Problem 1

Self-Driving Cars

Performance: A self-driving car must drive safely from point A to point B without putting passengers or citizens at risk. It also must do so in a lawful manner that follows traffic laws, and federal and provincial regulations.

Environment: Urban and rural areas. Will need to navigate roads and highways with lots of other cars and pedestrians. Traffic controllers such as stop signs, merges, lights and roundabouts will be present.

Actuators: Motors, signal, wheel, horn, steering wheel.

Sensors: Cameras, infrared range finders, pressure sensors, lidar, speedometer, GPS.

Attribute	Answer	Justification
Fully/Partially Observable	Partially Observable	The sensors on an autonomous vehicle do not give it access to the complete state of the environment. The self-driving car cannot identify the choices of other cars.
Single/Multi agent,	Multi Agent	Pedestrians and other vehicles are categorized as agents. The vehicle must take into account the actions of these agents.
Deterministic/Stochastic,	Stochastic	The next state of the environment is not completely determined by the current state and next action of the agent. Pedestrians and other vehicles can impact the next state.
Static/Dynamic,	Dynamic	The environment can change while the agent is deliberating. Another car might cut you off or a pedestrian steps out in front of the car.
Discrete/Continuous	Continuous	The time is continuous as there is no finite number of distinct states, there is no turnover of actions.

Digital Assistant

Performance: Assistant should accurately process what is being asked and provide a timely and accurate response. The assistant should integrate easily with the internet and recognize when it is being called.

Environment: A home or office environment. Can be either noisy or quiet.

Actuators: Speaker

Sensors: Microphones

Attribute	Answer	Justification
Fully/Partially Observable	Partially	The sensors on a digital assistant do not give it access to the complete state of the environment. A digital assistant will not have temperature sensors attached.
Single/Multi agent,	Multi Agent	The interacting human is the second agent making it multi-agent.

Deterministic/Stochastic,	Stochastic	The next state of the environment is not completely determined by the current state and next action of the agent. Humans interacting with the assistant will often dictate the next state.
Static/Dynamic,	Dynamic	The environment can change while the agent is deliberating. The user may cancel the current command and ask a new question requiring the assistant to be dynamic.
Discrete/Continuous	Discrete	The assistant is discrete as there are a finite number of distinct states, such as “play music” or “what is the temperature”

Automated Drive-Through

Performance: The drive-through should be able to accurately handle both simple and complex orders and process them in a timely manner. This means the natural language processing should be accurate at processing lots of different commands and all order elements should be remembered. The drive through should accurately identify when a customer is ready to order.

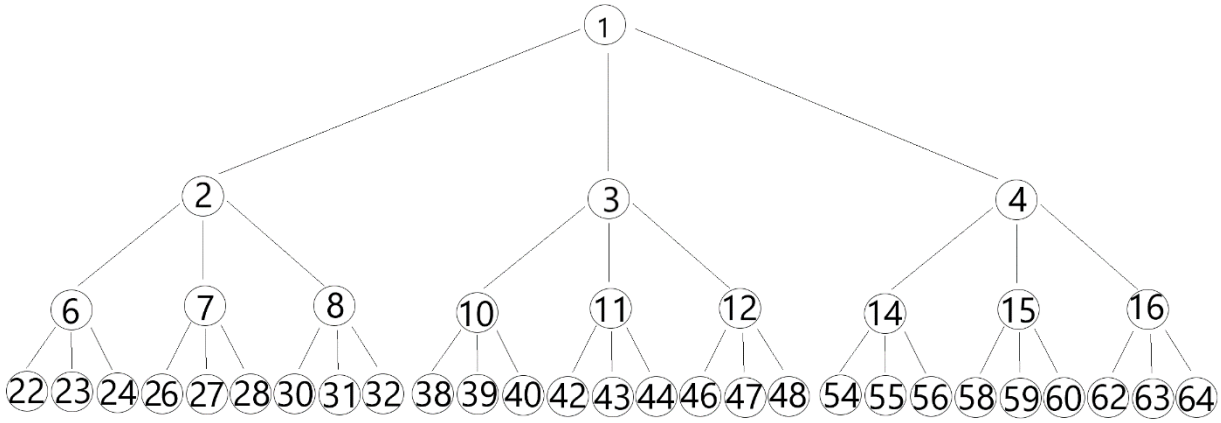
Environment: Different users will interact with the agent with different speaking styles and voices. Drive-throughs are often loud indicating high background noise.

Actuators: Speaker, hand mechanism to deliver food to customer

Sensors: Camera, Microphone

Attribute	**Answer**	**Justification**
Fully/Partially Observable	Partially Observable	The sensors on an automated drive-through do not give it access to the complete state of the environment.
single/multi agent,	Multi Agent	The interacting human is the second agent making it multi-agent.
Deterministic/Stochastic,	Stochastic	The next state of the environment is not completely determined by the current state and next action of the agent. Humans interacting with the assistant will often dictate the next state.
Static/Dynamic,	Dynamic	The environment can change while the agent is deliberating. The customer may change their order while the agent is placing the order, the agent should be capable of handling this.
Discrete/Continuous	Discrete	The drive-through is discrete as there are a finite number of distinct states, such as “ask for an order” or “give total amount”

Problem 2



b) Goal state is 43

BFS: 1,2,3,4,6,7,8,9,10,11,12,14,15,16,22,23,24,26,27,28,30,31,32,38,39,40,42,**43**

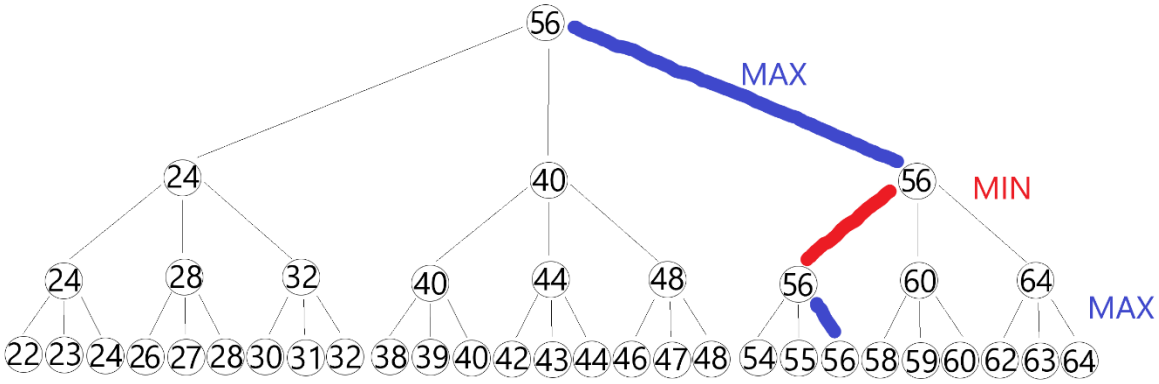
DFS:1,2,6,22,23,24,7,26,27,28,8,30,31,32,3,10,38,39,40,11,42,**43**

DLS:1,2,6,22,23,24,7,26,27,28,8,30,31,32,3,10,38,39,40,11,42,**43**

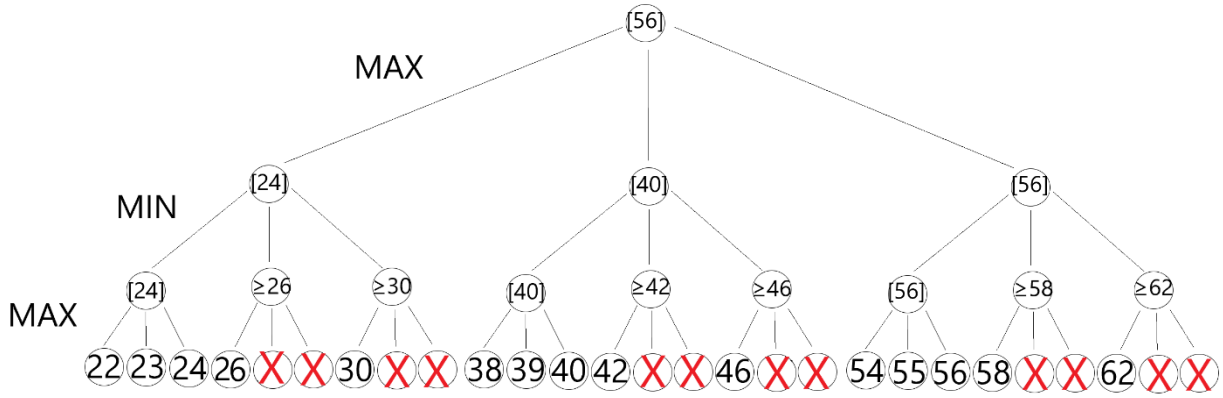
IDS:
1,1,2,3,4,1,2,6,7,8,3,10,11,12,4,14,15,16,1,2,6,22,23,24,7,26,27,28,8,30,31,32,3,10,38,39,40,11,42,**43**

Problem 3

MiniMax



Alpha Beta Pruning



Problem 4

$y = 3x^2 + 4x - 2$

$\nabla y(x) = 6x + 4$

$x_0 = -2$

Learning rate = 0.1

$x_0 = -2$

$x_1 = x_0 - n(6x + 4) = -2 - 0.1(-12 + 4) = -1.2$

$x_2 = x_1 - n(6x + 4) = -1.2 - 0.1(-7.2 + 4) = -0.88$

$x_3 = x_2 - n(6x + 4) = -0.88 - 0.1(-5.28 + 4) = -0.752$

$x_4 = x_3 - n(6x + 4) = -0.752 - 0.1(-4.512 + 4) = -0.7008$

$x_5 = x_4 - n(6x + 4) = -0.7008 - 0.1(-4.2048 + 4) = -0.68032$

Learning rate = 1

$x_0 = -2$

$x_1 = x_0 - n(6x + 4) = -2 - 1(-12 + 4) = 6$

$x_2 = x_1 - n(6x + 4) = 6 - 1(36 + 4) = -34$

$x_3 = x_2 - n(6x + 4) = -34 - 1(-204 + 4) = 166$

$x_4 = x_3 - n(6x + 4) = 166 - 1(996 + 4) = -834$

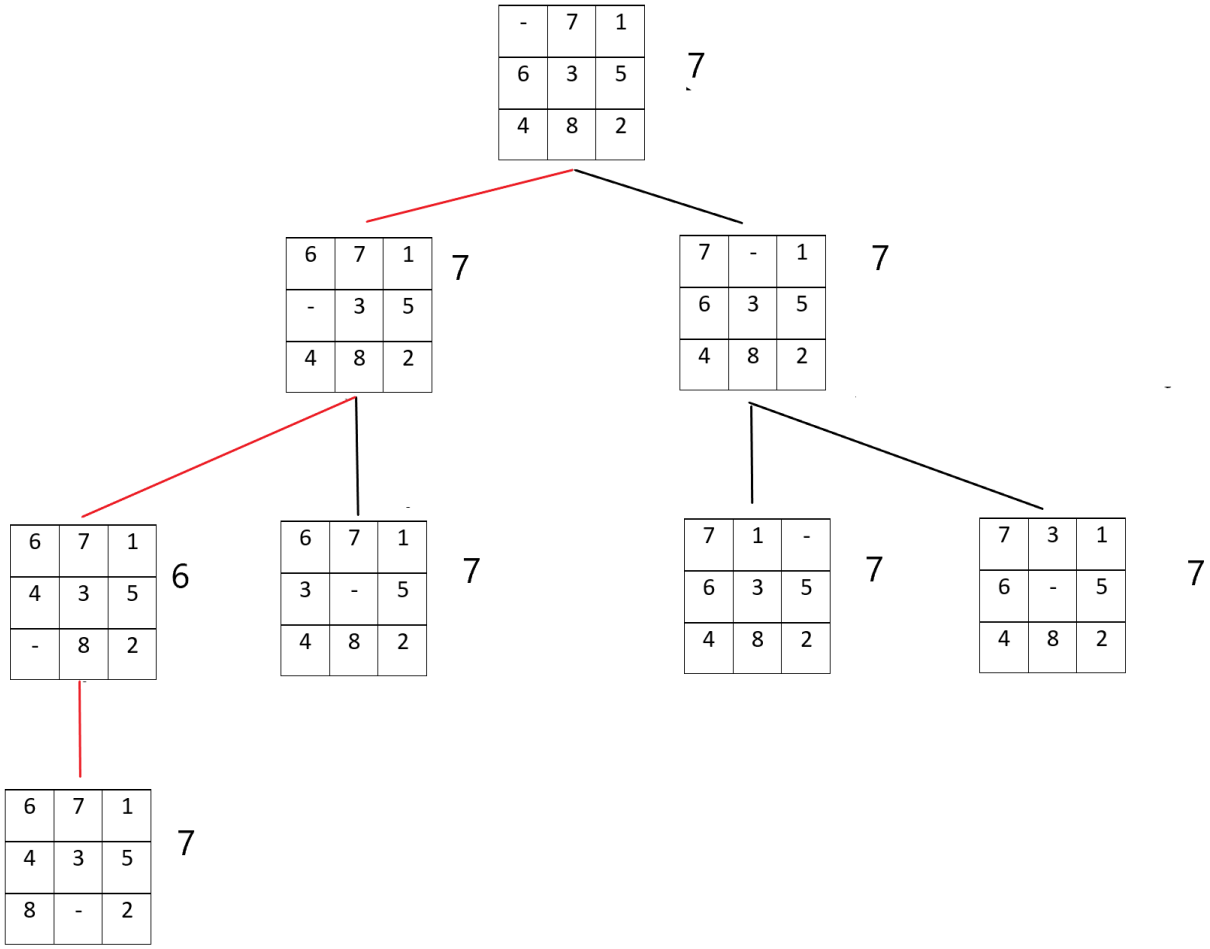
$x_5 = x_4 - n(6x + 4) = -834 - 1(-5004 + 4) = 4166$

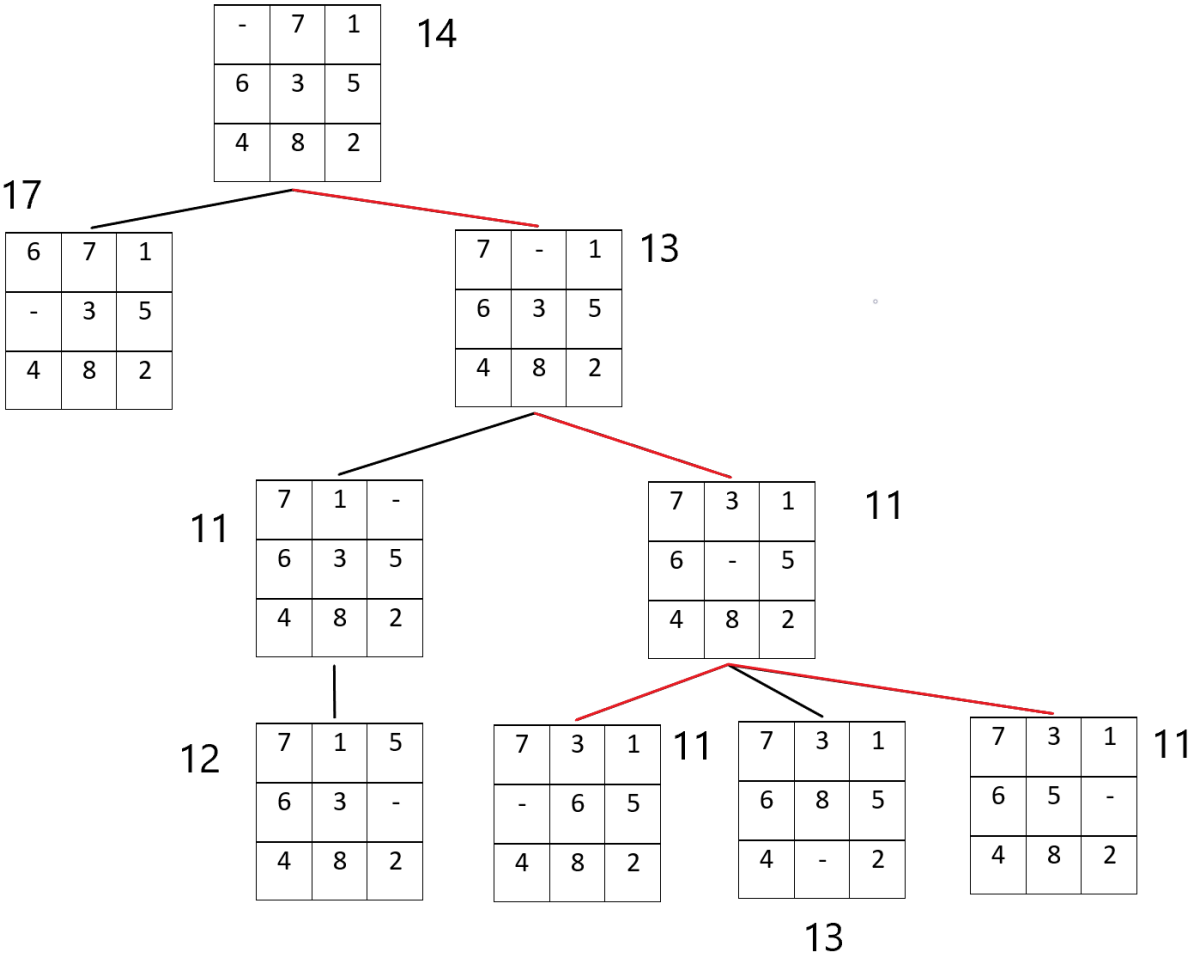
As the learning rate is increased the solution precision decreases.

Problem 5

$h_1 = 7$

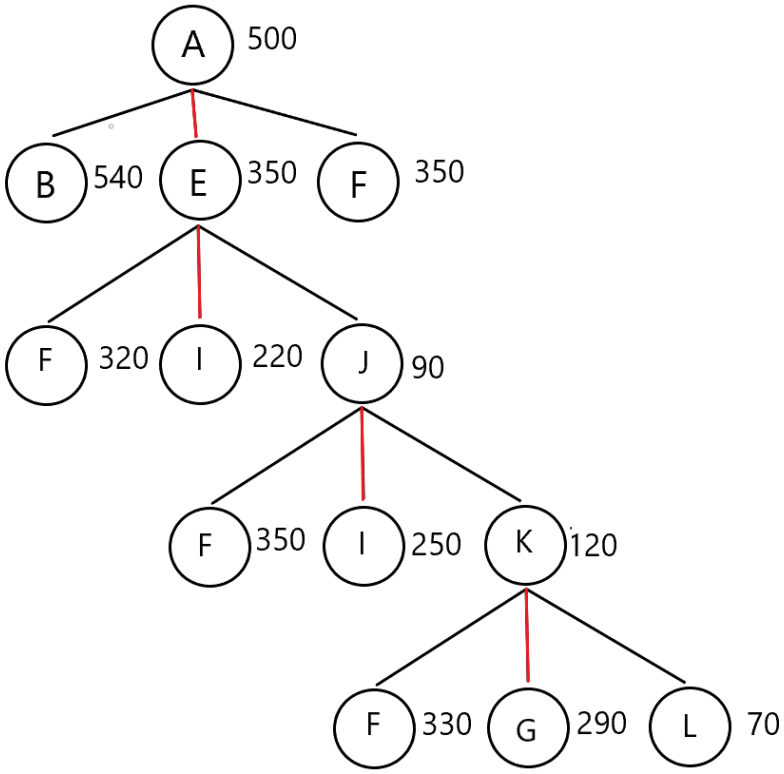
$h_2 = 2 + 3 + 2 + 1 + 1 + 2 + 3 = 14$



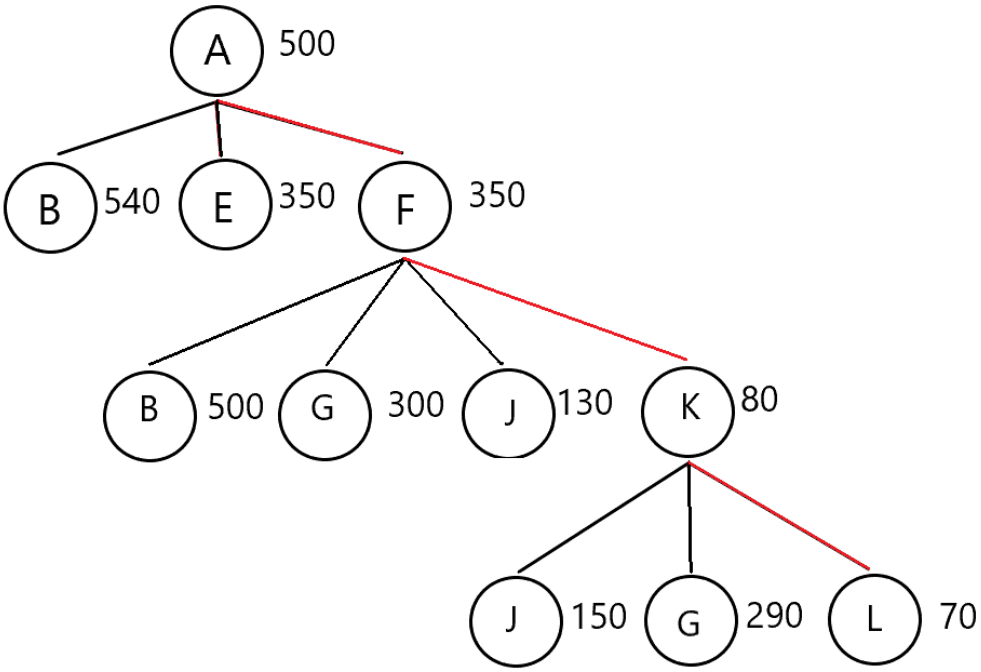


The second heuristic appears to be working better. In general numbers are gravitating towards their intended positions, better than in the first “misplaced” heuristic. It becomes easier to measure progress this way as sometimes a tile may be required to move from its correct position in order to reach the solution.

Problem 6



Step	Cost
A	500
A,E	850
A,E,J	940
A,E,J,K	1060
A,E,J,K,L	**1130**



Step	Cost
A	500
A,F	850
A,E,K	930
A,E,K,L	**1000**

The A* path is that of the second tree diagram. Two trees had to be created as there was equal scores for the first move.