 322.180424 | 1037 | 9605 | 9 |



Air Cargo Problem 3:

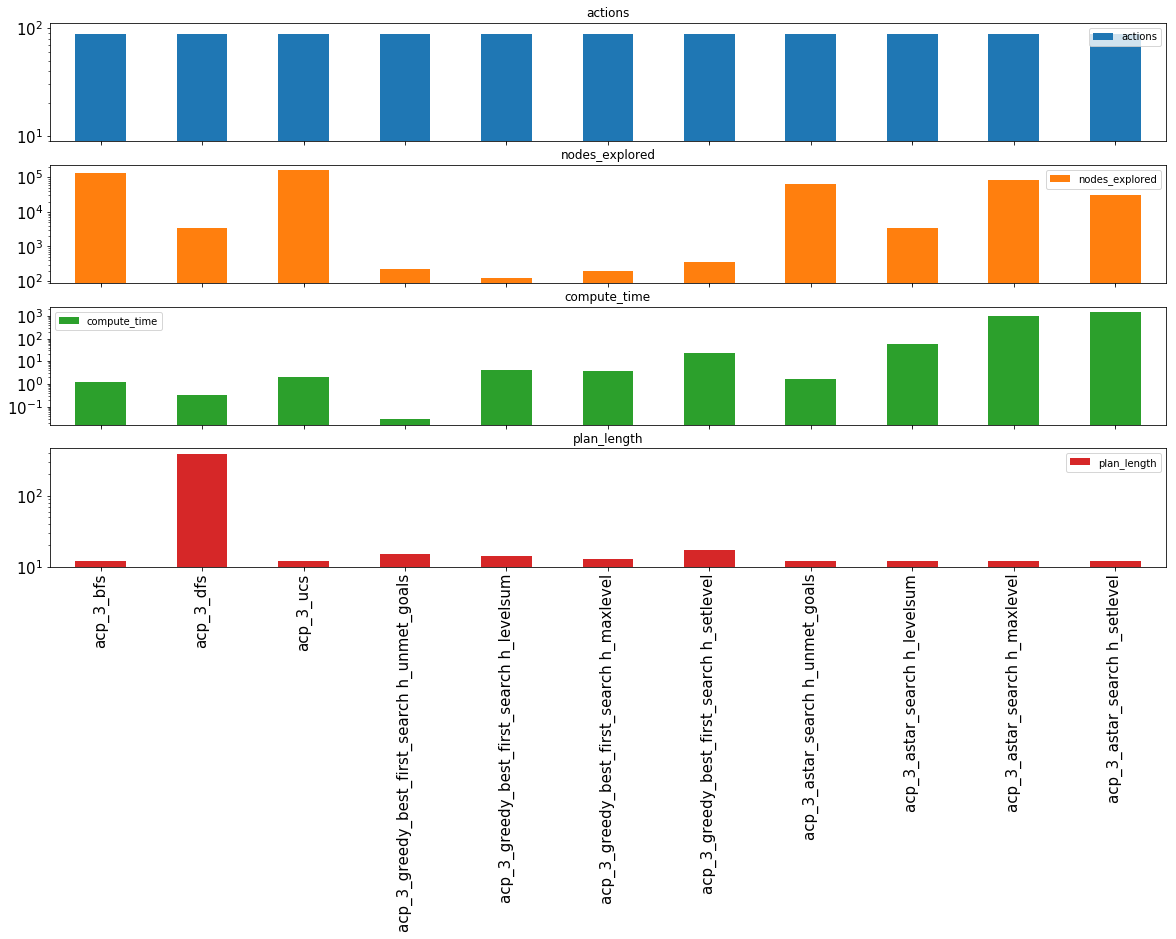
|  | **actions** | **compute\_time** | **graph\_expansions** | **nodes\_explored** | **plan\_length** |
| --- | --- | --- | --- | --- | --- |
| **acp\_3\_bfs** | 88 | 1.284745 | 14663 | 129625 | 12 |
| **acp\_3\_dfs** | 88 | 0.316636 | 408 | 3364 | 392 |
| **acp\_3\_ucs** | 88 | 1.957874 | 18510 | 161936 | 12 |
| **acp\_3\_greedy\_best\_first\_search h\_unmet\_goals** | 88 | 0.027968 | 25 | 230 | 15 |
| **acp\_3\_greedy\_best\_first\_search h\_levelsum** | 88 | 4.171586 | 14 | 126 | 14 |
| **acp\_3\_greedy\_best\_first\_search h\_maxlevel** | 88 | 3.591809 | 21 | 195 | 13 |
| **acp\_3\_greedy\_best\_first\_search h\_setlevel** | 88 | 22.038052 | 35 | 345 | 17 |
| **acp\_3\_astar\_search h\_unmet\_goals** | 88 | 1.705692 | 7388 | 65711 | 12 |
| **acp\_3\_astar\_search h\_levelsum** | 88 | 58.063234 | 369 | 3403 | 12 |
| **acp\_3\_astar\_search h\_maxlevel** | 88 | 937.574236 | 9580 | 86312 | 12 |
| **acp\_3\_astar\_search h\_setlevel** | 88 | 1470.351643 | 3423 | 31596 | 12 |

In [32]:



Air Cargo Problem 4:

|  | **actions** | **compute\_time** | **graph\_expansions** | **nodes\_explored** | **plan\_length** |
| --- | --- | --- | --- | --- | --- |
| **acp\_4\_bfs** | 104 | 8.143862 | 99736 | 944130 | 14 |
| **acp\_4\_dfs** | 104 | 1730.883094 | 25174 | 228849 | 24132 |
| **acp\_4\_ucs** | 104 | 14.118177 | 113339 | 1066413 | 14 |
| **acp\_4\_greedy\_best\_first\_search h\_unmet\_goals** | 104 | 0.067324 | 29 | 280 | 18 |
| **acp\_4\_greedy\_best\_first\_search h\_levelsum** | 104 | 7.887879 | 17 | 165 | 17 |
| **acp\_4\_greedy\_best\_first\_search h\_maxlevel** | 104 | 14.306673 | 56 | 580 | 17 |
| **acp\_4\_greedy\_best\_first\_search h\_setlevel** | 104 | 99.651816 | 107 | 1164 | 23 |
| **acp\_4\_astar\_search h\_unmet\_goals** | 104 | 5.877387 | 34330 | 328509 | 14 |
| **acp\_4\_astar\_search h\_levelsum** | 104 | 345.657024 | 1208 | 12210 | 15 |
| **acp\_4\_astar\_search h\_maxlevel** | 104 | 9562.792889 | 62077 | 599376 | 14 |

****

**Questions**[**¶**](http://localhost:8888/notebooks/Classical%20Planning/Classical%20Planning%20Data%20Exploration.ipynb#Questions)

**Which algorithm or algorithms would be most appropriate for planning in a very restricted domain (i.e., one that has only a few actions) and needs to operate in real time?**

**Answer:**

The greedy best first searches algorithms, regardless of heuristics, reliably performed the fast enough for real time operations when action states were kept low.

**Which algorithm or algorithms would be most appropriate for planning in very large domains (e.g., planning delivery routes for all UPS drivers in the U.S. on a given day)**

**Answer:**

Breadth First Search was the more optimal at exploring nodes and expanding the graph. A\* searches worked well also at exploring large domains at the trade off for computational expense.

**Which algorithm or algorithms would be most appropriate for planning problems where it is important to find only optimal plans?**

**Answer:**

All A\* Search variants and BFS reliably found the most optmial plan.