Heuristic Analysis

- **Experiment and document metrics for non-heuristic planning solution searches:**
  DFS: Depth first search
  BFS: Breadth first search
  UCS: Uniform cost search
  EXP: Expansions
  GT: Goal Tests
  T: Time (seconds)
  L: Plan length

	BFS				DFS				UCS			
	EXP	***GT***	***T***	***L***	*EXP*	***GT***	***T***	***L***	***EXP***	***GT***	***T***	***L***
Problem 1	**43**	**56**	**0.14**	**6**	**12**	**13**	**0.03**	**12**	**55**	**57**	**0.17**	**6**
Problem 2	**3343**	**4609**	**44.8**	**9**	**582**	**583**	**12.1**	**575**	**4852**	**4854**	**33**	**9**
Problem 3	**14663**	**18098**	**130**	**12**	**627**	**628**	**7.8**	**596**	**18235**	**18237**	**197**	**12**

The optimality of solution for each search algorithm:

1- DFS is optimal in terms of Expansions & Goal Tests & Time
But very inefficient in terms of Plan length.

2 – BFS & UCS are both optimal in terms of plan length.

3- BFS is more efficient than UCS in terms of Expansions & Goal Tests & Time.

- **Experiment and document: metrics of A* searches with these heuristics:**

Problem 1:

1- A search h_1:*

Expansions Goal Tests New Nodes
55 57 224
Plan length: 6, , Time elapsed in seconds: 0.1938 seconds

2- A search with h_ignore_preconditions:*

Expansions Goal Tests New Nodes
41 43 170
Plan length: 6, Time elapsed in seconds: 0.1850411900572383

3- A search with h_pg_levelsum:*

Expansions Goal Tests New Nodes
11 13 50
Plan length: 6, Time elapsed in seconds: 2.2808026334047957

Problem 2:

1- *A* search h_1:*

Expansions Goal Tests New Nodes

4852 4854 44030

Plan length: 9, Time elapsed in seconds: 63.0999720007784

2- A search with h_ignore_preconditions:*

Expansions Goal Tests New Nodes

1450 1452 13303

Plan length: 9, Time elapsed in seconds: 23.29748967682658

3- A search with h_pg_levelsum:*

Expansions Goal Tests New Nodes

86 88 841

Plan length: 9, Time elapsed in seconds: 157.37948962591892

Problem 3:

1- *A* search h_1:*

Expansions Goal Tests New Nodes

18235 18237 159716

Plan length: 12 ,Time elapsed in seconds: 179.51654047858142

2- *A* search with h_ignore_preconditions:*

Expansions Goal Tests New Nodes

5040 5042 44944

Plan length: 12 Time elapsed in seconds: 36.17529483344569

3- *A* search with h_pg_levelsum:*

Took more than 10 minuets.

- What was the best heuristic used in these problems? Was it better than non-heuristic search planning methods for all problems? Why or why not?

  The best heuristic used is h_pg_levelsum heuristic, is has the best Expansions, Goal Tests , New Nodes and plan length , But it takes a lot of time.

  Yes it is better than non-heuristic search planning methods for all problems in terms of all factor except time.

  The reason is that when the heuristic methods uses heuristic, then the number of calculations will be less than the non-heuristic methods.

- Provide tables or other visual aids as needed for clarity in your discussion.

	***A* search** with h_pg_levelsum*				**BFS**				**DFS**				**UCS**			
	EXP	***GT***	***T***	***L***	***EXP***	***GT***	***T***	***L***	*EXP*	***GT***	***T***	***L***	***EXP***	***GT***	***T***	***L***
Problem 1	**11**	**13**	**2.2**	**6**	**43**	**56**	**0.14**	**6**	**12**	**13**	**0.03**	**12**	**55**	**57**	**0.17**	**6**
Problem 2	**86**	**88**	**157**	**9**	**3343**	**4609**	**44.8**	**9**	**582**	**583**	**12.1**	**575**	**4852**	**4854**	**33**	**9**
Problem 3	*	*	*	*	**14663**	**18098**	**130**	**12**	**627**	**628**	**7.8**	**596**	**18235**	**18237**	**197**	**12**