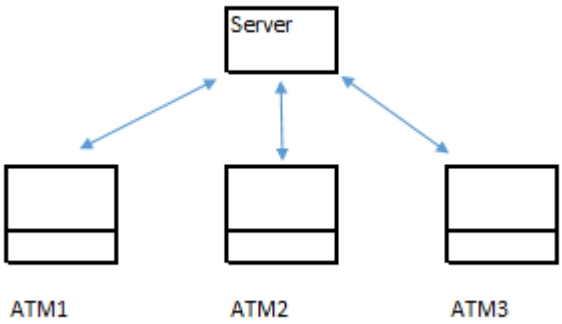
Name: Zhihan Wang

Student ID: 17272381

Problem 1:

Solve the planning problem for a back end server to process various amount of withdraw cash requests by customers using three existing ATMs in a bank lobby. The source code is in 'Problem1_ATM' file.



Primitive Features:

Feature	Comment
T_IDLE:{'T1','T2','T3','T1_2','T1_3','T2_3','T1_2_3' }	Enumerate the proposed ATM terminals to be used at the same time
FREE_SOCKET_T1: { True , False }	Whether ATM terminal 1 has free socket
FREE_SOCKET_T2: { True , False }	Whether ATM terminal 2 has free socket
FREE_SOCKET_T3: { True , False }	Whether ATM terminal 3 has free socket
T1_CONNECTTED: { True , False }	Whether ATM terminal 1 has connect to server
T2_CONNECTTED: { True , False }	Whether ATM terminal 2 has connect to server
T3_CONNECTTED: { True , False }	Whether ATM terminal 3 has connect to server
REQUEST_SENT_FROM_T1: { True , False }	Whether server has received the withdraw cash request from ATM terminal 1
REQUEST_SENT_FROM_T2: { True , False }	Whether server has received the withdraw cash request from ATM terminal 2
REQUEST_SENT_FROM_T3: { True , False }	Whether server has received the withdraw cash request from ATM terminal 3
RESPONSE_SENT_TO_T1: { True , False }	Whether server has responded to ATM terminal 1 and pop out cash
RESPONSE_SENT_TO_T2: { True , False }	Whether server has responded to ATM terminal 2 and pop out cash
RESPONSE_SENT_TO_T3: { True , False }	Whether server has responded to ATM terminal 3 and pop out cash
SERVER_LISTENING: { True , False }	Whether server has been awakened to connect one of ATM terminal

Actions:

Operator: 'insert_bank_card_in_T1'

Pre- Condition: {'T_IDLE': 'T1'}
Effect: {'FREE_SOCKET_T1': True,'T1_IDLE': False, 'SERVER_LISTENING': True }
Comment: Customer has inserted his bank card and input request in ATM terminal 1 for various amount of cash to withdraw.

Operator: 'insert_bank_card_in_T2'
Pre- Condition: {'T_IDLE': 'T2'}
Effect: {'FREE_SOCKET_T2': True,'T2_IDLE': False, 'SERVER_LISTENING': True }
Comment: Customer has inserted his bank card and input request in ATM terminal 2 for various amount of cash to withdraw.

Operator: 'insert_bank_card_in_T3'
Pre- Condition: {'T_IDLE': 'T3'}
Effect: {'FREE_SOCKET_T3': True,'T3_IDLE': False, 'SERVER_LISTENING': True }
Comment: Customer has inserted his bank card and input request in ATM terminal 3 for various amount of cash to withdraw.

Operator: 'insert_bank_card_in_T1_&_T2'
Pre- Condition: {'T_IDLE': 'T1_T2'}
Effect: {'FREE_SOCKET_T1': True,'FREE_SOCKET_T2': True, 'SERVER_LISTENING': True }
Comment: two customers have inserted his bank card and input request in ATM terminal 1 & 2 at the same time for various amount of cash to withdraw respectively.

Operator: 'insert_bank_card_in_T1_&_T3'
Pre- Condition: {'T_IDLE': 'T1_T3'},
Effect: {'FREE_SOCKET_T1': True,'FREE_SOCKET_T3': True, 'SERVER_LISTENING': True }
Comment: two customers have inserted his bank card and input request in ATM terminal 1 & 3 at the same time for various amount of cash to withdraw respectively.

Operator: 'insert_bank_card_in_T2_&_T3'
Pre- Condition: {'T_IDLE': 'T2_T3'},
Effect: {'FREE_SOCKET_T2': True,'FREE_SOCKET_T3': True, 'SERVER_LISTENING': True }
Comment: two customers have inserted his bank card and input request in ATM terminal 2 & 3 at the same time for various amount of cash to withdraw respectively.

Operator: 'insert_bank_card_in_T1_&_T2_&_T3'
Pre- Condition: {'T_IDLE': 'T1_T2_T3'}
Effect: {'FREE_SOCKET_T1': True,'FREE_SOCKET_T2':

True,'FREE_SOCKET_T3': True, 'SERVER_LISTENING': True }
Comment: Three customer have inserted his bank card and input request in ATM terminal 1 ,2 and 3 at the same time for various amount of cash to withdraw respectively.

Operator: 'server_connect_T1'
Pre- Condition: {'SERVER_LISTENING': True, 'FREE_SOCKET_T1': True }
Effect: {'T1_CONNECTTED': True }
Comment: Sever has connected to ATM terminal 1

Operator: 'server_process_withdraw_cash_request_from_T1'
Pre- Condition: {'T1_CONNECTTED': True }
Effect: {'REQUEST_SENT_FROM_T1': True }
Comment: Server has processed request from ATM terminal 1

Operator: 'cash_pop_out_from_T1'
Pre- Condition: {'REQUEST_SENT_FROM_T1': True }
Effect: {'RESPONSE_SENT_TO_T1': True }
Comment: Proposed amount of cash has been pop out from ATM terminal 1

Operator: 'close_T1_connection':
Pre- Condition: {'RESPONSE_SENT_TO_T1': True }
Effect: {'T1_CONNECTTED' : False, 'SERVER_LISTENING': False,'FREE_SOCKET_T1': False }
Comment: Server has closed ATM terminal 1 connection and waiting for the next request

Operator: 'server_connect_T2'
Pre- Condition: {'SERVER_LISTENING': True, 'FREE_SOCKET_T2': True }
Effect: {'T2_CONNECTTED': True }
Comment: Sever has connected to ATM terminal 2

Operator: 'server_process_withdraw_cash_request_from_T2'
Pre- Condition: {'T2_CONNECTTED': True }
Effect: {'REQUEST_SENT_FROM_T2': True }
Comment: Server has processed request from ATM terminal 2

Operator: 'cash_pop_out_from_T2'
Pre- Condition: {'REQUEST_SENT_FROM_T2': True }
Effect: {'RESPONSE_SENT_TO_T2': True }
Comment: Proposed amount of cash has been pop out from ATM terminal 2

Operator: 'close_T2_connection':
Pre- Condition: {'RESPONSE_SENT_TO_T2': True }
Effect: {'T2_CONNECTTED' : False, 'SERVER_LISTENING': False,'FREE_SOCKET_T2': False }
Comment: Server has closed ATM terminal 2 connection and waiting for the next request

Operator: 'server_connect_T3'
Pre- Condition: {'SERVER_LISTENING': True, 'FREE_SOCKET_T3': True }
Effect: {'T3_CONNECTTED': True }
Comment: Sever has connected to ATM terminal 3

Operator: 'server_process_withdraw_cash_request_from_T3'
Pre- Condition: {'T3_CONNECTTED': True }
Effect: {'REQUEST_SENT_FROM_T3': True }
Comment: Server has processed request from ATM terminal 3

Operator: 'cash_pop_out_from_T3'
Pre- Condition: {'REQUEST_SENT_FROM_T3': True }
Effect: {'RESPONSE_SENT_TO_T3': True }
Comment: Proposed amount of cash has been pop out from ATM terminal 3

Operator: 'close_T3_connection':
Pre- Condition: {'RESPONSE_SENT_TO_T3': True }
Effect: {'T3_CONNECTTED' : False, 'SERVER_LISTENING': False,'FREE_SOCKET_T2': False }
Comment: Server has closed ATM terminal 3 connection and waiting for the next request

Problem Solutions:

Case1: Customer uses one of ATM terminals to withdraw cash

Initial State: {'T_IDLE': 'T1'},

Goal State: {'RESPONSE_SENT_TO_T1': True,'T1_CONNECTTED': False}

Comment: 'T_IDLE' can also be switched T2 or T3 in initial state, its goal state needs to be change respectively.

Both STRIPS forward planner and regression planner give the solution:

Step	Actions
0	Insert_bank_card_in_T1

1	server_connect_T1
2	server_process_withdraw_cash_request_from_T1
3	cash_pop_out_from_T1
4	close_T1_connection

Case2: Customers use two of ATM terminals to withdraw cash at the same time

Initial State: { 'T_IDLE': 'T2_T3' },

Goal State: { 'RESPONSE_SENT_TO_T3':True, 'RESPONSE_SENT_TO_T2':True, 'T3_CONNECTTED' : False,'T2_CONNECTTED' : False}

Comment: 'T_IDLE' can also be switched other any other two terminal combinations in initial state, its goal state needs to be change respectively.

One of solutions from STRIPS forward planner:

Step	Actions
0	insert_bank_card_in_T2_&_T3
1	server_connect_T2
2	server_process_withdraw_cash_request_from_T2
3	server_connect_T3
4	server_process_withdraw_cash_request_from_T3
5	cash_pop_out_from_T2
6	cash_pop_out_from_T3
7	close_T2_connection
8	close_T3_connection

One of solutions from STRIPS regression planner:

Step	Actions
0	insert_bank_card_in_T2_&_T3
1	server_connect_T2
2	server_connect_T3
3	server_process_withdraw_cash_request_from_T2
4	server_process_withdraw_cash_request_from_T3
5	cash_pop_out_from_T2
6	close_T2_connection
7	cash_pop_out_from_T3
8	close_T3_connection

Case3: Customers use three ATM terminals to withdraw cash at the same time

Initial State: { 'T_IDLE': 'T1_T2_T3'},

Goal State: { 'RESPONSE_SENT_TO_T1':True, 'RESPONSE_SENT_TO_T2':True, 'RESPONSE_SENT_TO_T3':True, 'T1_CONNECTTED' : False,'T2_CONNECTTED' : False,'T3_CONNECTTED' : False}

Solution from STRIPS forward planner:

Step	Actions
0	insert_bank_card_in_T1_&_T2_&_T3
1	server_connect_T2
2	server_process_withdraw_cash_request_from_T2
3	cash_pop_out_from_T2
4	server_connect_T1
5	server_connect_T3
6	server_process_withdraw_cash_request_from_T3
7	server_process_withdraw_cash_request_from_T1
8	close_T2_connection
9	cash_pop_out_from_T1
10	cash_pop_out_from_T3
11	close_T1_connection
12	close_T3_connection

One of solutions from STRIPS regression planner:

Step	Actions
0	insert_bank_card_in_T1_&_T2_&_T3
1	server_connect_T1
2	server_connect_T3
3	server_connect_T2
4	server_process_withdraw_cash_request_from_T3
5	server_process_withdraw_cash_request_from_T1
6	cash_pop_out_from_T3
7	cash_pop_out_from_T1
8	close_T3_connection
9	close_T1_connection
10	server_process_withdraw_cash_request_from_T2
11	cash_pop_out_from_T2
12	close_T2_connection

Additional Comments:

In this problem, I have simplified the network connection process, such as free server socket and bind server socket operators. In addition, the initial T_IDLE feature has to be enumerated all its terminal combinations, otherwise the search space of problem will jump to cycle / loop if we only set up T_IDLE: { 'T1','T2','T3'} when querying solution for operating T1 and T2 at the same time. Similarly, if we want to solve problem for four or more terminals, it needs to enumerate all its combinations. The multi path pruning searcher has been used for this STRIP planner, A star searcher will cause this problem drop into loop as well.

There are multiple solutions for this problem. To validate the result above, the main sequence/cycle of each terminal connect to and get response from server process is

Customer_insert_bank_card ->

server_connect_to_ATM_terminal ->

server_process_request_from_ATM_terminal ->

cash_pop_out_from_ATM_terminal ->

close_ATM_terminal_connection.

It doesn’t matter which ATM terminal to response first subject to the main sequence is correct as the whole process should be done less than 1 second by computer and customer will not realise the time.