**AI Nano Degree**

**Project 2 – Classical Planning**

**Air Cargo Problem 1**

**Summary of Results**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Algorithm | Actions | Expansions | Goal Tests | New Nodes | Plan Length | Time |
| Breadth first search | **20** | **43** | **56** | **178** | **6** | **0.006** |
| Depth first graph search | **20** | **21** | **22** | **84** | **20** | **0.003** |
| Uniform cost search | **20** | **60** | **62** | **240** | **6** | **0.009** |
| Greedy best first graph search h\_unmet\_goals | **20** | **7** | **9** | **29** | **6** | **0.002** |
| Greedy best first graph search h\_pg\_levelsum | **20** | **6** | **8** | **28** | **6** | **0.370** |
| Greedy best first graph search h\_pg\_maxlevel | **20** | **6** | **8** | **24** | **6** | **0.294** |
| Greedy best first graph search h\_pg\_setlevel | **20** | **6** | **8** | **28** | **6** | **1.142** |
| A\* search h\_unmet\_goals | **20** | **50** | **52** | **206** | **6** | **0.009** |
| A\* search h\_pg\_levelsum | **20** | **28** | **30** | **122** | **6** | **0.982** |
| A\* search h\_pg\_maxlevel | **20** | **43** | **45** | **180** | **6** | **1.022** |
| A\* search h\_pg\_setlevel | **20** | **33** | **35** | **138** | **6** | **3.011** |

**Air Cargo Problem 2**

**Summary of Results**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Algorithm | Actions | Expansions | Goal Tests | New Nodes | Plan Length | Time |
| Breadth first search | **72** | **3343** | **4609** | **30503** | **9** | **1.830** |
| Depth first graph search | **72** | **624** | **625** | **5602** | **619** | **2.861** |
| Uniform cost search | **72** | **5154** | **5156** | **46618** | **9** | **3.141** |
| Greedy best first graph search h\_unmet\_goals | **72** | **17** | **19** | **170** | **9** | **0.019** |
| Greedy best first graph search h\_pg\_levelsum | **72** | **9** | **11** | **86** | **9** | **8.833** |
| Greedy best first graph search h\_pg\_maxlevel | **72** | **27** | **29** | **249** | **9** | **18.293** |
| Greedy best first graph search h\_pg\_setlevel | **72** | **9** | **11** | **84** | **9** | **25.395** |
| A\* search h\_unmet\_goals | **72** | **2467** | **2469** | **22522** | **9** | **2.118** |
| A\* search h\_pg\_levelsum | **72** | **357** | **359** | **3426** | **9** | **232.866** |
| A\* search h\_pg\_maxlevel | **72** | **2887** | **2889** | **26594** | **9** | **1329.608** |
| A\* search h\_pg\_setlevel | **72** | **1037** | **1039** | **9605** | **9** | **1885.515** |

**Air Cargo Problem 3**

**Summary of Results**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Algorithm | Actions | Expansions | Goal Tests | New Nodes | Plan Length | Time |
| Breadth first search | **88** | **14663** | **18098** | **129625** | **12** | **10.023** |
| Depth first graph search | **88** | **408** | **409** | **3364** | **392** | **1.124** |
| Uniform cost search | **88** | **18510** | **18512** | **161936** | **12** | **13.942** |
| Greedy best first graph search h\_unmet\_goals | **88** | **25** | **27** | **230** | **15** | **0.037** |
| Greedy best first graph search h\_pg\_levelsum | **88** | **14** | **16** | **126** | **14** | **20.745** |
| Greedy best first graph search h\_pg\_maxlevel | **88** | **21** | **23** | **195** | **13** | **24.701** |
| Greedy best first graph search h\_pg\_setlevel | **88** | **35** | **37** | **345** | **17** | **122.659** |
| A\* search h\_unmet\_goals | **88** | **7388** | **7390** | **65711** | **12** | **7.876** |
| A\* search h\_pg\_levelsum | **88** | **369** | **371** | **3403** | **12** | **367.723** |

**Air Cargo Problem 4**

**Summary of Results**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Algorithm | Actions | Expansions | Goal Tests | New Nodes | Plan Length | Time |
| Breadth first search | **104** | **99736** | **114953** | **944130** | **14** | **88.194** |
| Greedy best first graph search h\_unmet\_goals | **104** | **29** | **31** | **280** | **18** | **0.0601** |
| Greedy best first graph search h\_pg\_levelsum | **104** | **17** | **19** | **165** | **17** | **36.189** |
| A\* search h\_unmet\_goals | **104** | **34330** | **34332** | **328509** | **14** | **50.802** |
| A\* search h\_pg\_levelsum | **104** | **1208** | **1210** | **12210** | **15** | **2063.194** |

**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?**

Since the problem asks about real-time results with a small domain, then, generally speaking, greedy best-first search outperforms other algorithms in terms of speed and can be applied to real-life applications.

* **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)?**

The problem is for a situation where the problem space is large. Therefore, we must choose an efficient algorithm with modest memory requirements. One can use DFS since it only keeps the nodes of the current path and no other nodes. A\* is another viable option that will give an optimal solution. However, it is conditioned that A\* uses an optimal heuristic.

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

A\* would be the best choice using any of its variants. The algorithm is sounds and generally optimal (assuming we are using an admissible heuristics).