

DAT530
Discrete Simulation and Performance Analysis
Final Project
Solitaire game strategy

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Abstract. This project is such and such... +++

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Abbreviations

DP Draw Pile Module
FIFO First In First Out (Queue)
FP Foundation Pile Module
GUI Graphical User Interface
LIFO Last In First Out (Stack)

P Player Module
PB Player Bot Module
TP Tableau Pile Module

Nomenclature

card (In the Petri Net context) A token with a color which represents a card in the deck.

command A token with a color which represents a turn or movement command.

1 Introduction

This project aims to study the popular card game, Solitaire[Site]. Solitaire is bundled with most Windows[Site] installations, as well as being available for free on several sources. It is also easy to play the game with a physical card deck. A detailed explanation of the games rules can be found in the next chapter, Solitaire Rules[REF]

Since the game utilizes all 52 cards of the deck, the number of possible initial game states is $52!$, which is a very high number. A large number of these initial game states can be merged, as they offer no difference in the difficulty to solve. Some of these initial states are unsolvable, but even given a solvable game state, one often find oneself in an unsolvable game state, due to certain actions in the game are non-reversible,. There has been attempts to find the distribution of solvable and unsolvable initial game states [ref]. This is roughly 75 percent are solvable, however the study also shows that only 35 percent of the games are won by an experienced player.

This project contains a complete model of the game, a GUI to play the game, and a basic bot to simulate user actions.

1.1 Solitaire Rules

Klondike, or Solitaire as it has been called in North America, is one of the most popular patience games.

The game became very popular in the 19th century and the name Klondike is believed to have originated from the prospectors that were mining for gold in the Klondike region in Canada.

Solitaire is played with a standard deck of 52 cards and no Jokers. We will describe the layout and rules of the game

At the beginning of the game, the deck is shuffled and the cards are laid out in seven tableau piles from left to right. Each pile contains one additional card compared to the previous one. There is one upturned card at the beginning of each pile. The first pile to the left contains one card facing up, the second contains one card facing down and one up, the third pile contains two cards facing

down and one up, continuing to the seventh pile respectively, which contains six cards facing down and one facing up. Tableau piles can be built down by alternating colors. Partial or complete piles can be moved on top of other piles as long as long as the constraint of alternating card color is respected. Empty piles can be filled with a King or a pile of cards that starts with a King.

We build up the piles by stacking cards of the same suit starting from Ace and finishing with King. The aim of the game is to build up a stack of cards of the same suit. When this is accomplished, the goal is to move this stack to foundation where the Ace of the suit had previously been placed.

The remainder of the deck is dealt by turning one card at a time from the draw pile. When all the cards from the draw pile have been turned, the draw pile can be reset.

The layout of the piles is illustrated in figure 1.

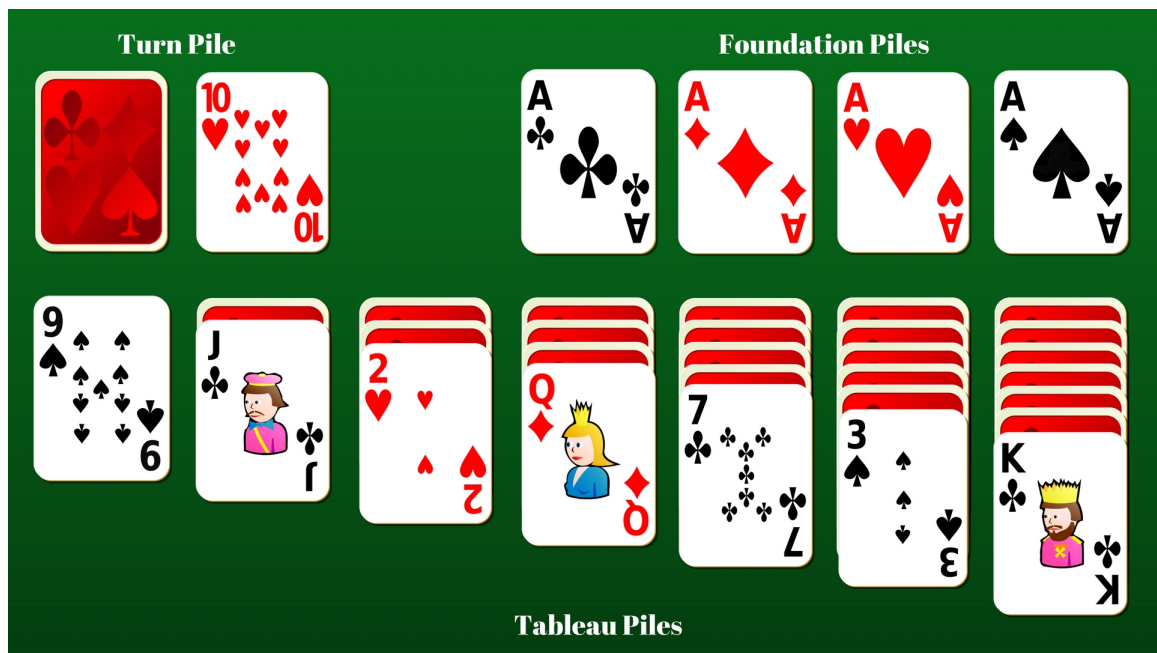


Fig. 1. Illustration of card layout in Solitaire

2 Method and Design

2.1 Naming Policy

2.2 File structure

To reduce the number of files, most of the pre- and post-processor files of the FP and TP modules have been combined in one single file. An example of this can be shown in listing 1.1, which shows parts of `COMMON_PRE`

Listing 1.1. `COMMON_PRE.m` lines 1-5

```

1 function [fire, transition] = COMMON_PRE(transition)
2
3 if ismember(transition.name, {'tFPe_Clubs_Add', 'tFPe_Diamonds_Add', ...
4   'tFPe_Hearts_Add', 'tFPe_Spades_Add'}),
5     [fire, transition] = pre_tFPe_Add(transition);

```

By doing this it is possible to reduce the number of files required without overloading the `COMMON_PRE` and `COMMON_POST` files. It also makes it much easier to work and maintain the code as the logic is only located in one place, as opposed to four or seven places if each transition had their own file.

With this approach it is no longer possible to hard-code the names of the related transitions and places, so two additional functions; `get_tableau_from_transname` and `get_suit_from_transname` were developed. These functions take the name of the transition as input, and then return the unique identifier for which module it belongs to. The actual code is pretty simple, and parts of `get_suit_from_transname` is shown in listing 1.2. The reasoning behind not using the Matlab command `contains` is simply that it is not supported in older versions.

Listing 1.2. `get_suit_from_transname.m` lines 7-17

```

1 if ~isempty(strfind(transitionname, 'Clubs')),
2     suit = 'Clubs';
3 elseif ~isempty(strfind(transitionname, 'Diamonds')),
4     suit = 'Diamonds';
5 elseif ~isempty(strfind(transitionname, 'Hearts')),
6     suit = 'Hearts';
7 elseif ~isempty(strfind(transitionname, 'Spades')),
8     suit = 'Spades';
9 else,
10     suit = 0; % Invalid suit.
11 end

```

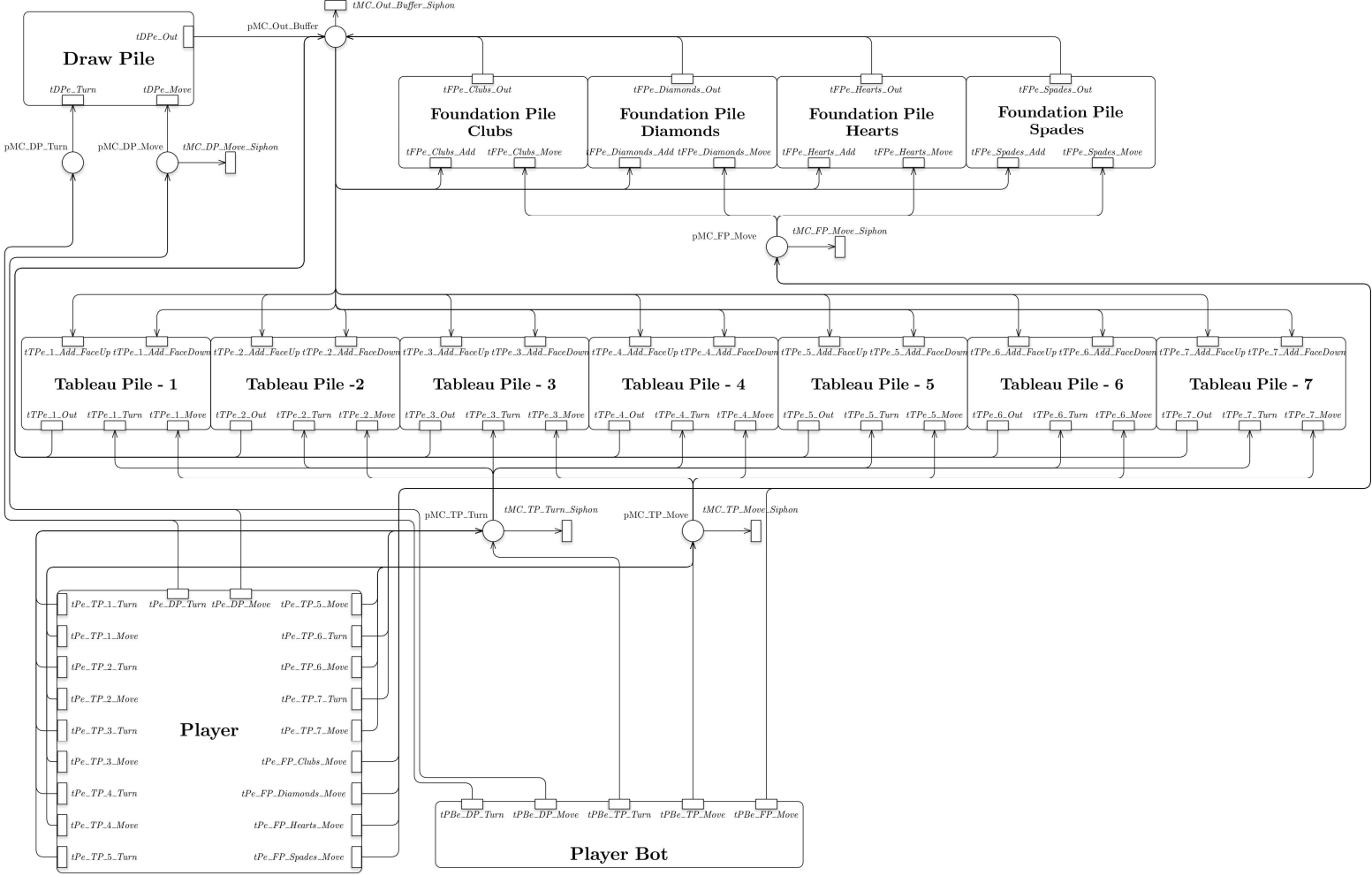


Fig. 2. The complete model - Without the internal components of the modules.

The model developed is pretty large, and contains 94 transition and 42 places. It is developed using the modular approach, and encompasses 6 different modules. Some of the modules are duplicated, with the only difference being the names of the transitions and places.

2.4 Draw Pile Module

The Draw Pile module is depicted in figure 3, and has several key responsibilities, one of which is to do the initial dealing of cards. In order to preserve the correctness of the gameplay, external input is not allowed during this phase. When first running the model, all the initial tokens of **pDP_Dealer** will be sent to **tDPi_Dealer**. This transition will give each token a color which represents a card in the deck. Possible colors are initially stored in the cell **global_info.DECK**.

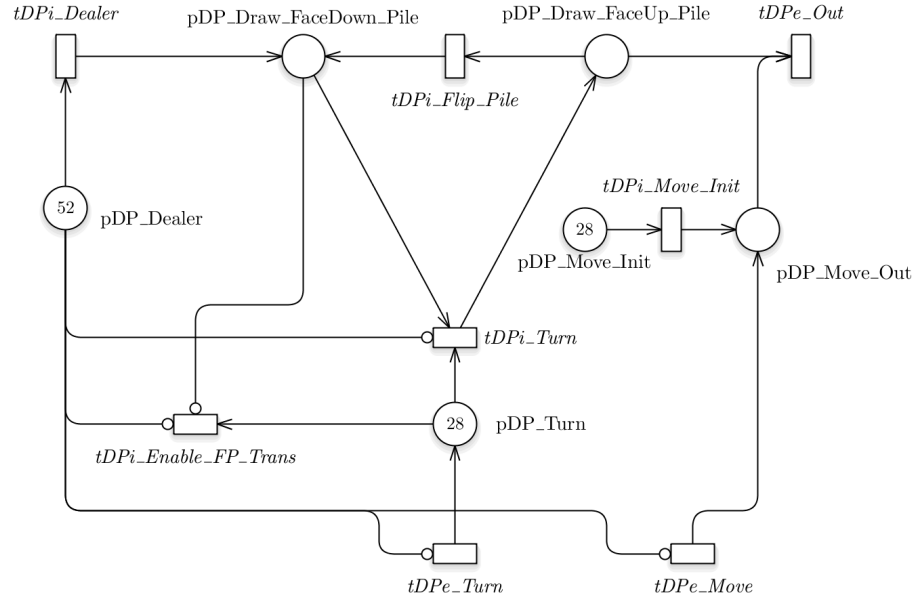


Fig. 3. Draw Pile Module

If `global_info.RANDOM_DECK` is set, a random permutation of the colors will be given to the tokens. By having `global_info.RANDOM_DECK` set to false, it is possible to run analytics which require that the cards are dealt equally each time.

After all tokens are given a color, `tDPi_Turn` will be enabled. This transition will move cards from the pile which represents face-down cards, `pDP_Draw_FaceDown_Pile` to the one representing face-up cards, `pDP_Draw_FaceUp_Pile`. This transition will fire as many times as the length of `global_info.INITIAL_DEAL_MOVE`, which is 28 in a normal game. This is not something that would be done if the game were played with physical cards, as they would just be dealt without turning them. In this model however, this is required so that existing logic could be re-used.

Concurrently to the firing of `tDPi_Turn`, the transition `tDPi_Move_Init` will fire an equal amount of times. The transition will give each of the tokens in `pDP_Move_Init` a color which represents to which tableau pile the card should be moved to. The color given to each token is augmented by the cell, `global_info.INITIAL_DEAL_MOVE`. An example of a color given is *Move:TP1:DP* which means; *Moving a card from source DP to destination TP1*. Every time a card reaches its destined tableau pile, the variable `global_info.CARDS_DEALT` will be incremented by one in `COMMON_POST`. Once it becomes equal to the length

of `global_info.INITIAL_DEAL_MOVE`, the initial dealing phase is over, and the normal phase starts.

During the normal phase, external input is allowed. The first input of the Draw Pile Module is `tDPe_Move`. This transition has an pre-processor file, which makes it only fire if there are tokens in `pDP_Draw_FaceUp_Pile`. Additionally, the Player and Player Bot modules ensures that the enabling token has color on the format *Move:(destination):DP*.

Listing 1.3. `tDPe_Move_pre.m`

```

1 function [fire, transition] = tDPe_Move_pre(transition)
2
3 fire = 0;
4 if ~isempty(tokIDs('pDP_Draw_FaceUp_Pile')),
5     fire = 1;
6 end

```

The second input, `tDPe_Turn` is used to simply move cards from the face-down pile to the face-up pile during the normal phase. An interesting thing about this is that once all the cards are in the face-up pile, the next time one attempts to turn a card, all cards should be moved back to the face-down pile in LIFO style, just as they would if you simply flip the deck of cards around in real-life.

This is accomplished by the transitions `tDPi_Flip_Pile` and `tDPi_Enable_DP_Trans`. The `tDPi_Enable_FP_Trans` is actually a siphon, and becomes enabled once `pDP_Draw_FaceDown_Pile` is empty, and there is an active turn action on-going so that `pDP_Turn` has at least one token. The transition has one post-processor file, shown in listing 1.4. Given that there are actually any tokens left in `pDP_Draw_FaceUp_Pile` it will set the global flag, `global_info.DP_Flip_Pile_Running` to `true`, if there are no tokens in the face-up pile, it will simply release the `playerAction` resource. The use of resources is discussed further in chapter 3.5. The reason for not having an arc directly from the face-up pile is due to this transition being a siphon, so the card would be removed from the game if it fired.

Listing 1.4. `tDPi_Enable_FP_Trans_post.m`

```

1 function [] = tDPi_Enable_FP_Trans_post(transition)
2
3 global global_info;
4 if ~isempty(tokIDs('pDP_Draw_FaceUp_Pile')),
5     global_info.DP_Flip_Pile_Running = true;
6 else,
7     % Release playerAction resource to allow for another player action.
8     release(global_info.last_command_source);
9 end;

```

Once `global_info.DP_Flip_Pile_Running` is set to `true` and there are tokens in `pDP_Draw_FaceUp_Pile`, the transition `tDPi_Flip_Pile` will start firing. The pre-processor file is listed in 1.5, and will keep selecting the latest arrived card from `pDP_Draw_FaceUp_Pile` and fire. In the post-processor file, listed in 1.6, it will check for the length of the face-up pile, once it becomes empty it will set the flag `global_info.DP_Flip_Pile_Running` to `false`, and the cards have been successfully turned around.

Listing 1.5. tDPi_Flip_Pile_pre.m

```

1 function [fire, transition] = tDPi_Flip_Pile_pre(transition)
2
3 global global_info;
4 fire = 0;
5 if global_info.DP_Flip_Pile_Running == true,
6     transition.selected_tokens = tokenArrivedLate('pDP_Draw_FaceUp_Pile',1);
7     fire = 1;
8 end

```

Listing 1.6. tDPi_Flip_Pile_post.m

```

1 function [] = tDPi_Flip_Pile_post(transition)
2
3 global global_info;
4 if isempty(tokIDs('pDP_Draw_FaceUp_Pile')),
5     global_info.DP_Flip_Pile_Running = false;
6     global_info.SCORE = max(global_info.SCORE - 100, 0);
7     % Release playerAction resource to allow for another player action.
8     release(global_info.last_command_source);
9 end;

```

Lastly, there is the `tDPe_Out` transition. This is the only external output of the module. When enabled, its pre-processor will take the latest card arrived at `pDP_Draw_FaceUp_Pile`, but the earliest command arrived at `pDP_Move_Out` when firing. By taking the earliest command arrived in a FIFO manner, we ensure that the initial dealing will be correct. If we were to take the latest command, we would have to add additional logic such as alternating firing to make certain the ordering of cards would be correct. The code is shown in listing 1.7

Listing 1.7. tDPe_Out_pre.m

```

1 function [fire, transition] = tDPe_Out_pre(transition)
2
3 % Want to make sure that we get the earliest move-token, and the latest
4 % card. This is so that we can have a natural ordering of the cards during
5 % the initial dealing.
6 moveToken = tokenArrivedEarly('pDP_Move_Out', 1);
7 % Explicitly sure to get the card at the top of the stack.
8 cardToken = tokenArrivedLate('pDP_Draw_FaceUp_Pile', 1);
9
10 transition.selected_tokens = [moveToken cardToken];
11 fire = 1;

```

Interestingly, moving cards out of the `tDPe_Out` transition is a non-reversible action as the module has no external input. So by doing this one could potentially put the game in an unsolvable state.

Table 1. Places and transitions used in Draw Pile

| | Name | Description |
|----|------------------------|---|
| 1 | pDP_Dealer | Holds the initial tokens which will become cards. |
| 2 | pDP_Draw_FaceDown_Pile | Holds the face-down cards. These are not visible to the player. |
| 3 | pDP_Draw_FaceUp_Pile | Holds the face-up cards. Only the top card is visible to the player. |
| 4 | pDP_Move_Init | Holds initial tokens used for generating move-commands. |
| 5 | pDP_Move_Out | Buffer for move-commands. |
| 6 | pDP_Turn | Buffer for turn-commands. |
| 7 | tDPe_Move | External input for the move-command |
| 8 | tDPe_Out | External output |
| 9 | tDPe_Turn | External input for the turn-command |
| 10 | tDPi_Dealer | Gives every token a color to represent a card in the deck. |
| 11 | tDPi_Enable_FP_Trans | Used to facilitate the flipping of the face-up pile. |
| 12 | tDPi_Flip_Pile | Moves cards from face-up pile to face-down pile in a LIFO manner. |
| 13 | tDPi_Move_Init | Generates initial move-commands to facilitate initial dealing of the cards. |
| 14 | tDPi_Turn | Moves a card from the face-down pile to the face-up pile. |

2.5 Foundation Pile Module

The Foundation Pile module is depicted figure 4. It is duplicated four times, once for every suit, clubs, diamonds, hearts, and spades. The only difference between these modules is the names of their respective transitions and names, so the description given for clubs will count for the other duplicates as well. All the pre- and post-processor files are shared between all the suits.

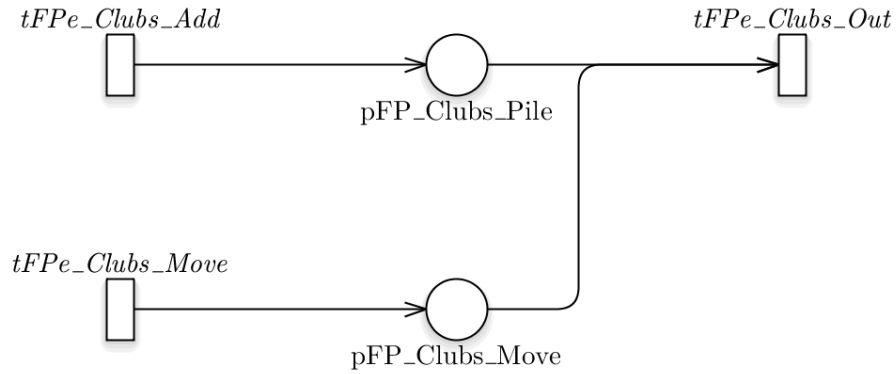


Fig. 4. Foundation Pile Module

This module is inactive during the initial phase, and only becomes interactive once the normal phase starts. It has two external inputs, the first of which is `tFPe_Clubs_Add`. This transition has a shared pre-processor file, `pre_tFPe_Add`. Listing 1.8 shows parts of the logic, the full file can be found in B.19. The pre-processor fetches the token arrived earliest at `pMC_Out_Buffer`. This is an important step, but is not strictly required because of the limitations the resource `playerAction` enforces on the transitions of the Player and Player Bot modules. Still, it makes sense to fetch the earliest token in FIFO style to make sure that the first moved card reaches its destination first.

Given that the colors of the token have the correct length, the `get_suit_from_transname` function will be run to determine which FP the executing transition belongs to. More information about this step can be found in 2.2. Lastly, the `checkCommand_Move` function is ran to determine the validity of the command in the context of this particular transition. The `checkCommand_Move` function is quite involved, and is discussed in detail in chapter 3.3.1.

Listing 1.8. `pre_tFPe_Add.m` lines 5-17

```

1 moveToken = tokenArrivedEarly('pMC_Out_Buffer',1);
2 tokenColor = get_color('pMC_Out_Buffer',moveToken);
3 if(length(tokenColor) ~= 2),
4     return;
5 end;
6 [~, suit, handle_err] = get_suit_from_transname(transition.name);
7 [doCommand, cmdDest, card, cmdSource] = ...
8     checkCommand_Move(tokenColor, suit, '', handle_err);
9 if(doCommand),
10     transition.selected_tokens = moveToken;
11     transition.new_color = card;
12     transition.override = 1;
13     fire = 1;

```

The second external input is **tFPe_Clubs_Move**. Its used for moving cards to other modules, and works similarly to how movement in handle in the Draw Pile, with the additional caveat that all four Foundation Piles becomes enabled at the time from **pMC_FP_Move**. Due to this its necessary to introduce additional logic to ensure that the issued move-command from the Player or Player Bot modules are meant for this particular module. As with the other modules, the actual validity of the move-command are handles by the P and PB modules.

Listing 1.9. pre.tFPe_Move.m lines 4-10

```

1 moveToken = tokenArrivedLate('pMC_FP_Move',1);
2 [suit_abbr, suit, ~] = get_suit_from_transname(transition.name);
3 [moveCmd, ~] = splitCommand(get_color('pMC_FP_Move',moveToken));
4 if(length(moveCmd) >= 3 && strcmp(moveCmd{3},strcat('FP',suit_abbr))),
5     transition.selected_tokens = moveToken;
6     fire = 1;
7 end

```

The only external output of the fp is **tFPe_Clubs_Out**. It works similarly to the output of the Draw Pile, where the pre-processor takes the latest arrived card **pFP_Clubs_Pile** and the earliest arrived command from **pFP_Clubs_Move**. This ensures that the first issued command will be processed first, should there be more than one. The only time there would be more than one command executing concurrently is if neither the Player or the Player Bot modules where enabled, and the command was issued from another module which did not use the **playerAction** resource. Listing 1.10 shows parts of the code.

Listing 1.10. pre.tFPe_Out.m lines 4-10

```

1 [~, suit, ~] = get_suit_from_transname(transition.name);
2
3 moveToken = tokenArrivedEarly(strcat('pFP_',suit,'_Move'), 1);
4 cardToken = tokenArrivedLate(strcat('pFP_',suit,'_Pile'), 1);
5
6 transition.selected_tokens = [moveToken cardToken];
7 fire = 1;

```

Another interesting fact about the Foundation Pile modules is the place **pFP_Clubs_Pile**. Once this place is filled with 13 tokens for all the suits, the game is won, and the simulation ends. There is no check done on the actual color or order of the tokens, as that is done when adding them by the pre-processor of **tFPe_Clubs_Add**. The win condition can be found in **COMMON_POST**. Parts of the code is shown in listing 1.11.

Listing 1.11. COMMON_POST.m lines 36-45

```

1 % Check if game is won. Win condition: 13 tokens on each of the foundation

```

```

2 | % piles.
3 | if(length(tokIDs('pFP_Clubs_Pile')) == 13 && ...
4 |     length(tokIDs('pFP_Diamonds_Pile')) == 13 && ...
5 |     length(tokIDs('pFP_Hearts_Pile')) == 13 && ...
6 |     length(tokIDs('pFP_Spades_Pile')) == 13),
7 |     set_handle('GameStatus', 'String', 'GAME_WON!');
8 |     disp('GAME_WON!');
9 |     global_info.STOP_SIMULATION = 1;
10| end

```

Table 2. Places and transitions used in Foundation Pile - Clubs

| | Name | Description |
|---|-----------------|---|
| 1 | pFP_Clubs_Move | Buffer for move-commands |
| 2 | pFP_Clubs_Pile | Holds the cards which are added to the Foundation Pile. |
| 3 | tFPe_Clubs_Add | External input for adding cards to the Foundation Pile. |
| 4 | tFPe_Clubs_Move | External input for the move-command. |
| 5 | tFPe_Clubs_Out | External output |

2.6 Tableau Pile Module

The Tableau Pile module is depicted in figure 5. It is duplicated 7 times, once for every pile in the tableau. The main difference between these modules is the names of their respective transitions and names, so the description given for the first pile will count for the other duplicates as well. Another difference is how many cards each pile are dealt during the initial phase. This is discussed in more detail in chapter 4.3 and 2.4. All the pre- and post-processor files are shared between all piles.

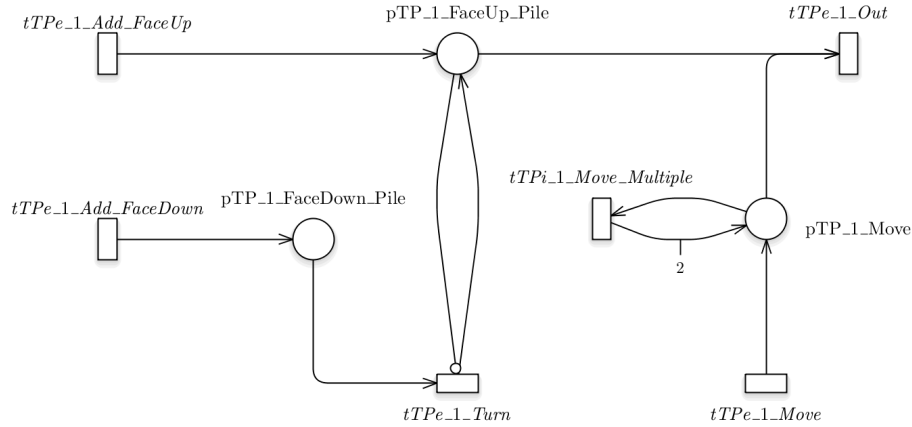


Fig. 5. Tableau Pile Module

As with the Draw Pile module, the module encompasses both a face-down and a face-up pile. The inner workings between these two piles is different however, as moving a card from the face-down pile to the face-up pile is a non-reversible action. Doing so could put the game in an unsolvable state, but at the same time if there were no cards in any of the face-down piles the game would be trivial to solve.

The only time it's possible to add cards to `pTP_1_FaceDown_Pile` is during the initial phase. During this phase, one less than the piles identification number will be added, so that pile one will have zero cards in the face-down pile, whilst pile 7 will have 6. All the piles will have a single card added to `pTP_1_FaceUp_Pile`. This is discussed in more detail in chapter 4.3.

Once the initial phase is over, the pre-processor of `tTPe_1_Add_FaceDown` will prevent any more firings. This is shown in listing 1.12, and is done by simply counting how many cards have been dealt in the variable `global_info.CARDS.DEALT`.

The secondary condition in the if statement is used to control the amount of firings during the initial phase.

Listing 1.12. pre_tTPe_Add_FaceDown.m lines 5-11

```

1 [tableau, ~, ~, ~, ~, ~] = get_tableau_from_transname(transition.name);
2 % Can only add FaceDown cards during the initial dealing.
3 if global_info.CARDS_DEALT >= global_info.INITIAL_DEAL_MOVE_LENGTH ...
4     || length(tokIDs(strcat('pTP_', tableau, '_FaceDown_Pile')) + 1 ...
5     == str2double(tableau),
6     return;
7 end;

```

Instead, the `tTpe_1_Add_FaceUp` transition will have potential to fire, given that all of its conditions in the pre-processor is fulfilled. Parts of the code for the pre-processor can be found in listing 1.13, whilst the whole file is found in B.26. The main job of the pre-processor is to check whether the game is still in the initial phase, and if so, how many cards have been added to `pTP_1_FaceDown_Pile`. While the game is in the initial phase, there are no checks on the the suit or rank of the cards being added, but once it enters the normal phase, the pre-processor will rely on the `checkCommand_Move` function to check the validity against the actual Solitaire rules. More information about the `checkCommand_Move` function is found in chapter 3.3.1.

Listing 1.13. pre_tTPe_Add_FaceUp.m lines 7-31

```

1 % Can only add FaceUp cards once the initial dealing is complete.
2 isFDFull = length(tokIDs(strcat('pTP_', tableau, '_FaceDown_Pile')) + 1 ...
3     == str2double(tableau));
4 isDealingInProgress = global_info.CARDS_DEALT < ...
5     global_info.INITIAL_DEAL_MOVE_LENGTH;
6 if isDealingInProgress && ~isFDFull,
7     return;
8 end;
9
10 moveToken = tokenArrivedEarly('pMC-Out-Buffer', 1);
11 tokenColor = get_color('pMC-Out-Buffer', moveToken);
12 if (length(tokenColor) ~= 2),
13     return;
14 end;
15
16 if isDealingInProgress && isFDFull,
17     doCommand = true;
18     [moveCmd, card] = splitCommand(tokenColor);
19     cmdDest = moveCmd{2};
20     source = 'DP';
21 else,
22     [doCommand, cmdDest, card, cmdSource] = ...
23         checkCommand_Move(tokenColor, tableau, '', handle_err);
24     source = cmdSource;
25 end

```

Both the `tTpe_1_Add_FaceDown` and `tTpe_1_Add_FaceUp` also have post-processors which will increment the variable `global_info.CARDS_DEALT`. The post-processor for `tTpe_1_Add_FaceUp` also decrements the variable `global_info.TP_Move_Multiple_Count` which is used when multiple cards are to be moved from the pile. Listing 1.14 shows how the variable is decremented, and once the last card has been received, the `playerAction` resource will be released. Full code for the post-processor can be found in B.18. More details on moving multiple cards will follow in the next paragraphs.

Listing 1.14. post_tTPe_Add_FaceUp.m lines 5-12

```

1
2 if global_info.TP_Move_Multiple_Count <= 1,
3     if isfield(global_info, 'last_command_source'),
4         release(global_info.last_command_source);
5     end
6 else,
7     global_info.TP_Move_Multiple_Count = global_info.TP_Move_Multiple_Count -
8     1;
end;

```

The module encompasses two external inputs, the first of which is `tTPe_1_Turn`. As can be seen in figure 5, the transition is only enabled if there is at least one token in `pTP_1_FaceDown_Pile` and no tokens in `pTP_1_FaceUp_Pile`. The transitions pre-processor will check that the command in `pMC_TP_Turn` is meant for this particular pile. This is done through extracting the unique identifier using the function `get_tableau_from_transname`.

The next external input is `tTPe_1_Move`, which works similarly to the movement inputs of DP and FP, but with one big difference; it supports moving multiple cards at a time. This is achieved in conjunction with `tTPi_1_Move_Multiple` using two global variables shown in listing 1.15. Note that it is only possible to move multiple cards to other TP.

Listing 1.15. `pre.tTPe_Move.m` lines 11-19

```

1 if (length(moveCmd) >= 4 && strcmp(moveCmd{3}, strcat('TP', tableau))),
2     amount = str2double(moveCmd{4});
3     global_info.TP_Move_Multiple_Count = amount;
4     global_info.TP_Move_Multi_Gen_Tokens = amount - 1;
5
6     transition.selected_tokens = moveToken;
7     fire = 1;
8 end

```

The same functionality could be achieved using only one variable, however by using two we make sure that the `playerAction` resource remains taken until all the cards have reached their destination. When `tTPi_1_Move_Multiple` fire it will take the token in `pTP_1_Move`, and return two new ones, essentially duplicating the token. By doing this one time less than the amount of cards to be moved, we end up with the desired number of tokens in `pTP_1_Move`. Listing 1.16 shows the pre-processor of `tTPi_1_Move_Multiple`, and listing 1.17 shows how `global_info.TP_Move_Multi_Gen_Tokens` is decremented in the `COMMON_POST` file.

Listing 1.16. `pre.tTPi_Move_Multiple.m` lines 6-13

```

1 if global_info.TP_Move_Multi_Gen_Tokens > 0,
2     [tableau, ~, ~, ~, ~] = get_tableau_from_transname(transition.name);
3     moveToken = tokenArrivedEarly(strcat('pTP-', tableau, '_Move'), 1);
4     transition.selected_token = moveToken;
5     transition.new_color = get_color(strcat('pTP-', tableau, '_Move'), moveToken)
6     ;
7     transition.override = 1;
8     fire = 1;
end;

```

Listing 1.17. `COMMON_POST.m` lines 28-34

```

1 elseif ismember(transition.name, {'tTPi_1_Move_Multiple', ...
2     'tTPi_2_Move_Multiple', 'tTPi_3_Move_Multiple', ...

```

```

3      'tTPi_4.Move.Multiple', 'tTPi_5.Move.Multiple', ...
4      'tTPi_6.Move.Multiple', 'tTPi_7.Move.Multiple'}));
5      global_info.TP_Move_Multi_Gen_Tokens = ...
6          global_info.TP_Move_Multi_Gen_Tokens - 1;
7  end;

```

The only external output is `tTPe_1_Out`, which will only fire once enough tokens are generated by `tTPi_1_Move_Multiple`. In order ensure that the correct card is moved, the pre-processor will fetch the `n`-th latest arrived card. Where `n` is the number of tokens in `pTP_1_Move`. This is repeated for every token in `pTP_1_Move`. By doing this, correctness is preserved by always moving the highest ranking card first. Listing 1.18 shows the main logic of the pre-processor, the whole file is found in at B.28.

Listing 1.18. `pre.tTPe_Out.m` lines 6-19

```

1  if global_info.TP_Move_Multi_Gen_Tokens == 0,
2      [tableau, ~, ~, ~, ~, ~] = get_tableau_from_transname(transition.name);
3      moveToken = tokenArrivedEarly(strcat('pTP-',tableau,'_Move'),1);
4
5      % Get the n-th latest arrived card from the face-up pile in order to
6      % move the correct card first.
7      lenMoveTokens = length(tokIDs(strcat('pTP-',tableau,'_Move')));
8      cardToken = tokenArrivedLate(strcat('pTP-',tableau,'_FaceUp_Pile'), ...
9          lenMoveTokens);
10     cardToken = cardToken(lenMoveTokens);
11
12     transition.selected_tokens = [moveToken cardToken];
13     fire = 1;
14 end;

```

Table 3. Places and transitions used in Tableau Pile - 1

| | Name | Description |
|---|----------------------|---|
| 1 | pTP_1.FaceDown_Pile | Holds the face-down cards. These are not visible to the player. |
| 2 | pTP_1.FaceUp_Pile | Holds the face-up cards. All cards are visible to the player. |
| 3 | pTP_1.Move | Buffer for move-commands |
| 4 | tTPe_1.Add.FaceDown | External input for adding cards to the face-up pile. |
| 5 | tTPe_1.Add.FaceUp | External input for adding cards to the face-down pile during the initial phase. |
| 6 | tTPe_1.Move | External input for the move-command. |
| 7 | tTPe_1.Out | External output |
| 8 | tTPe_1.Turn | External input for the turn-command. |
| 9 | tTPi_1.Move.Multiple | Internal transition which duplicates the move-command when moving multiple cards. |

2.7 Player Module

The Player module is a set of 20 transitions, tightly knit with the GUI and the Module Connector. This module differs from the DP, FP and TP modules in that the arcs to the Module Connector are done in the Player module rather than in the Module Connector. By doing this, it is possible to toggle this module on/off in the variable `global_info.GUI_ENABLED`.



Fig. 6. Player module

An important aspect of the Player module is the acquisition of the `playerAction` resource in the pre-processor file of every transition. By doing this, the atomicity of each action is preserved, as it's not possible to start a new action before the previous one finishes executing. Resources are discussed in more detail in chapter 3.5.

In order to make the buttons of the GUI be responsive, it was necessary to introduce the `pause` command in one of the pre-processors. For this, the `tPe_DP_Turn_pre` pre-processor was chosen. It's a bit unclear what exactly happens when the `pause` command executes, but I suspect Matlab has a separate event queue for all GUI elements. This queue is likely checked every time the main program execution is halted with `pause`. There might be a more elegant way of doing this, but none was located. Having the `pause` command execute in the pre-processor executes might not be well-suited for real-time simulations as it might introduce bias in the timings. In this project however, this solution worked very well, with no problems or unresponsiveness at all.

Listing 1.19. `tPe_DP_Turn_pre.m`

```

1 function [fire, transition] = tPe_DP_Turn_pre(transition)
2
3 global global_info;
4 pause(0.01); % Halts execution in the main loop to allow to check for events.
5 fire = 0;
6 if global_info.CARDS_DEALT < global_info.INITIAL_DEAL_MOVE_LENGTH,
7     return;
8 end;
9
10 [playerAction] = request(transition.name, {'playerAction', 1});
11 if global_info.DP_Turn_Btn ~= false && playerAction,
12     global_info.DP_Turn_Btn = false;
13     global_info.last_command_source = transition.name;
14     fire = 1;
15 end;

```

As can be seen in listing 1.19, to check if a button is pressed is actually a matter of checking whether the global variable corresponding to that button is set. In the listing above, it is accomplished by checking if `global_info.DP_Turn_Btn` is set, and if so set it back to false. A consequence of doing this, is that it's possible to queue up actions, for example by hitting the DP Turn-button when the game is in process of moving cards from one pile to another.

When issuing a new move command, its destination and possibly amount of cards to be moved is fetched directly from the GUI elements.

Table 4. Transitions used in Player

| | Name | Description |
|----|----------------------|---|
| 1 | tPe_DP_Move | Sends a move command to the DP module. |
| 2 | tPe_DP_Turn | Sends a turn command to the DP module. |
| 3 | tPe_FP_Clubs_Move | Sends a move command to the FP Clubs module. |
| 4 | tPe_FP_Diamonds_Move | Sends a move command to the FP Diamonds module. |
| 5 | tPe_FP_Hearts_Move | Sends a move command to the FP Hearts module. |
| 6 | tPe_FP_Spades_Move | Sends a move command to the FP Spades module. |
| 7 | tPe_TP_1_Move | Sends a move command to the TP 1 module. |
| 8 | tPe_TP_1_Turn | Sends a turn command to the TP 1 module. |
| 9 | tPe_TP_2_Move | Sends a move command to the TP 2 module. |
| 10 | tPe_TP_2_Turn | Sends a turn command to the TP 2 module. |
| 11 | tPe_TP_3_Move | Sends a move command to the TP 3 module. |
| 12 | tPe_TP_3_Turn | Sends a turn command to the TP 3 module. |
| 13 | tPe_TP_4_Move | Sends a move command to the TP 4 module. |
| 14 | tPe_TP_4_Turn | Sends a turn command to the TP 4 module. |
| 15 | tPe_TP_5_Move | Sends a move command to the TP 5 module. |
| 16 | tPe_TP_5_Turn | Sends a turn command to the TP 5 module. |
| 17 | tPe_TP_6_Move | Sends a move command to the TP 6 module. |
| 18 | tPe_TP_6_Turn | Sends a turn command to the TP 6 module. |
| 19 | tPe_TP_7_Move | Sends a move command to the TP 7 module. |
| 20 | tPe_TP_7_Turn | Sends a turn command to the TP 7 module. |

2.8 Player Bot Module

Table 5. Places and transitions used in Player Bot

| | Name | Description |
|---|--------------|-------------|
| 1 | pPB_Cmd | |
| 2 | tPBe_DP_Move | |
| 3 | tPBe_DP_Turn | |
| 4 | tPBe_FP_Move | |
| 5 | tPBe_TP_Move | |
| 6 | tPBe_TP_Turn | |
| 7 | tPBi_Gen | |
| 8 | tPBi_Siphon | |

tPBi_Gen_Stop is deleted. But code is still there. Make comment on why this is removed

2.9 Module Connector

Table 6. Places and transitions used in Module Connector

| | Name | Description |
|----|-----------------------|-------------|
| 1 | pMC_DP_Move | |
| 2 | pMC_DP_Turn | |
| 3 | pMC_FP_Move | |
| 4 | pMC_Out_Buffer | |
| 5 | pMC_TP_Move | |
| 6 | pMC_TP_Turn | |
| 7 | tMC_DP_Move_Siphon | |
| 8 | tMC_FP_Move_Siphon | |
| 9 | tMC_Out_Buffer_Siphon | |
| 10 | tMC_TP_Move_Siphon | |
| 11 | tMC_TP_Turn_Siphon | |

3 Implementation

3.1 GUI

The interface developed for this project is similar to the interface of the Solitaire game. Sorting and arranging the cards is described using the same concepts that we have defined in the Solitaire Rules section.

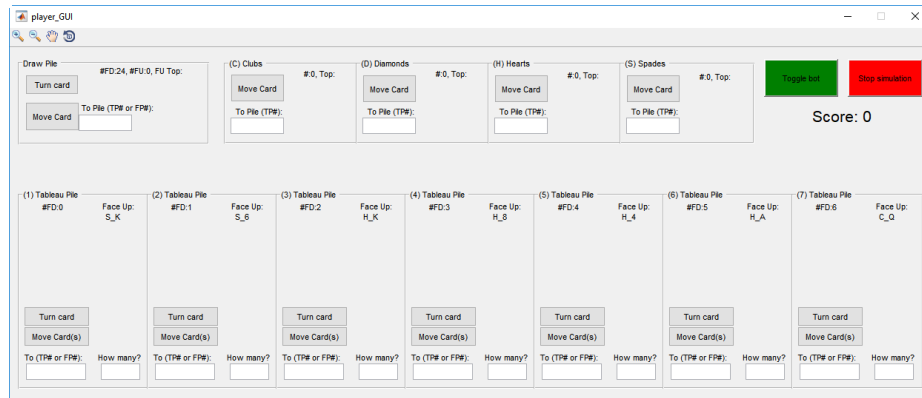


Fig. 7. GUI after initial dealing cards

Each pile is indexed in order to make it easier to simulate moving cards between piles. The interface allows to move cards to a pile by writing the index of the pile that we want to move to in the "To Pile" box - see Figure 7.

Additionally, we can chose the amount of cards to be moved. Should the "How many?" field be left blank, one card will be moved automatically. We have defined the four suits in the deck of cards:

| Suit | Cards index name |
|----------|---|
| Clubs | C_A, C_2, C_3, C_4, C_5, C_6, C_7, C_8, C_9, C_X, C_J, C_Q, C_K |
| Diamonds | D_A, D_2, D_3, D_4, D_5, D_6, D_7, D_8, D_9, D_X, D_J, D_Q, D_K |
| Hearts | H_A, H_2, H_3, H_4, H_5, H_6, H_7, H_8, H_9, H_X, H_J, H_Q, H_K |
| Spades | S_A, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_X, S_J, S_Q, S_K |

The Draw Pile does not have an index, as we are not able to move cards back to this pile. The "Turn card" button allows us to shuffle to the next card in the Draw Pile. This action cannot be reversed. There are four foundation piles corresponding the fours suits in the deck of cards:

| Index name | Pile name |
|------------|--------------------------|
| FPC | Foundation Pile Clubs |
| FPD | Foundation Pile Diamonds |
| FPH | Foundation Pile Hearts |
| FPS | Foundation Pile Spades |

There are also seven Tableau Piles:

| Index name | Pile name |
|------------|-------------------|
| TP1 | Foundation Pile 1 |
| TP2 | Foundation Pile 2 |
| TP3 | Foundation Pile 3 |
| TP4 | Foundation Pile 4 |
| TP5 | Foundation Pile 5 |
| TP6 | Foundation Pile 6 |
| TP7 | Foundation Pile 7 |

3.2 Algorithms

3.2.1 Atomicity

3.3 Commands

3.3.1 Move Command

The move command contains four parts; the command, destination, source and amount. Each part is concatenated together, with colon as a separator. An example of a move command would be: *Move:TP1:TP5:3*, which means *Move 3 cards from TP1 to TP5*. If amount is not given, it will assume one card to be moved.

In order to make sure that only validity of the move-commands, the function `checkCommand_Move` has been developed. It is used both for validation before sending a command, and validation after receiving a command. The function takes the input parameters; `command`, `destination`, `source`, and `handle_err`.

The input parameter `command` contains the actual command, `destination` contains the unique identifiers of the FP or TP modules. Valid input for `destination` would be *C, D, H, S, 1, 2, 3, 4, 5, 6 or 7*, and is used to ensure that the command is received by the destined module. Parameter `source` is only used when sending a command, and contains the actual name of the transition which issued the game. This is mainly used to set the variable `global_info.last_command_source` which will be the name of the transition holding the `playerAction` resource. Resources are discussed in more detail in chapter 3.5. Lastly, the parameter `handle_err` holds the GUI-component where error messages will be written. Full code for the function can be found in the appendix, at chapter B.1.

Figure 8 shows a flowchart of the logic in the function.

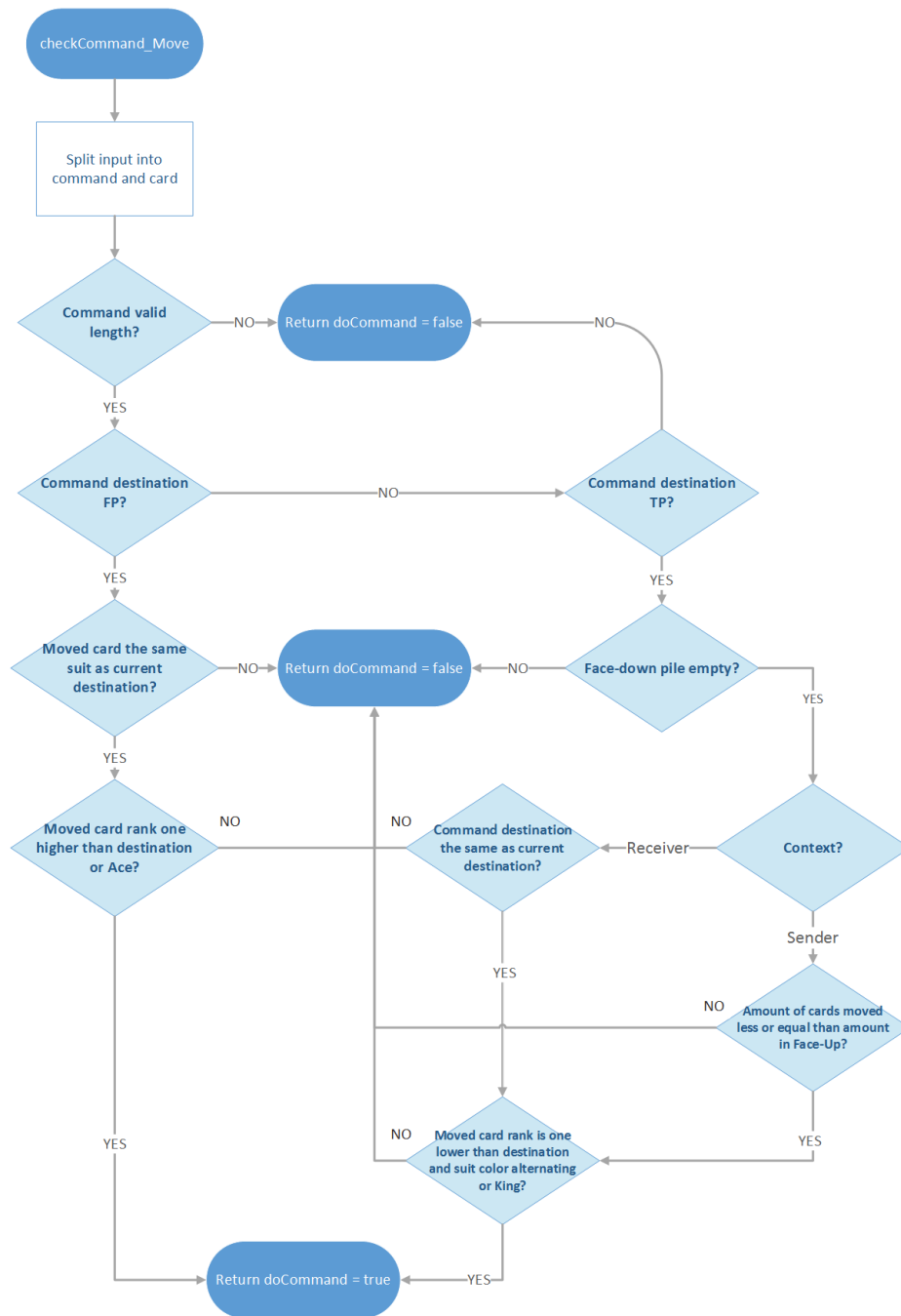


Fig. 8. Flowchart - checkCommand_Move

3.4 Initial Dealing

3.5 Resources

3.6 Moving Multiple Cards

3.7 Scoring

The standard scoring scheme in the Windows Solitaire game defines the amount of points that are awarded for moving cards between piles and is described as follows:

| Move | Points |
|---------------------------------|---------------------------|
| Draw pile to tableau pile | 5 |
| Draw pile to foundation pile | 10 |
| Tableau pile to foundation pile | 10 |
| Turn over tableau card | 5 |
| Foundation pile to tableau pile | -15 |
| Reset draw pile | -100 (minimum score is 0) |

3.8 Possible improvements

A major drawback of the siphon `tMC_Out_Buffer_Siphon` is that if it fires, the card will actually be removed from the game, and the game becomes unsolvable. This transition will fire if the move-command of the token has an invalid destination. Due to how the Player and Player Bot modules are set up, this will never happen as they will check the validity of the move command before actually issuing the command. Still, I think it would be an improvement add an additional transition to the Draw Pile module which would accept cards from `tMC_Out_Buffer_Siphon`, instead of totally discarding them.

Another improvement would be to re-factor the code base by moving more of the validity check of the commands from the Player and Player Bot modules to the destination transitions. The Player Bot modules uses roughly 200 lines of code to always issue valid commands, I think this could be drastically reduced. By doing this it would be easier to create additional modules which could interface with the game, for example a hardware-based module.

It might also be a slight improvement to combine the Add-face-up and Add-face-down transitions of the TP modules. By doing this, it would remove the need for the Add-face-down's pre-processor to execute once the initial phase is over. However, doing so for every Tableau Pile would require 7 more transitions and 14 more places.

Lastly, a performance increase might be gained by reducing the number of transitions in the Player module, or at least introducing a new place and transition. This new place would serve as an input to all of the 20 transitions of the

Player module, whilst the new transition would serve as an input the new place. By doing this, the number enabled transitions, and pre-processors which would have to be executed would drastically drop.

3.9 Future work

dladl

4 Testing, Analysis and Results

4.1 Matlab version

The project has been developed and tested in versions R2013a and R2017a. Due to using two versions of Matlab it was necessary to only use functionality that is supported in both versions. Examples of this is using `GUIDE` for developing the GUI, and omitting to use the `contains` command.

4.2 Algorithms

4.2.1 Atomicity In order to preventdd

4.3 Initial Dealing

4.4 Resources

4.5 Moving Multiple Cards

5 Discussion

References

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A Overall design - horizontal view

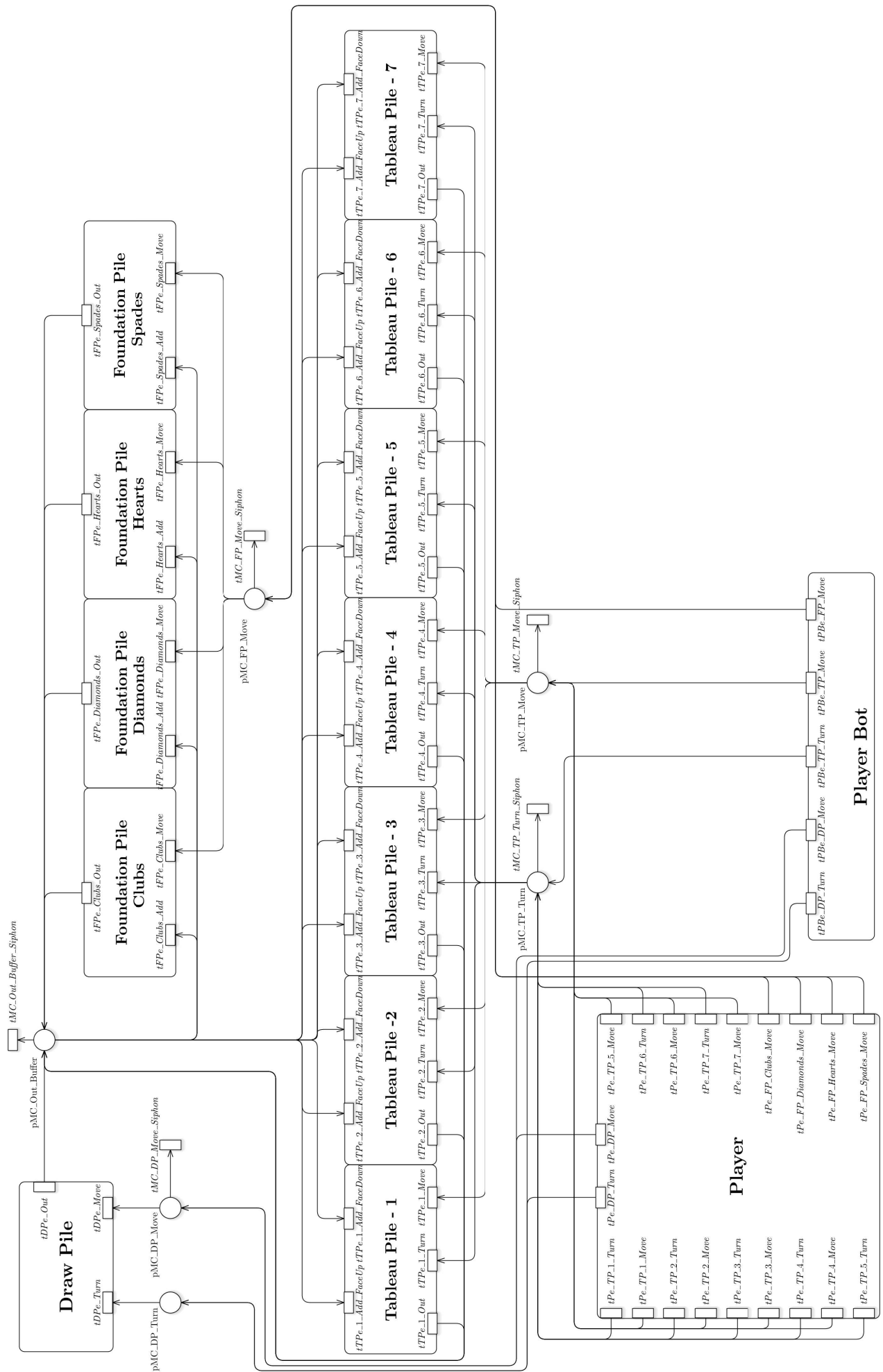


Fig. 9. The complete model in horizontal view

B Matlab code

B.1 checkCommand_Move.m

```

1 function [ doCommand, cmdDest, card, cmdSource ] = ...
2     checkCommand_Move( command, destination, source, handle_err )
3
4 global global_info;
5 [moveCmd, card] = splitCommand(command);
6 cmdDest = moveCmd{2};
7 cmdSource = moveCmd{3};
8
9 doCommand = false;
10 if length(cmdDest) < 3,
11     set_handle(handle_err, 'String', 'INCOMPLETE_COMMAND');
12     return;
13 elseif ~ismember(cmdDest, global_info.FP_TP_PILES),
14     set_handle(handle_err, 'String', 'INVALID_MOVE_COMMAND');
15     return;
16 end
17
18 % Foundation Piles
19 if ismember(cmdDest, global_info.FP_PILES),
20     if ~isempty(destination) && destination(1) ~= cmdDest(3),
21         return;
22     end;
23     movedCard_split = strsplit(card, '_');
24     moved_suit = movedCard_split(1);
25     moved_rank = movedCard_split(2);
26     if ~isfield(global_info.SUITS, cmdDest(3)),
27         set_handle(handle_err, 'String', 'INVALID_SUIT');
28         return;
29     end;
30     if moved_suit{1} ~= cmdDest(3),
31         set_handle(handle_err, 'String', 'INVALID_LOCATION');
32         return;
33     end;
34     global_suit = global_info.SUITS.(cmdDest(3));
35     fp_Pile = strcat('pFP_', global_suit(1), '_Pile');
36     if (iscell(fp_Pile)),
37         fp_Pile = fp_Pile{1};
38     end;
39     dest_topCard_Id = tokenArrivedLate(fp_Pile, 1);
40     moved_rank_value = global_info.CARDVALUEMAP(moved_rank{1});
41     if dest_topCard_Id,
42         dest_topCard_Color = get_color(fp_Pile, dest_topCard_Id);
43         dest_topCard_split = strsplit(dest_topCard_Color{1}, '_');
44         dest_topCard_Rank = dest_topCard_split(2);
45         diffRank = moved_rank_value - global_info.CARDVALUEMAP(
46             dest_topCard_Rank{1});
47         if (diffRank ~= 1), % Added card must be 1 value higher than the
48             % current card.
49             set_handle(handle_err, 'String', 'INVALID_CARD_VALUE');
50             return;
51         end;
52     elseif moved_rank_value ~= 1,
53         set_handle(handle_err, 'String', 'FIRST_CARD_MUST_BE_ACE');
54         return;
55     end;
56 elseif ismember(cmdDest, global_info.TP_PILES),
57     tableau_dest = cmdDest(3);
58     if ~isempty(destination) == 1 && destination(1) ~= tableau_dest,
59         return;
60     end;
61     movedCard_split = strsplit(card, '_');
62     moved_suit = movedCard_split(1);
63     moved_rank = movedCard_split(2);
64     tp_FU_Pile_Dest = strcat('pTP_', tableau_dest, '_FaceUp_Pile');
65
66 % Can not add to tableau piles where face up is empty and there exist
67 % cards in face down pile.
68 if ~isempty(tokIDs(strcat('pTP_', tableau_dest, '_FaceDown_Pile'))) && ...
69     isempty(tokIDs(tp_FU_Pile_Dest)),

```

```

70         set_handle(handle_err, 'String', 'FACE_DOWN_PILE_MUST_BE_EMPTY');
71         return;
72     end
73
74     if (iscell(tp_FU_Pile_Dest)),
75         tp_FU_Pile_Dest = tp_FU_Pile_Dest{1};
76     end;
77
78     % Do not check amount once the command has reached it's destination.
79     if length(moveCmd) >= 4 && ~isempty(source),
80         if ismember(moveCmd{3}, global_info.TP_PILES),
81             tableau_src = moveCmd{3};
82             tableau_src = tableau_src(3);
83             tp_Pile_Src = strcat('pTP_', tableau_src, '_FaceUp_Pile');
84             if (iscell(tp_Pile_Src)),
85                 tp_Pile_Src = tp_Pile_Src{1};
86             end;
87         else,
88             set_handle(handle_err, 'String', 'INVALID_MOVE_COMMAND');
89             return;
90         end
91         amount = str2double(moveCmd{4});
92         if amount > length(tokIDs(tp_Pile_Src)) || amount < 1,
93             set_handle(handle_err, 'String', 'INVALID_AMOUNT');
94             return;
95         end;
96     end
97
98     % Check against the latest (lowest) card at destination.
99     dest_topCard_Id = tokenArrivedLate(tp_FU_Pile_Dest, 1);
100     moved_rank_value = global_info.CARDVALUE_MAP(moved_rank{1});
101     if dest_topCard_Id,
102         dest_topCard_Color = get_color(tp_FU_Pile_Dest, dest_topCard_Id);
103         dest_topCard_Split = strsplit(dest_topCard_Color{1}, '-');
104         dest_topCard_Suit = dest_topCard_split(1);
105         dest_topCard_Rank = dest_topCard_split(2);
106
107         moved_global_suit = global_info.SUITS.(moved_suit{1});
108         dest_global_suit = global_info.SUITS.(dest_topCard_Suit{1});
109
110         diffRank = moved_rank_value - global_info.CARDVALUE_MAP(
111             dest_topCard_Rank{1});
112         % Added card must be 1 value lower than the current card.
113         if (diffRank ~= -1),
114             set_handle(handle_err, 'String', 'INVALID_CARD_VALUE');
115             return;
116         end;
117         % Moved and current suit color must be different (red/black).
118         if (strcmp(moved_global_suit{2}, dest_global_suit{2})),
119             set_handle(handle_err, 'String', 'SUIT_COLOR_MUST_BE_ALTERNATING');
120             return;
121         end;
122     elseif moved_rank_value ~= 13,
123         set_handle(handle_err, 'String', 'FIRST_CARD_MUST_BE_KING');
124         return;
125     end;
126 else,
127     set_handle(handle_err, 'String', 'INVALID_PILE');
128     return
129 end;
130
131 if ~isempty(source),
132     global_info.last_command_source = source;
133 end;
134
135 set_handle(handle_err, 'String', '');
136 doCommand = true;

```

B.2 COMMON POST.m

```

1 function [] = COMMON_POST(transition)
2
3 global global_info;
4

```

```

5 | % Release playerAction resource to allow for another player action.
6 | if ismember(transition.name, {'tTPe_1.Add.FaceDown', ...
7 |     'tTPe_2.Add.FaceDown', 'tTPe_3.Add.FaceDown', ...
8 |     'tTPe_4.Add.FaceDown', 'tTPe_5.Add.FaceDown', ...
9 |     'tTPe_6.Add.FaceDown', 'tTPe_7.Add.FaceDown'}),
10 |     global_info.CARDS.DEALT = global_info.CARDS.DEALT + 1;
11 | elseif ismember(transition.name, {'tTPe_1.Add.FaceUp', ...
12 |     'tTPe_2.Add.FaceUp', 'tTPe_3.Add.FaceUp', ...
13 |     'tTPe_4.Add.FaceUp', 'tTPe_5.Add.FaceUp', ...
14 |     'tTPe_6.Add.FaceUp', 'tTPe_7.Add.FaceUp'}),
15 |     post_tTPe.Add.FaceUp(transition);
16 | elseif ismember(transition.name, {
17 |     'tFPe_Clubs.Add', 'tFPe_Diamonds.Add', 'tFPe_Hearts.Add', ...
18 |     'tFPe_Spades.Add', 'tTPe_1.Turn', 'tTPe_2.Turn', 'tTPe_3.Turn', ...
19 |     'tTPe_4.Turn', 'tTPe_5.Turn', 'tTPe_6.Turn', 'tTPe_7.Turn', ...
20 |     'tMC_DP_Move.Siphon', 'tMC_FP_Move.Siphon', ...
21 |     'tMC_Out_Buffer.Siphon', 'tMC_TP_Move.Siphon', ...
22 |     'tMC_TP_Turn.Siphon'}),
23 |     release(global_info.last_command.source);
24 | elseif ismember(transition.name, {
25 |     'tPBe_DP_Move', 'tPBe_DP_Turn', 'tPBe_FP_Move', 'tPBe_TP_Move', ...
26 |     'tPBe_TP_Turn'},),
27 |     global_info.BOT.ACTIONS.NEW_CMD = 1;
28 | elseif ismember(transition.name, {'tTPi_1.Move.Multiple', ...
29 |     'tTPi_2.Move.Multiple', 'tTPi_3.Move.Multiple', ...
30 |     'tTPi_4.Move.Multiple', 'tTPi_5.Move.Multiple', ...
31 |     'tTPi_6.Move.Multiple', 'tTPi_7.Move.Multiple'}),
32 |     global_info.TP_Move_Multi_Gen_Tokens = ...
33 |     global_info.TP_Move_Multi_Gen_Tokens - 1;
34 | end;
35 |
36 | % Check if game is won. Win condition: 13 tokens on each of the foundation
37 | % piles.
38 | if (length(tokIDs('pFP_Clubs_Pile')) == 13 && ...
39 |     length(tokIDs('pFP_Diamonds_Pile')) == 13 && ...
40 |     length(tokIDs('pFP_Hearts_Pile')) == 13 && ...
41 |     length(tokIDs('pFP_Spades_Pile')) == 13),
42 |     set_handle('GameStatus', 'String', 'GAME_WON!');
43 |     disp('GAME_WON!');
44 |     global_info.STOP_SIMULATION = 1;
45 | end
46 |
47 | if global_info.CARDS.DEALT >= global_info.INITIAL_DEAL_MOVE_LENGTH,
48 |     if global_info.GULENABLED,
49 |         player.update.GUI();
50 |     end
51 | end

```

B.3 COMMON_PRE.m

```

1 | function [fire, transition] = COMMON_PRE(transition)
2 |
3 | if ismember(transition.name, {'tFPe_Clubs.Add', 'tFPe_Diamonds.Add', ...
4 |     'tFPe_Hearts.Add', 'tFPe_Spades.Add'}),
5 |     [fire, transition] = pre_tFPe.Add(transition);
6 | elseif ismember(transition.name, {'tFPe_Clubs.Move', 'tFPe_Diamonds.Move', ...
7 |     'tFPe_Hearts.Move', 'tFPe_Spades.Move'}),
8 |     [fire, transition] = pre_tFPe.Move(transition);
9 | elseif ismember(transition.name, {'tPe_FP_Clubs.Move', 'tPe_FP_Diamonds.Move',
10 |     'tPe_FP_Hearts.Move', 'tPe_FP_Spades.Move'}),
11 |     [fire, transition] = pre_tPe_FP.Move(transition);
12 | elseif ismember(transition.name, {'tPe_FP_Clubs.Out', 'tPe_FP_Diamonds.Out',
13 |     'tPe_FP_Hearts.Out', 'tPe_FP_Spades.Out'}),
14 |     [fire, transition] = pre_tPe_FP.Out(transition);
15 | elseif ismember(transition.name, {'tTPe_1.Add.FaceDown', 'tTPe_2.Add.FaceDown',
16 |     'tTPe_3.Add.FaceDown', 'tTPe_4.Add.FaceDown', 'tTPe_5.Add.FaceDown',
17 |     'tTPe_6.Add.FaceDown', 'tTPe_7.Add.FaceDown'}),
18 |     [fire, transition] = pre_tTPe.Add.FaceDown(transition);
19 | elseif ismember(transition.name, {'tTPe_1.Add.FaceUp', 'tTPe_2.Add.FaceUp',

```

```

20         'tTPe_3.Add.FaceUp', 'tTPe_4.Add.FaceUp', 'tTPe_5.Add.FaceUp', ...
21         'tTPe_6.Add.FaceUp', 'tTPe_7.Add.FaceUp'});
22     [fire, transition] = pre_tTPe.Add.FaceUp(transition);
23 elseif ismember(transition.name, {'tTPe_1.Add.FaceUp', 'tTPe_2.Add.FaceUp',
24     ...
25     'tTPe_3.Add.FaceUp', 'tTPe_4.Add.FaceUp', 'tTPe_5.Add.FaceUp', ...
26     'tTPe_6.Add.FaceUp', 'tTPe_7.Add.FaceUp'});
27     [fire, transition] = pre_tTPe.Add.FaceUp(transition);
28 elseif ismember(transition.name, {'tPe_TP_1.Turn', 'tPe_TP_2.Turn', ...
29     'tPe_TP_3.Turn', 'tPe_TP_4.Turn', 'tPe_TP_5.Turn', ...
30     'tPe_TP_6.Turn', 'tPe_TP_7.Turn'});
31     [fire, transition] = pre_tPe_TP.Turn(transition);
32 elseif ismember(transition.name, {'tTPe_1.Turn', 'tTPe_2.Turn', ...
33     'tTPe_3.Turn', 'tTPe_4.Turn', 'tTPe_5.Turn', ...
34     'tTPe_6.Turn', 'tTPe_7.Turn'});
35     [fire, transition] = pre_tTPe.Turn(transition);
36 elseif ismember(transition.name, {'tPe_TP_1.Move', 'tPe_TP_2.Move', ...
37     'tPe_TP_3.Move', 'tPe_TP_4.Move', 'tPe_TP_5.Move', ...
38     'tPe_TP_6.Move', 'tPe_TP_7.Move'});
39     [fire, transition] = pre_tPe_TP.Move(transition);
40 elseif ismember(transition.name, {'tTPe_1.Move', 'tTPe_2.Move', ...
41     'tTPe_3.Move', 'tTPe_4.Move', 'tTPe_5.Move', ...
42     'tTPe_6.Move', 'tTPe_7.Move'});
43     [fire, transition] = pre_tTPe.Move(transition);
44 elseif ismember(transition.name, {'tTPe_1.Out', 'tTPe_2.Out', ...
45     'tTPe_3.Out', 'tTPe_4.Out', 'tTPe_5.Out', ...
46     'tTPe_6.Out', 'tTPe_7.Out'});
47     [fire, transition] = pre_tTPe.Out(transition);
48 elseif ismember(transition.name, {'tTPi_1.Move.Multiple', '
49     tTPi_2.Move.Multiple', ...
50     'tTPi_3.Move.Multiple', 'tTPi_4.Move.Multiple', 'tTPi_5.Move.Multiple'
51     , ...
52     'tTPi_6.Move.Multiple', 'tTPi_7.Move.Multiple'});
53     [fire, transition] = pre_tTPi.Move.Multiple(transition);
54 else
55     fire = 1;
56 end
57 end

```

B.4 draw_pile_pdf.m

```

1 function [png] = draw_pile_pdf()
2 png.PN_name = 'Draw_Pile';
3
4 png.set_of_Ps = {'pDP_Draw.FaceUp.Pile', 'pDP_Draw.FaceDown.Pile', ...
5     'pDP_Move.Out', 'pDP_Dealer', 'pDP_Turn', 'pDP_Move.Init'};
6 png.set_of_Ts = {'tDPi_Dealer', 'tDPe_Out', 'tDPe_Turn', 'tDPi_Turn', ...
7     'tDPe_Move', 'tDPi_Enable_FP_Trans', 'tDPi_Flip_Pile', 'tDPi_Move.Init'};
8 png.set_of_As = {
9     'tDPi_Dealer', 'pDP_Draw.FaceDown.Pile', 1, ...
10    'pDP_Draw.FaceUp.Pile', 'tDPe_Out', 1, ...
11    'pDP_Dealer', 'tDPi_Dealer', 1, ...
12    'pDP_Draw.FaceDown.Pile', 'tDPi_Turn', 1, ...
13    'tDPi_Turn', 'pDP_Draw.FaceUp.Pile', 1, ...
14    'pDP_Move.Out', 'tDPe_Out', 1, ...
15    'tDPe_Move', 'pDP_Move.Out', 1, ...
16    'pDP_Draw.FaceUp.Pile', 'tDPi_Flip_Pile', 1, ...
17    'tDPi_Flip_Pile', 'pDP_Draw.FaceDown.Pile', 1, ...
18    'pDP_Turn', 'tDPi_Enable_FP_Trans', 1, ...
19    'pDP_Turn', 'tDPi_Turn', 1, ...
20    'tDPe_Turn', 'pDP_Turn', 1, ...
21    'pDP_Move.Init', 'tDPi_Move.Init', 1, ...
22    'tDPi_Move.Init', 'pDP_Move.Out', 1, ...
23    };
24 png.set_of_Is = {
25    'pDP_Dealer', 'tDPe_Move', 1, ...
26    'pDP_Dealer', 'tDPe_Turn', 1, ...
27    'pDP_Dealer', 'tDPi_Enable_FP_Trans', 1, ...
28    'pDP_Dealer', 'tDPi_Turn', 1, ...
29    'pDP_Draw.FaceDown.Pile', 'tDPi_Enable_FP_Trans', 1
30    };

```

B.5 foundation_pile_clubs_pdf.m

```

1 function [png] = foundation_pile_clubs_pdf()
2 modname = 'Clubs';
3 png.PN_name = strcat('Foundation_Pile_',{ '_' },modname);
4
5 png.set_of_Ps = {strcat('pFP_',modname, '_Pile '),...
6   strcat('pFP_',modname, '_Move')};
7 png.set_of_Ts = {strcat('tFPe_',modname, '_Add '),...
8   strcat('tFPe_',modname, '_Move'), strcat('tFPe_',modname, '_Out')};
9 png.set_of_As = {
10   strcat('tFPe_',modname, '_Add'), strcat('pFP_',modname, '_Pile '),1, ...
11   strcat('pFP_',modname, '_Pile '), strcat('tFPe_',modname, '_Out'),1, ...
12   strcat('tFPe_',modname, '_Move'), strcat('pFP_',modname, '_Move'), 1, ...
13   strcat('pFP_',modname, '_Move'), strcat('tFPe_',modname, '_Out'), 1, ...
14   };

```

B.6 foundation_pile_diamonds_pdf.m

```

1 function [png] = foundation_pile_diamonds_pdf()
2 modname = 'Diamonds';
3 png.PN_name = strcat('Foundation_Pile_',{ '_' },modname);
4
5 png.set_of_Ps = {strcat('pFP_',modname, '_Pile '),...
6   strcat('pFP_',modname, '_Move')};
7 png.set_of_Ts = {strcat('tFPe_',modname, '_Add '),...
8   strcat('tFPe_',modname, '_Move'), strcat('tFPe_',modname, '_Out')};
9 png.set_of_As = {
10   strcat('tFPe_',modname, '_Add'), strcat('pFP_',modname, '_Pile '),1, ...
11   strcat('pFP_',modname, '_Pile '), strcat('tFPe_',modname, '_Out'),1, ...
12   strcat('tFPe_',modname, '_Move'), strcat('pFP_',modname, '_Move'), 1, ...
13   strcat('pFP_',modname, '_Move'), strcat('tFPe_',modname, '_Out'), 1, ...
14   };

```

B.7 foundation_pile_hearts_pdf.m

```

1 function [png] = foundation_pile_hearts_pdf()
2 modname = 'Hearts';
3 png.PN_name = strcat('Foundation_Pile_',{ '_' },modname);
4
5 png.set_of_Ps = {strcat('pFP_',modname, '_Pile '),...
6   strcat('pFP_',modname, '_Move')};
7 png.set_of_Ts = {strcat('tFPe_',modname, '_Add '),...
8   strcat('tFPe_',modname, '_Move'), strcat('tFPe_',modname, '_Out')};
9 png.set_of_As = {
10   strcat('tFPe_',modname, '_Add'), strcat('pFP_',modname, '_Pile '),1, ...
11   strcat('pFP_',modname, '_Pile '), strcat('tFPe_',modname, '_Out'),1, ...
12   strcat('tFPe_',modname, '_Move'), strcat('pFP_',modname, '_Move'), 1, ...
13   strcat('pFP_',modname, '_Move'), strcat('tFPe_',modname, '_Out'), 1, ...
14   };

```

B.8 foundation_pile_spades_pdf.m

```

1 function [png] = foundation_pile_spades_pdf()
2 modname = 'Spades';
3 png.PN_name = strcat('Foundation_Pile_',{ '_' },modname);
4
5 png.set_of_Ps = {strcat('pFP_',modname, '_Pile '),...
6   strcat('pFP_',modname, '_Move')};
7 png.set_of_Ts = {strcat('tFPe_',modname, '_Add '),...
8   strcat('tFPe_',modname, '_Move'), strcat('tFPe_',modname, '_Out')};
9 png.set_of_As = {
10   strcat('tFPe_',modname, '_Add'), strcat('pFP_',modname, '_Pile '),1, ...
11   strcat('pFP_',modname, '_Pile '), strcat('tFPe_',modname, '_Out'),1, ...
12   strcat('tFPe_',modname, '_Move'), strcat('pFP_',modname, '_Move'), 1, ...
13   strcat('pFP_',modname, '_Move'), strcat('tFPe_',modname, '_Out'), 1, ...
14   };

```

B.9 get_handle.m

```

1 function [value] = get_handle(Handle,PropertyName)
2     % Extend Matlab GET command to first check if GUI is enabled.
3     % GET(H,'PropertyName')
4     global global_info;
5     if global_info.GULENABLED,
6         value = get(global_info.handles.(Handle),PropertyName);
7     else,
8         value = 0;
9     end;
10 end

```

B.10 get_suit_from_transname.m

```

1 function [suit_abbr, suit, handle_err, move_btn, handle_move_loc] ...
2     = get_suit_from_transname(transitionname)
3     global global_info;
4     handle_err = 0;
5     move_btn = 0;
6     handle_move_loc = 0;
7     if ~isempty(strfind(transitionname,'Clubs')),
8         suit = 'Clubs';
9     elseif ~isempty(strfind(transitionname,'Diamonds')),
10        suit = 'Diamonds';
11    elseif ~isempty(strfind(transitionname,'Hearts')),
12        suit = 'Hearts';
13    elseif ~isempty(strfind(transitionname,'Spades')),
14        suit = 'Spades';
15    else,
16        suit = 0; % Invalid suit.
17    end
18    suit_abbr = suit(1);
19    if global_info.GULENABLED,
20        handle_err = strcat('FP_',suit_abbr,'_ErrorMsg');
21        move_btn = strcat('FP_',suit_abbr,'_Move.Btn');
22        handle_move_loc = strcat('FP_',suit_abbr,'_Move.Location');
23    end
24 end
25 end

```

B.11 get_tableau_from_transname.m

```

1 function [tableau, handle_err, move_btn, turn_btn, handle_move_loc,
2     handle_move_amount] ...
3     = get_tableau_from_transname(transitionname)
4     global global_info;
5     handle_err = 0;
6     move_btn = 0;
7     turn_btn = 0;
8     handle_move_loc = 0;
9     handle_move_amount = 0;
10    if ~isempty(strfind(transitionname,'1')),
11        tableau = '1';
12    elseif ~isempty(strfind(transitionname,'2')),
13        tableau = '2';
14    elseif ~isempty(strfind(transitionname,'3')),
15        tableau = '3';
16    elseif ~isempty(strfind(transitionname,'4')),
17        tableau = '4';
18    elseif ~isempty(strfind(transitionname,'5')),
19        tableau = '5';
20    elseif ~isempty(strfind(transitionname,'6')),
21        tableau = '6';
22    elseif ~isempty(strfind(transitionname,'7')),
23        tableau = '7';
24    else,
25

```

```

24     tableau = 0; % Invalid tableau.
25 end
26 if global_info.GULENABLED,
27     handle_err = strcat('TP_',tableau,'_ErrorMsg');
28     move_btn = strcat('TP_',tableau,'_Move.Btn');
29     turn_btn = strcat('TP_',tableau,'_Turn.Btn');
30     handle_move_loc = strcat('TP_',tableau,'_Move.Location');
31     handle_move_amount = strcat('TP_',tableau,'_Move.Amount');
32 end
33 end

```

B.12 main_simulation_file.m

```

1 % Solitaire main simulation file
2 clear all; clc;
3 global global_info;
4
5 %%%% SIMULATION SETTINGS %%%%
6 global_info.GULENABLED = 1;
7 global_info.BOT_ENABLED = 0;
8 global_info.DISPLAY_CHANGES = 1;
9 global_info.DELTA_TIME = 1;
10 global_info.MAXLOOP = 15000;
11
12 if ~global_info.BOT_ENABLED,
13     global_info.MAXLOOP = 9999999;
14 end
15
16
17 %%%% GAME SETTINGS %%%%
18 % The bot generates a number from 1-100, this is number is used with the
19 % array below to determine which action is to be taken. The cutoffs are,
20 % DP.Turn, DP.Move, FP.Move, TP.Turn, TP.Move. Given array [20, 50, 70,
21 % 80], a number between 1-20 would attempt a DP.Turn action, 21-50 DP.Move,
22 % and so on.
23 global_info.BOT_ACTIONS = [10, 42, 44, 60];
24 % The probability of moving to a tableau pile versus a foundation pile.
25 global_info.BOT_ACTIONS.TP_FP = 15;
26 % The probability that the bot will attempt to move the full stack versus a
27 % part of it.
28 global_info.BOT_ACTIONS.TP_FULL_PARTIAL_MOVE = 35;
29
30 global_info.RANDOM_DECK = 0;
31 % First entry is bottom of the deck. Last entry is top of the deck.
32 global_info.DECK = {...
33     'D_A','D_2','D_3','D_4','D_5','D_6','D_7', ...
34     'D_8','D_9','D_X','D_J','D_Q','D_K', ...
35     'C_A','C_2','C_3','C_4','C_5','C_6','C_7', ...
36     'C_8','C_9','C_X','C_J','C_Q','C_K', ...
37     'H_A','H_2','H_3','H_4','H_5','H_6','H_7', ...
38     'H_8','H_9','H_X','H_J','H_Q','H_K', ...
39     'S_A','S_2','S_3','S_4','S_5','S_6','S_7', ...
40     'S_8','S_9','S_X','S_J','S_Q','S_K'
41 };
42 % To which Tableau pile the cards will be dealt. The first entry is to top
43 % of the deck (See global_info.DECK).
44 global_info.INITIAL_DEAL_MOVE = {
45     '1','2','3','4','5','6','7', ...
46     '2','3','4','5','6','7', ...
47     '3','4','5','6','7', ...
48     '4','5','6','7', ...
49     '5','6','7', ...
50     '6','7', ...
51 };
52
53 global_info.SUITS.D = {'Diamonds','Red'};
54 global_info.SUITS.C = {'Clubs','Black'};
55 global_info.SUITS.H = {'Hearts','Red'};
56 global_info.SUITS.S = {'Spades','Black'};
57 global_info.CARDVALUE_MAP = containers.Map(...
58     {'A','2','3','4','5','6','7','8','9','X','J','Q','K'}, ...
59     [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13] ...
60

```



```

61     );
62     global_info.FP_PILES = {'FPC','FPD','FPH','FPS'};
63     global_info.TP_PILES = {'TP1','TP2','TP3','TP4','TP5','TP6','TP7'};
64     global_info.FP_TP_PILES = [global_info.FP_PILES, global_info.TP_PILES];
65
66     %%%% GLOBAL PARAMETERS %%%%
67     global_info.SCORE = 0;
68     global_info.TP_Move_Multiple = 0;
69     global_info.TP_Move_Multiple_Count = 0;
70     global_info.DP_Flip_Pile_Running = false;
71     global_info.CARDS_DEALT = 0;
72     global_info.INITIAL_DEAL_MOVE_LENGTH = length(global_info.INITIAL_DEAL_MOVE);
73     global_info.INITIAL_DECK_LENGTH = length(global_info.DECK);
74     global_info.BOT_ACTIONS_NEW_CMD = 1;
75     global_info.BOT_LAST_CMD = '';
76     global_info.BOT_NEXT_CMD = '';
77
78     %%%% COMPOSE STATIC GRAPH %%%%%%%%%
79     pn_struct = {
80         'module_connector.pdf'; % Module connector ...
81         'draw_pile.pdf'; % Game pile ...
82         'foundation_pile_clubs.pdf'; % Foundation pile: Clubs ...
83         'foundation_pile_diamonds.pdf'; % Foundation pile: Diamonds ...
84         'foundation_pile_hearts.pdf'; % Foundation pile: Hearts ...
85         'foundation_pile_spades.pdf'; % Foundation pile: Spades ...
86         'tableau_pile_1.pdf'; % Tableau pile 1 ...
87         'tableau_pile_2.pdf'; % Tableau pile 2 ...
88         'tableau_pile_3.pdf'; % Tableau pile 3 ...
89         'tableau_pile_4.pdf'; % Tableau pile 4 ...
90         'tableau_pile_5.pdf'; % Tableau pile 5 ...
91         'tableau_pile_6.pdf'; % Tableau pile 6 ...
92         'tableau_pile_7.pdf'; % Tableau pile 7 ...
93     };
94
95     if global_info.GUI_ENABLED,
96         pn_struct{length(pn_struct) + 1} = 'player.pdf';
97     end;
98     if global_info.BOT_ENABLED,
99         pn_struct{length(pn_struct) + 1} = 'player_bot.pdf';
100    end;
101    pns = pnstruct(pn_struct);
102    %%%% DYNAMIC DETAILS %%%%
103    % Only one resource in the PN. Used to symbolize that there is an ongoing
104    % action, so that a new one can not be started. This assures the atomicity
105    % and correctness of the system.
106    dyn.re = {'playerAction', 1, inf};
107
108    % Initial tokens.
109    dyn.m0 = {'pDP_Dealer', global_info.INITIAL_DECK_LENGTH, 'pDP_Turn', ...
110        length(global_info.INITIAL_DEAL_MOVE), 'pDP_Move_Init', ...
111        length(global_info.INITIAL_DEAL_MOVE)};
112
113    % Set priority on the initial move transition to be higher than all other
114    % transition in order to have a more natural ordering of cards.
115    dyn.ip = {'tDPe_Out', 10};
116    % Need to have some time to be able to fetch tokens based on time. (Which
117    % arrived earliest or latest).
118    dyn.ft = {'allothers', 0.01};
119    if global_info.BOT_ENABLED,
120        %dyn.ft = [dyn.ft, 'tPBt-Gen', 1];
121    end;
122
123    if global_info.GUI_ENABLED,
124        player_GUI;
125    end
126
127    %%%% SIMULATE %%%%
128    pni = initialdynamics(pns, dyn);
129    sim = gpensim(pni);
130
131    %prnss(sim);
132    prnfinalcolors(sim)
133
134    % cotree(pni, 0, 1)
135

```

B.13 module_connector_pdf.m

```

1 function [png] = module_connector_pdf()
2 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
3 % File: module_connector_pdf.m : Handles the connections of the modules.
4 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
5
6 png.PN_name = 'Module_connector';
7
8 png.set_of_Ps = {'pMC_Out_Buffer', 'pMC_DP_Turn', 'pMC_DP_Move', ...
9 'pMC_TP_Turn', 'pMC_TP_Move', 'pMC_FP_Move'};
10 png.set_of_Ts = {'tMC_Out_Buffer_Siphon', 'tMC_DP_Move_Siphon', ...
11 'tMC_TP_Turn_Siphon', 'tMC_TP_Move_Siphon', 'tMC_FP_Move_Siphon'};
12 png.set_of_As = {
13 'tDPe_Out', 'pMC_Out_Buffer', 1, ...
14 'pMC_DP_Turn', 'tDPe_Turn', 1, ...
15 'pMC_DP_Move', 'tDPe_Move', 1, ...
16 'pMC_Out_Buffer', 'tMC_Out_Buffer_Siphon', 1, ...
17 'pMC_DP_Move', 'tMC_DP_Move_Siphon', 1, ...
18 'pMC_TP_Turn', 'tMC_TP_Turn_Siphon', 1, ...
19 'pMC_TP_Move', 'tMC_TP_Move_Siphon', 1, ...
20 'pMC_FP_Move', 'tMC_FP_Move_Siphon', 1, ...
21 };
22 % Add connections to all 7 tableau piles %
23 for i = 1:7
24     num = num2str(i);
25     png.set_of_As = [png.set_of_As, {strcat('tTPe_',num,'_Out'),'
26     pMC_Out_Buffer', 1}];
27     png.set_of_As = [png.set_of_As, {'pMC_Out_Buffer',strcat('tTPe_',num,'
28     _Add_FaceDown'), 1}];
29     png.set_of_As = [png.set_of_As, {'pMC_Out_Buffer',strcat('tTPe_',num,'
30     _Add_FaceUp'), 1}]; % Moving cards from one TP to another
31     png.set_of_As = [png.set_of_As, {'pMC_TP_Move',strcat('tTPe_',num,'_Move')
32     , 1}];
33     png.set_of_As = [png.set_of_As, {'pMC_TP_Turn',strcat('tTPe_',num,'_Turn')
34     , 1}];
35 end;
36
37 % Add connections to all 4 foundation piles %
38 foundationpiles = {'Spades','Hearts','Diamonds','Clubs'};
39 for i = 1:4
40     fp = foundationpiles(i);
41     png.set_of_As = [png.set_of_As, {strcat('tFPe_',fp{1},'_Out'),'
42     pMC_Out_Buffer', 1}];
43     png.set_of_As = [png.set_of_As, {'pMC_Out_Buffer',strcat('tFPe_',fp{1},'_
44     Add'), 1}];
45     png.set_of_As = [png.set_of_As, {'pMC_FP_Move',strcat('tFPe_',fp{1},'_Move
46     '), 1}];
47 end;

```

B.14 player_bot_pdf.m

```

1 function [png] = player_bot_pdf()
2 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
3 % File: player_bot_pdf.m : Bot for simulating user actions.
4 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
5
6 png.PN_name = 'Player_Bot_module';
7
8 png.set_of_Ps = {'pPB_Cmd'};
9 png.set_of_Ts = {'tPBi_Gen', 'tPBe_DP_Turn', 'tPBe_DP_Move', 'tPBe_TP_Turn',
10 ...
11 'tPBe_TP_Move', 'tPBe_FP_Move', 'tPBi_Siphon'};
12 png.set_of_As = {
13 'tPBi_Gen', 'pPB_Cmd', 1, ...
14 'pPB_Cmd', 'tPBi_Siphon', 1, ...
15 'pPB_Cmd', 'tPBe_DP_Turn', 1, ...
16 'pPB_Cmd', 'tPBe_DP_Move', 1, ...
17 'pPB_Cmd', 'tPBe_FP_Move', 1, ...
18 'pPB_Cmd', 'tPBe_TP_Turn', 1, ...
19 'pPB_Cmd', 'tPBe_TP_Move', 1, ...
20 'tPBe_DP_Turn', 'pMC_DP_Turn', 1, ...

```

```

20     'tPBe_DP_Move', 'pMC_DP_Move', 1, ...
21     'tPBe_FP_Move', 'pMC_FP_Move', 1, ...
22     'tPBe_TP_Turn', 'pMC_TP_Turn', 1, ...
23     'tPBe_TP_Move', 'pMC_TP_Move', 1, ...
24 };
25
26 % Add connections to all 7 tableau piles %
27 % for i = 1:7
28 %     num = num2str(i);
29 %     png.set_of_As = [png.set_of_As, {strcat('tPe_TP_',num,'_Turn')}, '
    pMC_TP_Turn', 1]];
30 %     png.set_of_As = [png.set_of_As, {strcat('tPe_TP_',num,'_Move')}, '
    pMC_TP_Move', 1]];
31 % end;
32 %
33 % Add connections to all 4 foundation piles %
34 % foundationpiles = {'Clubs','Diamonds','Hearts','Spades'};
35 % for i = 1:4
36 %     fp = foundationpiles(i);
37 %     png.set_of_As = [png.set_of_As, {strcat('tPe_FP_',fp{1},'Move')}, '
    pMC_FP_Move', 1]];
38 % end;

```

B.15 player_GUI.m

```

1  function varargout = player_GUI(varargin)
2  % Last Modified by GUIDE v2.5 07-Nov-2017 18:47:57
3
4  % Begin initialization code - DO NOT EDIT
5  gui_Singleton = 1;
6  gui_State = struct('gui_Name',       mfilename, ...
7                    'gui_Singleton',   gui_Singleton, ...
8                    'gui_OpeningFcn',  @player_GUI_OpeningFcn, ...
9                    'gui_OutputFcn',   @player_GUI_OutputFcn, ...
10                   'gui_LayoutFcn',    [], ...
11                   'gui_Callback',     []);
12  if nargin && ischar(varargin{1})
13      gui_State.gui_Callback = str2func(varargin{1});
14  end
15
16  if nargout
17      [varargout{1:nargout}] = gui_mainfcn(gui_State, varargin{:});
18  else
19      gui_mainfcn(gui_State, varargin{:});
20  end
21  % End initialization code - DO NOT EDIT
22
23
24  % --- Executes just before player_GUI is made visible.
25  function player_GUI_OpeningFcn(hObject, eventdata, handles, varargin)
26  % This function has no output args, see OutputFcn.
27  % hObject    handle to figure
28  % eventdata  reserved - to be defined in a future version of MATLAB
29  % handles    structure with handles and user data (see GUIDATA)
30  % varargin   command line arguments to player_GUI (see VARARGIN)
31
32  % Choose default command line output for player_GUI
33  handles.output = hObject;
34  global global_info;
35  global_info(handles) = handles;
36
37  % Define default states for all click buttons
38  global_info.DP_Turn_Btn = false;
39  global_info.DP_Move_Btn = false;
40
41  global_info.TP_1_Turn_Btn = false;
42  global_info.TP_1_Move_Btn = false;
43  global_info.TP_2_Turn_Btn = false;
44  global_info.TP_2_Move_Btn = false;
45  global_info.TP_3_Turn_Btn = false;
46  global_info.TP_3_Move_Btn = false;
47  global_info.TP_4_Turn_Btn = false;
48  global_info.TP_4_Move_Btn = false;

```

```

49 global_info.TP_5.Turn_Btn = false;
50 global_info.TP_5.Move_Btn = false;
51 global_info.TP_6.Turn_Btn = false;
52 global_info.TP_6.Move_Btn = false;
53 global_info.TP_7.Turn_Btn = false;
54 global_info.TP_7.Move_Btn = false;
55
56 global_info.FP_C.Move_Btn = false;
57 global_info.FP_D.Move_Btn = false;
58 global_info.FP_H.Move_Btn = false;
59 global_info.FP_S.Move_Btn = false;
60
61 % Update handles structure
62 guidata(hObject, handles);
63
64 % UIWAIT makes player_GUI wait for user response (see UIRESUME)
65 % uiwait(handles.figure1);
66
67 % --- Outputs from this function are returned to the command line.
68 function varargout = player_GUI_OutputFcn(hObject, eventdata, handles)
69 varargout{1} = handles.output;
70
71 % --- Executes on button press in STOPSIM.
72 function STOPSIM_Callback(hObject, eventdata, handles)
73 global global_info;
74 global_info.STOP_SIMULATION = 1;
75
76 % --- Executes on button press in TOGGLEBOT.
77 function TOGGLEBOT_Callback(hObject, eventdata, handles)
78 global global_info;
79 global_info.BOT_ENABLED = ~global_info.BOT_ENABLED;
80
81 % --- Executes on button press in DP_Turn_Btn.
82 function DP_Turn_Btn_Callback(hObject, eventdata, handles)
83 global global_info;
84 if global_info.DP_Turn_Btn == false,
85     global_info.DP_Turn_Btn = true;
86 end
87
88 % --- Executes on button press in DP_Move_Btn.
89 function DP_Move_Btn_Callback(hObject, eventdata, handles)
90 global global_info;
91 if global_info.DP_Move_Btn == false,
92     global_info.DP_Move_Btn = true;
93 end
94
95 % --- Executes on button press in FP_C_Move_Btn.
96 function FP_C_Move_Btn_Callback(hObject, eventdata, handles)
97 global global_info;
98 if global_info.FP_C_Move_Btn == false,
99     global_info.FP_C_Move_Btn = true;
100 end
101
102 % --- Executes on button press in FP_D_Move_Btn.
103 function FP_D_Move_Btn_Callback(hObject, eventdata, handles)
104 global global_info;
105 if global_info.FP_D_Move_Btn == false,
106     global_info.FP_D_Move_Btn = true;
107 end
108
109 % --- Executes on button press in FP_H_Move_Btn.
110 function FP_H_Move_Btn_Callback(hObject, eventdata, handles)
111 global global_info;
112 if global_info.FP_H_Move_Btn == false,
113     global_info.FP_H_Move_Btn = true;
114 end
115
116 % --- Executes on button press in FP_S_Move_Btn.
117 function FP_S_Move_Btn_Callback(hObject, eventdata, handles)
118 global global_info;
119 if global_info.FP_S_Move_Btn == false,
120     global_info.FP_S_Move_Btn = true;
121 end
122
123 % --- Executes on button press in TP_1_Turn_Btn.
124 function TP_1_Turn_Btn_Callback(hObject, eventdata, handles)
125 global global_info;
126 if global_info.TP_1_Turn_Btn == false,

```

```

127     global_info.TP_1_Turn_Btn = true;
128 end
129
130 % --- Executes on button press in TP_1_Move_Btn.
131 function TP_1_Move_Btn_Callback(hObject, eventdata, handles)
132 global global_info;
133 if global_info.TP_1_Move_Btn == false,
134     global_info.TP_1_Move_Btn = true;
135 end
136
137 % --- Executes on button press in TP_2_Turn_Btn.
138 function TP_2_Turn_Btn_Callback(hObject, eventdata, handles)
139 global global_info;
140 if global_info.TP_2_Turn_Btn == false,
141     global_info.TP_2_Turn_Btn = true;
142 end
143
144 % --- Executes on button press in TP_2_Move_Btn.
145 function TP_2_Move_Btn_Callback(hObject, eventdata, handles)
146 global global_info;
147 if global_info.TP_2_Move_Btn == false,
148     global_info.TP_2_Move_Btn = true;
149 end
150
151 % --- Executes on button press in TP_3_Turn_Btn.
152 function TP_3_Turn_Btn_Callback(hObject, eventdata, handles)
153 global global_info;
154 if global_info.TP_3_Turn_Btn == false,
155     global_info.TP_3_Turn_Btn = true;
156 end
157
158 % --- Executes on button press in TP_3_Move_Btn.
159 function TP_3_Move_Btn_Callback(hObject, eventdata, handles)
160 global global_info;
161 if global_info.TP_3_Move_Btn == false,
162     global_info.TP_3_Move_Btn = true;
163 end
164
165 % --- Executes on button press in TP_4_Turn_Btn.
166 function TP_4_Turn_Btn_Callback(hObject, eventdata, handles)
167 global global_info;
168 if global_info.TP_4_Turn_Btn == false,
169     global_info.TP_4_Turn_Btn = true;
170 end
171
172 % --- Executes on button press in TP_4_Move_Btn.
173 function TP_4_Move_Btn_Callback(hObject, eventdata, handles)
174 global global_info;
175 if global_info.TP_4_Move_Btn == false,
176     global_info.TP_4_Move_Btn = true;
177 end
178
179 % --- Executes on button press in TP_5_Turn_Btn.
180 function TP_5_Turn_Btn_Callback(hObject, eventdata, handles)
181 global global_info;
182 if global_info.TP_5_Turn_Btn == false,
183     global_info.TP_5_Turn_Btn = true;
184 end
185
186 % --- Executes on button press in TP_5_Move_Btn.
187 function TP_5_Move_Btn_Callback(hObject, eventdata, handles)
188 global global_info;
189 if global_info.TP_5_Move_Btn == false,
190     global_info.TP_5_Move_Btn = true;
191 end
192
193 % --- Executes on button press in TP_6_Turn_Btn.
194 function TP_6_Turn_Btn_Callback(hObject, eventdata, handles)
195 global global_info;
196 if global_info.TP_6_Turn_Btn == false,
197     global_info.TP_6_Turn_Btn = true;
198 end
199
200 % --- Executes on button press in TP_6_Move_Btn.
201 function TP_6_Move_Btn_Callback(hObject, eventdata, handles)
202 global global_info;
203 if global_info.TP_6_Move_Btn == false,
204     global_info.TP_6_Move_Btn = true;

```

```

205 end
206
207 % --- Executes on button press in TP_7_Turn_Btn.
208 function TP_7_Turn_Btn_Callback(hObject, eventdata, handles)
209 global global_info;
210 if global_info.TP_7_Turn_Btn == false,
211     global_info.TP_7_Turn_Btn = true;
212 end
213
214 % --- Executes on button press in TP_7_Move_Btn.
215 function TP_7_Move_Btn_Callback(hObject, eventdata, handles)
216 global global_info;
217 if global_info.TP_7_Move_Btn == false,
218     global_info.TP_7_Move_Btn = true;
219 end

```

B.16 player_pdf.m

```

1 function [png] = player_pdf()
2 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
3 % File: player_pdf.m : Handles inputs from the player.
4 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
5
6 png.PN_name = 'Player_module';
7
8 png.set_of_Ps = {};
9 png.set_of_Ts = {'tPe-DP-Turn', 'tPe-DP-Move', 'tPe-TP-1-Turn', 'tPe-TP-1-Move',
10     'tPe-TP-2-Turn', 'tPe-TP-2-Move', 'tPe-TP-3-Turn', 'tPe-TP-3-Move', ...
11     'tPe-TP-4-Turn', 'tPe-TP-4-Move', 'tPe-TP-5-Turn', 'tPe-TP-5-Move', ...
12     'tPe-TP-6-Turn', 'tPe-TP-6-Move', 'tPe-TP-7-Turn', 'tPe-TP-7-Move', ...
13     'tPe-FP-Clubs-Move', 'tPe-FP-Diamonds-Move', 'tPe-FP-Hearts-Move', 'tPe-FP-Spades-Move'};
14 png.set_of_As = {
15     'tPe-DP-Turn', 'pMC-DP-Turn', 1, ... % Player module
16     'tPe-DP-Move', 'pMC-DP-Move', 1, ... % Player module
17 };
18
19 % Add connections to all 7 tableau piles %
20 for i = 1:7
21     num = num2str(i);
22     png.set_of_As = [png.set_of_As, {strcat('tPe-TP-',num,'_Turn'),'pMC-TP-Turn', 1}];
23     png.set_of_As = [png.set_of_As, {strcat('tPe-TP-',num,'_Move'),'pMC-TP-Move', 1}];
24 end;
25
26 % Add connections to all 4 foundation piles %
27 foundationpiles = {'Clubs','Diamonds','Hearts','Spades'};
28 for i = 1:4
29     fp = foundationpiles(i);
30     png.set_of_As = [png.set_of_As, {strcat('tPe-FP-',fp{1},'_Move'),'pMC-FP-Move', 1}];
31 end;

```

B.17 player_update_GUI.m

```

1 function [] = player_update_GUI()
2 global global_info;
3
4 %% Clear initial game status.
5 if global_info.CARDS_DEALT == global_info.INITIAL_DEAL_MOVE_LENGTH,
6     set_handle('GameStatus', 'String', '');
7 end;
8
9 %% Update Score
10 set_handle('Score', 'String', strcat('Score:',{ '_' }, num2str(global_info.SCORE)));
11

```

```

12 %% Draw Pile
13 vistoken = tokenArrivedLate('pDP_Draw_FaceUp_Pile',1);
14 topcard = '';
15 if vistoken,
16     topcard = get_color('pDP_Draw_FaceUp_Pile',vistoken);
17 end;
18 set(global_info.handles.DP_StatusMsg,'String',strcat('#FD: ',num2str(length(
19     tokIDs('pDP_Draw_FaceDown_Pile'))),...
20     ',_#FU: ',num2str(length(tokIDs('pDP_Draw_FaceUp_Pile'))),',_FU_Top: ',{'_ '
21     },topcard));
22
23 %% Foundation Piles
24 foundationpiles = {'Clubs','Diamonds','Hearts','Spades'};
25 for i = 1:4
26     fp = foundationpiles(i);
27     pile = fp{1};
28     vistoken = tokenArrivedLate(strcat('pFP_',pile,'_Pile'),1);
29     topcard = '';
30     if vistoken,
31         topcard = get_color(strcat('pFP_',pile,'_Pile'),vistoken);
32     end;
33     statusHandle = strcat('FP_',pile(1),'_StatusMsg');
34     set(global_info.handles.(statusHandle),'String',strcat('#: ',num2str(
35         length(tokIDs(strcat('pFP_',pile,'_Pile'))),',_Top: ',{'_ '},topcard));
36 end;
37
38 %% Tableau Piles
39 for i = 1:7
40     num = num2str(i);
41     numtokens = length(tokIDs(strcat('pTP_',num,'_FaceUp_Pile')));
42     vistoken = tokenArrivedLate(strcat('pTP_',num,'_FaceUp_Pile'),numtokens);
43     statusmsg = 'Face-Up: ';
44     if vistoken,
45         for i = numtokens:-1:1,
46             tokencolors = get_color(strcat('pTP_',num,'_FaceUp_Pile'),vistoken
47                 (i));
48             statusmsg = sprintf('%s\n%s',statusmsg,tokencolors{1});
49         end
50     end;
51     faceup_handle = strcat('TP_',num,'_FaceUpMsg');
52     facedown_handle = strcat('TP_',num,'_FaceDownMsg');
53     set(global_info.handles.(faceup_handle),'String',statusmsg);
54     set(global_info.handles.(facedown_handle),'String',strcat('#FD: ',num2str(
55         length(tokIDs(strcat('pTP_',num,'_FaceDown_Pile')))))));
56 end;

```

B.18 post_tTPe_Add_FaceUp.m

```

1 function [] = post_tTPe_Add_FaceUp(transition)
2
3 global global_info;
4 global_info.CARDS_DEALT = global_info.CARDS_DEALT + 1;
5
6 if global_info.TP_Move_Multiple_Count <= 1,
7     if isfield(global_info,'last_command_source'),
8         release(global_info.last_command_source);
9     end
10 else,
11     global_info.TP_Move_Multiple_Count = global_info.TP_Move_Multiple_Count -
12         1;
13 end;

```

B.19 pre_tFPe_Add.m

```

1 function [fire, transition] = pre_tFPe_Add(transition)
2
3 global global_info;
4 fire = 0;

```

```

5 | moveToken = tokenArrivedEarly('pMC_Out_Buffer',1);
6 | tokenColor = get_color('pMC_Out_Buffer',moveToken);
7 | if(length(tokenColor) ~= 2),
8 |     return;
9 | end;
10 | [~, suit, handle_err] = get_suit_from_transname(transition.name);
11 | [doCommand, cmdDest, card, cmdSource] = ...
12 |     checkCommand_Move(tokenColor, suit, '', handle_err);
13 | if(doCommand),
14 |     transition.selected_tokens = moveToken;
15 |     transition.new_color = card;
16 |     transition.override = 1;
17 |     fire = 1;
18 |     global_info.SCORE = global_info.SCORE + 10;
19 |     if(global_info.DISP_CHANGES),
20 |         disp(strcat('Moved_card',{ '_'},card,{ '_'},'from',{ '_'},cmdSource,...
21 |             { '_'},'to',{ '_'},cmdDest));
22 |     end;
23 | end

```

B.20 pre_tFPe_Move.m

```

1 | function [fire, transition] = pre_tFPe_Move(transition)
2 |
3 | fire = 0;
4 | moveToken = tokenArrivedLate('pMC_FP_Move',1);
5 | [suit_abbrev, suit, ~] = get_suit_from_transname(transition.name);
6 | [moveCmd, ~] = splitCommand(get_color('pMC_FP_Move',moveToken));
7 | if(length(moveCmd) >= 3 && strcmp(moveCmd{3},strcat('FP',suit_abbrev))),
8 |     transition.selected_tokens = moveToken;
9 |     fire = 1;
10 | end

```

B.21 pre_tFPe_Out.m

```

1 | function [fire, transition] = pre_tFPe_Out(transition)
2 |
3 | % Explicitly sure to get the card at the top of the stack.
4 | [~, suit, ~] = get_suit_from_transname(transition.name);
5 |
6 | moveToken = tokenArrivedEarly(strcat('pFP_',suit,'_Move'), 1);
7 | cardToken = tokenArrivedLate(strcat('pFP_',suit,'_Pile'), 1);
8 |
9 | transition.selected_tokens = [moveToken cardToken];
10 | fire = 1;

```

B.22 pre_tPe_FP_Move.m

```

1 | function [fire, transition] = pre_tPe_FP_Move(transition)
2 |
3 | global global_info;
4 | fire = 0;
5 | if global_info.CARDS_DEALT < global_info.INITIAL_DEALT_MOVE_LENGTH,
6 |     return;
7 | end;
8 |
9 | [suit_abbrev, suit, handle_err, move_btn, handle_move_loc] =
10 |     get_suit_from_transname(transition.name);
11 | [playerAction] = request(transition.name, {'playerAction', 1});
12 | if global_info.(move_btn) ~= false && playerAction,
13 |     %global_info = setfield(global_info, move_btn, false);
14 |     global_info.(move_btn) = false;
15 |     dest = upper(get_handle(handle_move_loc, 'String'));
16 |     command = strcat('Move:',dest,':',strcat('FP',suit_abbrev));

```



```

16     vistoken = tokenArrivedLate(strcat('pFP_',suit,'_Pile'),1);
17     if vistoken,
18         color = get_color(strcat('pFP_',suit,'_Pile'),vistoken);
19         color = color{1};
20         if checkCommand.Move({command;color},' ',transition.name,handle_err),
21             transition.new_color = command;
22             fire = 1;
23         end;
24     end;
25 end

```

B.23 pre_tPe_TP_Move.m

```

1 function [fire, transition] = pre_tPe_TP_Move(transition)
2
3 global global_info;
4 fire = 0;
5 if global_info.CARDS_DEALT < global_info.INITIAL_DEAL_MOVE_LENGTH,
6     return;
7 end;
8
9 [tableau, handle_err, move_btn, ~, handle_move_loc, handle_move_amount]...
10 = get_tableau_from_transname(transition.name);
11 [playerAction] = request(transition.name, {'playerAction', 1});
12 if global_info.(move_btn) ~= false && playerAction,
13     global_info.(move_btn) = false;
14     dest = upper(get_handle(handle_move_loc, 'String'));
15
16     % Is amount numeric and equal or less than current cards in FaceUp?
17     if ismember(dest, global_info.FP_PILES),
18         amount = 1;
19     else,
20         amount = str2double(get_handle(handle_move_amount, 'String'));
21         if isnan(amount) || amount < 1,
22             amount = 1;
23         end;
24         if amount > length(tokIDs(strcat('pTP_',tableau,'_FaceUp_Pile'))),
25             set_handle(handle_err, 'String', 'INVALID_AMOUNT');
26             return;
27         end;
28     end;
29
30 command = strcat('Move:',dest,':TP',tableau,':',num2str(amount));
31
32 vistoken = tokenArrivedLate(strcat('pTP_',tableau,'_FaceUp_Pile'),amount);
33 vistoken = vistoken(amount);
34 if vistoken,
35     color = get_color(strcat('pTP_',tableau,'_FaceUp_Pile'),vistoken);
36     color = color{1};
37     if checkCommand.Move({command;color},' ',transition.name,handle_err),
38         % Need some sort of perpetual firing.
39         transition.new_color = command;
40         fire = 1;
41     end;
42 end;
43 end

```

B.24 pre_tPe_TP_Turn.m

```

1 function [fire, transition] = pre_tPe_TP_Turn(transition)
2
3 global global_info;
4 fire = 0;
5 if global_info.CARDS_DEALT < global_info.INITIAL_DEAL_MOVE_LENGTH,
6     return;
7 end;
8
9 [tableau, handle_err, ~, turn_btn, ~, ~] ...
10 = get_tableau_from_transname(transition.name);

```

```

11 [playerAction] = request(transition.name, {'playerAction', 1});
12 if global_info.(turn_btn) ~= false && playerAction,
13     global_info.(turn_btn) = false;
14     if isempty(tokIDs(strcat('pTP_', tableau, '_FaceUp_Pile'))),
15         set_handle(handle_err, 'String', 'FaceUp_Pile_must_be_empty');
16         return;
17     elseif isempty(tokIDs(strcat('pTP_', tableau, '_FaceDown_Pile'))),
18         set_handle(handle_err, 'String', 'FaceDown_Pile_is_empty');
19         return;
20     end;
21     set_handle(handle_err, 'String', '');
22     global_info.last_command_source = transition.name;
23     transition.new_color = strcat('Turn:TP', tableau);
24     fire = 1;
25 end;

```

B.25 pre_tTPe_Add_FaceDown.m

```

1 function [fire, transition] = pre_tTPe_Add_FaceDown(transition)
2
3 global global_info;
4 fire = 0;
5 [tableau, ~, ~, ~, ~, ~] = get_tableau_from_transname(transition.name);
6 % Can only add FaceDown cards during the initial dealing.
7 if global_info.CARDS.DEALT >= global_info.INITIAL_DEAL_MOVE_LENGTH ...
8     || length(tokIDs(strcat('pTP_', tableau, '_FaceDown_Pile'))) + 1 ...
9     == str2double(tableau),
10     return;
11 end;
12 moveToken = tokenArrivedEarly('pMC_Out_Buffer', 1);
13 [moveCmd, card] = splitCommand(get_color('pMC_Out_Buffer', moveToken));
14 if length(moveCmd) >= 2 && strcmp(moveCmd{2}, strcat('TP', tableau)),
15     transition.selected_tokens = moveToken;
16     transition.new_color = card;
17     transition.override = 1;
18     fire = 1;
19     if(global_info.DISP_CHANGES),
20         disp(strcat('Moved_card',{ '_'}, card, { '_'}, 'from_DP', { '_'}, ...
21             'to',{ '_'}, moveCmd{2}, { '_'}, '(FD)'));
22     end;
23 end

```

B.26 pre_tTPe_Add_FaceUp.m

```

1 function [fire, transition] = pre_tTPe_Add_FaceUp(transition)
2
3 global global_info;
4 [tableau, handle_err, ~, ~, ~, ~] = get_tableau_from_transname(transition.name);
5 fire = 0;
6
7 % Can only add FaceUp cards once the initial dealing is complete.
8 isFDFull = length(tokIDs(strcat('pTP_', tableau, '_FaceDown_Pile'))) + 1 ...
9     == str2double(tableau);
10 isDealingInProgress = global_info.CARDS.DEALT < ...
11     global_info.INITIAL_DEAL_MOVE_LENGTH;
12 if isDealingInProgress && ~isFDFull,
13     return;
14 end;
15
16 moveToken = tokenArrivedEarly('pMC_Out_Buffer', 1);
17 tokenColor = get_color('pMC_Out_Buffer', moveToken);
18 if(length(tokenColor) ~= 2),
19     return;
20 end;
21
22 if isDealingInProgress && isFDFull,
23     doCommand = true;
24     [moveCmd, card] = splitCommand(tokenColor);

```

```

25     cmdDest = moveCmd{2};
26     source = 'DP';
27 else,
28 [doCommand, cmdDest, card, cmdSource] = ...
29     checkCommand_Move(tokenColor, tableau, '', handle_err);
30     source = cmdSource;
31 end
32
33 if (doCommand && strcmp(cmdDest, strcat('TP', tableau))),
34     transition.selected_tokens = moveToken;
35     transition.new_color = card;
36     transition.override = 1;
37     fire = 1;
38
39     if ~isDealingInProgress,
40         if strcmp(source, 'DP'),
41             % 10 Points when moving from Draw Pile to Tableau
42             global_info.SCORE = global_info.SCORE + 5;
43         elseif ismember(source, global_info.FP_PILES),
44             % Lose 15 points when moving from a Foundation Pile to Tableau
45             global_info.SCORE = max(global_info.SCORE - 15, 0);
46         end;
47     end
48     if (global_info.DISP_CHANGES),
49         disp(strcat('Moved_card', {'_'}, card, {'_'}, 'from', {'_'}, source, ...
50             {'_'}, 'to', {'_'}, cmdDest, {'_'}, '(FU)'));
51     end;
52 end

```

B.27 pre_tTPe_Move.m

```

1 function [fire, transition] = pre_tTPe_Move(transition)
2
3 global global_info;
4 fire = 0;
5 moveToken = tokenArrivedLate('pMC_TP_Move', 1);
6 [tableau, ~, ~, ~, ~] = get_tableau_from_transname(transition.name);
7
8 moveColor = get_color('pMC_TP_Move', moveToken);
9 [moveCmd, ~] = splitCommand(moveColor);
10
11 if (length(moveCmd) >= 4 && strcmp(moveCmd{3}, strcat('TP', tableau))),
12     amount = str2double(moveCmd{4});
13     global_info.TP_Move_Multiple_Count = amount;
14     global_info.TP_Move_Multi_Gen_Tokens = amount - 1;
15
16     transition.selected_tokens = moveToken;
17     fire = 1;
18 end

```

B.28 pre_tTPe_Out.m

```

1 function [fire, transition] = pre_tTPe_Out(transition)
2
3 global global_info;
4 fire = 0;
5
6 if global_info.TP_Move_Multi_Gen_Tokens == 0,
7     [tableau, ~, ~, ~, ~] = get_tableau_from_transname(transition.name);
8     moveToken = tokenArrivedEarly(strcat('pTP_', tableau, '_Move'), 1);
9
10     % Get the n-th latest arrived card from the face-up pile in order to
11     % move the correct card first.
12     lenMoveTokens = length(tokIDs(strcat('pTP_', tableau, '_Move')));
13     cardToken = tokenArrivedLate(strcat('pTP_', tableau, '_FaceUp_Pile'), ...
14         lenMoveTokens);
15     cardToken = cardToken(lenMoveTokens);
16
17     transition.selected_tokens = [moveToken cardToken];

```

```

18     fire = 1;
19 end;

```

B.29 pre_tTPe_Turn.m

```

1 function [fire, transition] = pre_tTPe_Turn(transition)
2
3 global global_info;
4 fire = 0;
5 moveToken = tokenArrivedLate('pMC_TP_Turn',1);
6 [tableau, ~, ~, ~, ~, ~] = get_tableau_from_transname(transition.name);
7 turnCmd = get_color('pMC_TP_Turn',moveToken);
8
9 if(length(turnCmd) >= 1 && strcmp(turnCmd{1},strcat('Turn;TP',tableau))),
10     topCard = tokenArrivedLate(strcat('pTP_',tableau,'_FaceDown_Pile'),1);
11     transition.selected_tokens = topCard;
12     color = get_color(strcat('pTP_',tableau,'_FaceDown_Pile'), topCard);
13     transition.new_color = color{1};
14     transition.override = 1;
15     fire = 1;
16     global_info.SCORE = global_info.SCORE + 5;
17     if(global_info.DISPLAY_CHANGES),
18         disp(strcat('Turned card',{ '_ '},color{1},{ '_ '}, 'at',{ '_TP'},tableau));
19     end;
20 end

```

B.30 pre_tTPi_Move_Multiple.m

```

1 function [fire, transition] = pre_tTPi_Move_Multiple(transition)
2
3 global global_info;
4 fire = 0;
5
6 if global_info.TP_Move_Multi_Gen_Tokens > 0,
7     [tableau, ~, ~, ~, ~, ~] = get_tableau_from_transname(transition.name);
8     moveToken = tokenArrivedEarly(strcat('pTP_',tableau,'_Move'),1);
9     transition.selected_token = moveToken;
10    transition.new_color = get_color(strcat('pTP_',tableau,'_Move'),moveToken);
11    ;
12    transition.override = 1;
13    fire = 1;
14 end;

```

B.31 set_handle.m

```

1 function [] = set_handle(Handle,PropertyName,PropertyValue)
2 % Extend Matlab SET command to first check if GUI is enabled.
3 % SET(H,'PropertyName',PropertyValue)
4 global global_info;
5 if global_info.GULENABLED,
6     set(global_info.handles.(Handle),PropertyName,PropertyValue);
7 end;
8 end

```

B.32 splitCommand.m

```

1 function [command, card] = splitCommand( tokenColors )
2
3 color_1 = tokenColors{1};
4 if length(tokenColors) == 2,
5     color_2 = tokenColors{2};
6 else,
7     color_2 = '0';
8 end;
9 if ~isempty(strfind(color_1, 'Move;')),
10     command = strsplit(color_1, ';');
11     card = color_2;
12 else,
13     command = strsplit(color_2, ';');
14     card = color_1;
15 end;

```

B.33 tableau_pile_1_pdf.m

```

1 function [png] = tableau_pile_1_pdf()
2 modname = '1';
3 png.PN_name = strcat('Tableau_Pile_', {'_'}, modname);
4
5 png.set_of_Ps = {strcat('pTP_', modname, '_FaceUp_Pile'), strcat('pTP_', modname, '_FaceDown_Pile'), strcat('pTP_', modname, '_Move')};
6 png.set_of_Ts = {strcat('tTPe_', modname, '_Add.FaceUp'), strcat('tTPe_', modname, '_Add.FaceDown'), strcat('tTPe_', modname, '_Move'), ...
7     strcat('tTPe_', modname, '_Turn'), strcat('tTPe_', modname, '_Out'), strcat('tTPi_', modname, '_Move.Multiple')};
8 png.set_of_As = {
9     strcat('tTPe_', modname, '_Add.FaceUp'), strcat('pTP_', modname, '_FaceUp_Pile'), 1, ...
10    strcat('tTPe_', modname, '_Add.FaceDown'), strcat('pTP_', modname, '_FaceDown_Pile'), 1, ...
11    strcat('tTPe_', modname, '_Turn'), strcat('pTP_', modname, '_FaceUp_Pile'), 1, ...
12    strcat('pTP_', modname, '_FaceDown_Pile'), strcat('tTPe_', modname, '_Turn'), 1, ...
13    strcat('pTP_', modname, '_FaceUp_Pile'), strcat('tTPe_', modname, '_Out'), 1, ...
14    strcat('tTPe_', modname, '_Move'), strcat('pTP_', modname, '_Move'), 1, ...
15    strcat('pTP_', modname, '_Move'), strcat('tTPe_', modname, '_Out'), 1, ...
16    strcat('tTPi_', modname, '_Move.Multiple'), strcat('pTP_', modname, '_Move'), 2, ...
17    strcat('pTP_', modname, '_Move'), strcat('tTPi_', modname, '_Move.Multiple'), 1
18 };
19 png.set_of_Is = {
20     strcat('pTP_', modname, '_FaceUp_Pile'), strcat('tTPe_', modname, '_Turn'), 1
21 };

```

B.34 tableau_pile_2_pdf.m

```

1 function [png] = tableau_pile_2_pdf()
2 modname = '2';
3 png.PN_name = strcat('Tableau_Pile_', {'_'}, modname);
4
5 png.set_of_Ps = {strcat('pTP_', modname, '_FaceUp_Pile'), strcat('pTP_', modname, '_FaceDown_Pile'), strcat('pTP_', modname, '_Move')};
6 png.set_of_Ts = {strcat('tTPe_', modname, '_Add.FaceUp'), strcat('tTPe_', modname, '_Add.FaceDown'), strcat('tTPe_', modname, '_Move'), ...
7     strcat('tTPe_', modname, '_Turn'), strcat('tTPe_', modname, '_Out'), strcat('tTPi_', modname, '_Move.Multiple')};
8 png.set_of_As = {
9     strcat('tTPe_', modname, '_Add.FaceUp'), strcat('pTP_', modname, '_FaceUp_Pile'), 1, ...
10    strcat('tTPe_', modname, '_Add.FaceDown'), strcat('pTP_', modname, '_FaceDown_Pile'), 1, ...

```

```

11     strcat('tTPe_',modname,'_Turn'), strcat('pTP_',modname,'_FaceUp_Pile'), 1,
12     ...
13     strcat('pTP_',modname,'_FaceDown_Pile'), strcat('tTPe_',modname,'_Turn'),
14     1, ...
15     strcat('pTP_',modname,'_FaceUp_Pile'), strcat('tTPe_',modname,'_Out'), 1,
16     ...
17     strcat('tTPe_',modname,'_Move'), strcat('pTP_',modname,'_Move'), 1 ...
18     strcat('pTP_',modname,'_Move'), strcat('tTPe_',modname,'_Out'), 1, ...
19     strcat('tTPi_',modname,'_Move_Multiple'), strcat('pTP_',modname,'_Move'),
20     2, ...
21     strcat('pTP_',modname,'_Move'), strcat('tTPi_',modname,'_Move_Multiple'),
    1
    };
    png.set_of_Is = {
    strcat('pTP_',modname,'_FaceUp_Pile'), strcat('tTPe_',modname,'_Turn'), 1
    };

```

B.35 tableau_pile_3.pdf.m

```

1  function [png] = tableau_pile_3.pdf()
2  modname = '3';
3  png.PN_name = strcat('Tableau_Pile_',{ '_' },modname);
4
5  png.set_of_Ps = {strcat('pTP_',modname,'_FaceUp_Pile'), strcat('pTP_',modname,'
6  _FaceDown_Pile'), strcat('pTP_',modname,'_Move')};
7  png.set_of_Ts = {strcat('tTPe_',modname,'_Add_FaceUp'), strcat('tTPe_',modname,
8  '_Add_FaceDown'), strcat('tTPe_',modname,'_Move'), ...
9  strcat('tTPe_',modname,'_Turn'), strcat('tTPe_',modname,'_Out'), strcat('
10 tTPi_',modname,'_Move_Multiple')};
11 png.set_of_As = {
12     strcat('tTPe_',modname,'_Add_FaceUp'), strcat('pTP_',modname,'_FaceUp_Pile'
13     ), 1, ...
14     strcat('tTPe_',modname,'_Add_FaceDown'), strcat('pTP_',modname,'
15     _FaceDown_Pile'), 1, ...
16     strcat('tTPe_',modname,'_Turn'), strcat('pTP_',modname,'_FaceUp_Pile'), 1,
17     ...
18     strcat('pTP_',modname,'_FaceDown_Pile'), strcat('tTPe_',modname,'_Turn'),
19     1, ...
20     strcat('pTP_',modname,'_FaceUp_Pile'), strcat('tTPe_',modname,'_Out'), 1,
21     ...
22     strcat('tTPe_',modname,'_Move'), strcat('pTP_',modname,'_Move'), 1 ...
23     strcat('pTP_',modname,'_Move'), strcat('tTPe_',modname,'_Out'), 1, ...
24     strcat('tTPi_',modname,'_Move_Multiple'), strcat('pTP_',modname,'_Move'),
25     2, ...
26     strcat('pTP_',modname,'_Move'), strcat('tTPi_',modname,'_Move_Multiple'),
27     1
28     };
29  png.set_of_Is = {
30     strcat('pTP_',modname,'_FaceUp_Pile'), strcat('tTPe_',modname,'_Turn'), 1
31     };

```

B.36 tableau_pile_4.pdf.m

```

1  function [png] = tableau_pile_4.pdf()
2  modname = '4';
3  png.PN_name = strcat('Tableau_Pile_',{ '_' },modname);
4
5  png.set_of_Ps = {strcat('pTP_',modname,'_FaceUp_Pile'), strcat('pTP_',modname,'
6  _FaceDown_Pile'), strcat('pTP_',modname,'_Move')};
7  png.set_of_Ts = {strcat('tTPe_',modname,'_Add_FaceUp'), strcat('tTPe_',modname,
8  '_Add_FaceDown'), strcat('tTPe_',modname,'_Move'), ...
9  strcat('tTPe_',modname,'_Turn'), strcat('tTPe_',modname,'_Out'), strcat('
10 tTPi_',modname,'_Move_Multiple')};
11 png.set_of_As = {
12     strcat('tTPe_',modname,'_Add_FaceUp'), strcat('pTP_',modname,'_FaceUp_Pile'
13     ), 1, ...
14     strcat('tTPe_',modname,'_Add_FaceDown'), strcat('pTP_',modname,'
15     _FaceDown_Pile'), 1, ...

```

```

11     strcat('tTPe_',modname,'_Turn'),strcat('pTP_',modname,'_FaceUp_Pile'),1,
12     strcat('pTP_',modname,'_FaceDown_Pile'), strcat('tTPe_',modname,'_Turn'),
13     1, ...
14     strcat('pTP_',modname,'_FaceUp_Pile'), strcat('tTPe_',modname,'_Out'), 1,
15     ...
16     strcat('tTPe_',modname,'_Move'), strcat('pTP_',modname,'_Move'), 1 ...
17     strcat('pTP_',modname,'_Move'), strcat('tTPe_',modname,'_Out'), 1, ...
18     strcat('tTPi_',modname,'_Move_Multiple'), strcat('pTP_',modname,'_Move'),
19     2, ...
20     strcat('pTP_',modname,'_Move'), strcat('tTPi_',modname,'_Move_Multiple'),
21     1
    };
    png.set_of_Is = {
    strcat('pTP_',modname,'_FaceUp_Pile'), strcat('tTPe_',modname,'_Turn'), 1
    };

```

B.37 tableau_pile_5_pdf.m

```

1 function [png] = tableau_pile_5_pdf()
2 modname = '5';
3 png.PN_name = strcat('Tableau_Pile_',{ '_' },modname);
4
5 png.set_of_Ps = {strcat('pTP_',modname,'_FaceUp_Pile'),strcat('pTP_',modname,'
6 _FaceDown_Pile'),strcat('pTP_',modname,'_Move')};
7 png.set_of_Ts = {strcat('tTPe_',modname,'_Add_FaceUp'),strcat('tTPe_',modname,
8 '_Add_FaceDown'),strcat('tTPe_',modname,'_Move'), ...
9 strcat('tTPe_',modname,'_Turn'),strcat('tTPe_',modname,'_Out'),strcat('
10 tTPi_',modname,'_Move_Multiple')};
11 png.set_of_As = {
12 strcat('tTPe_',modname,'_Add_FaceUp'),strcat('pTP_',modname,'_FaceUp_Pile'
13 ),1, ...
14 strcat('tTPe_',modname,'_Add_FaceDown'),strcat('pTP_',modname,'
15 _FaceDown_Pile'),1, ...
16 strcat('tTPe_',modname,'_Turn'),strcat('pTP_',modname,'_FaceUp_Pile'),1,
17 ...
18 strcat('pTP_',modname,'_FaceDown_Pile'), strcat('tTPe_',modname,'_Turn'),
19 1, ...
20 strcat('pTP_',modname,'_FaceUp_Pile'), strcat('tTPe_',modname,'_Out'), 1,
21 ...
22 strcat('tTPe_',modname,'_Move'), strcat('pTP_',modname,'_Move'), 1 ...
23 strcat('pTP_',modname,'_Move'), strcat('tTPe_',modname,'_Out'), 1, ...
24 strcat('tTPi_',modname,'_Move_Multiple'), strcat('pTP_',modname,'_Move'),
25 2, ...
26 strcat('pTP_',modname,'_Move'), strcat('tTPi_',modname,'_Move_Multiple'),
27 1
28 };
29 png.set_of_Is = {
30 strcat('pTP_',modname,'_FaceUp_Pile'), strcat('tTPe_',modname,'_Turn'), 1
31 };

```

B.38 tableau_pile_6_pdf.m

```

1 function [png] = tableau_pile_6_pdf()
2 modname = '6';
3 png.PN_name = strcat('Tableau_Pile_',{ '_' },modname);
4
5 png.set_of_Ps = {strcat('pTP_',modname,'_FaceUp_Pile'),strcat('pTP_',modname,'
6 _FaceDown_Pile'),strcat('pTP_',modname,'_Move')};
7 png.set_of_Ts = {strcat('tTPe_',modname,'_Add_FaceUp'),strcat('tTPe_',modname,
8 '_Add_FaceDown'),strcat('tTPe_',modname,'_Move'), ...
9 strcat('tTPe_',modname,'_Turn'),strcat('tTPe_',modname,'_Out'),strcat('
10 tTPi_',modname,'_Move_Multiple')};
11 png.set_of_As = {
12 strcat('tTPe_',modname,'_Add_FaceUp'),strcat('pTP_',modname,'_FaceUp_Pile'
13 ),1, ...
14 strcat('tTPe_',modname,'_Add_FaceDown'),strcat('pTP_',modname,'
15 _FaceDown_Pile'),1, ...

```

```

11      strcat('tTPe_',modname,'_Turn'), strcat('pTP_',modname,'_FaceUp_Pile'), 1,
12      strcat('pTP_',modname,'_FaceDown_Pile'), strcat('tTPe_',modname,'_Turn'),
13      1, ...
14      strcat('pTP_',modname,'_FaceUp_Pile'), strcat('tTPe_',modname,'_Out'), 1,
15      ...
16      strcat('tTPe_',modname,'_Move'), strcat('pTP_',modname,'_Move'), 1 ...
17      strcat('pTP_',modname,'_Move'), strcat('tTPe_',modname,'_Out'), 1, ...
18      strcat('tTPi_',modname,'_Move_Multiple'), strcat('pTP_',modname,'_Move'),
19      2, ...
20      strcat('pTP_',modname,'_Move'), strcat('tTPi_',modname,'_Move_Multiple'),
21      1
    };
    png.set_of_Is = {
    strcat('pTP_',modname,'_FaceUp_Pile'), strcat('tTPe_',modname,'_Turn'), 1
    };

```

B.39 tableau_pile_7_pdf.m

```

1  function [png] = tableau_pile_7_pdf()
2  modname = '7';
3  png.PN_name = strcat('Tableau_Pile_',{ '_' },modname);
4
5  png.set_of_Ps = {strcat('pTP_',modname,'_FaceUp_Pile'), strcat('pTP_',modname,'
6  _FaceDown_Pile'), strcat('pTP_',modname,'_Move')};
7  png.set_of_Ts = {strcat('tTPe_',modname,'_Add_FaceUp'), strcat('tTPe_',modname,
8  '_Add_FaceDown'), strcat('tTPe_',modname,'_Move'), ...
9  strcat('tTPe_',modname,'_Turn'), strcat('tTPe_',modname,'_Out'), strcat('
10 tTPi_',modname,'_Move_Multiple')};
11 png.set_of_As = {
12 strcat('tTPe_',modname,'_Add_FaceUp'), strcat('pTP_',modname,'_FaceUp_Pile'
13 ), 1, ...
14 strcat('tTPe_',modname,'_Add_FaceDown'), strcat('pTP_',modname,'
15 _FaceDown_Pile'), 1, ...
16 strcat('tTPe_',modname,'_Turn'), strcat('pTP_',modname,'_FaceUp_Pile'), 1,
17 ...
18 strcat('pTP_',modname,'_FaceDown_Pile'), strcat('tTPe_',modname,'_Turn'),
19 1, ...
20 strcat('pTP_',modname,'_FaceUp_Pile'), strcat('tTPe_',modname,'_Out'), 1,
21 ...
22 strcat('tTPe_',modname,'_Move'), strcat('pTP_',modname,'_Move'), 1 ...
23 strcat('pTP_',modname,'_Move'), strcat('tTPe_',modname,'_Out'), 1, ...
24 strcat('tTPi_',modname,'_Move_Multiple'), strcat('pTP_',modname,'_Move'),
25 2, ...
26 strcat('pTP_',modname,'_Move'), strcat('tTPi_',modname,'_Move_Multiple'),
27 1
28 };
29 png.set_of_Is = {
30 strcat('pTP_',modname,'_FaceUp_Pile'), strcat('tTPe_',modname,'_Turn'), 1
31 };

```

B.40 tDPe_Move_pre.m

```

1  function [fire, transition] = tDPe_Move_pre(transition)
2
3  fire = 0;
4  if ~isempty(tokIDs('pDP_Draw_FaceUp_Pile')),
5      fire = 1;
6  end

```

B.41 tDPe_Out_pre.m


```

1 function [fire, transition] = tDPe_Out_pre(transition)
2
3 % Want to make sure that we get the earliest move-token, and the latest
4 % card. This is so that we can have a natural ordering of the cards during
5 % the initial dealing.
6 moveToken = tokenArrivedEarly('pDP_Move_Out', 1);
7 % Explicitly sure to get the card at the top of the stack.
8 cardToken = tokenArrivedLate('pDP_Draw_FaceUp_Pile', 1);
9
10 transition.selected_tokens = [moveToken cardToken];
11 fire = 1;

```

B.42 tDPi_Dealer_pre.m

```

1 function [fire, transition] = tDPi_Dealer_pre(transition)
2
3 global global_info;
4 fire = 0;
5 if isempty(global_info.DECK),
6     if global_info.RANDOMDECK,
7         card = randi([1, length(global_info.DECK)]);
8     else,
9         card = 1;
10    end;
11    transition.new_color = global_info.DECK(card);
12    global_info.DECK(card) = []; % Remove this card from the array
13    fire = 1;
14 end;

```

B.43 tDPi_Enable_FP_Trans_post.m

```

1 function [] = tDPi_Enable_FP_Trans_post(transition)
2
3 global global_info;
4 if isempty(tokIDs('pDP_Draw_FaceUp_Pile')),
5     global_info.DP_Flip_Pile_Running = true;
6 else
7     % Release playerAction resource to allow for another player action.
8     release(global_info.last_command_source);
9 end;

```

B.44 tDPi_Flip_Pile_post.m

```

1 function [] = tDPi_Flip_Pile_post(transition)
2
3 global global_info;
4 if isempty(tokIDs('pDP_Draw_FaceUp_Pile')),
5     global_info.DP_Flip_Pile_Running = false;
6     global_info.SCORE = max(global_info.SCORE - 100, 0);
7     % Release playerAction resource to allow for another player action.
8     release(global_info.last_command_source);
9 end;

```

B.45 tDPi_Flip_Pile_pre.m

```

1 function [fire, transition] = tDPi_Flip_Pile_pre(transition)
2
3 global global_info;
4 fire = 0;
5 if global_info.DP_Flip_Pile_Running == true,
6     transition.selected_tokens = tokenArrivedLate('pDP_Draw_FaceUp_Pile', 1);
7     fire = 1;
8 end

```

B.46 tDPi_Move_Init_pre.m

```

1 function [fire, transition] = tDPi_Move_Init_pre(transition)
2
3 global global_info;
4
5 fire = 0;
6 if ~isempty(global_info.INITIAL_DEAL_MOVE),
7     transition.new_color = strcat('Move:TP', num2str(global_info.
8         INITIAL_DEAL_MOVE{1}), ':DP');
9     global_info.INITIAL_DEAL_MOVE(1) = [];
10    fire = 1;
11 end;

```

B.47 tDPi_Turn_post.m

```

1 function [] = tDPi_Turn_post(transition)
2
3 global global_info;
4
5 % Release playerAction resource to allow for another player action.
6 if isfield(global_info, 'last_command_source'),
7     release(global_info.last_command_source);
8 end;

```

B.48 tDPi_Turn_pre.m

```

1 function [fire, transition] = tDPi_Turn_pre(transition)
2
3 global global_info;
4 fire = 0;
5 dealer_trans = get_trans('tDPi_Dealer');
6 % Make sure the dealer transition has fired enough times. Simply having an
7 % inhibitor arc is not enough as this transition seems to fire before all
8 % tokens are in the face-down pile.
9 if dealer_trans.times_fired == global_info.INITIAL_DECK_LENGTH,
10    topFD = tokenArrivedLate('pDP_Draw_FaceDown_Pile', 1);
11    transition.selected_tokens = topFD;
12    fire = 1;
13    if (global_info.DISP_CHANGES && global_info.CARDS_DEALT >= global_info.
14        INITIAL_DEAL_MOVE_LENGTH),
15        color = get_color('pDP_Draw_FaceDown_Pile', topFD);
16        disp(strcat('Turned_card', {'_'} , color{1}, {'_'} , 'at', {'_DP'}));
17    end;
18 end;

```

B.49 tMC_DP_Move_Siphon_pre.m

```

1 function [fire, transition] = tMC_DP_Move_Siphon_pre(transition)
2
3 % Siphon for the DP Move command. Should not attempt to move if there are
4 % no tokens in the FaceUp pile.
5 fire = 0;
6 if isempty(tokIDs('pDP_Draw_FaceUp_Pile')),
7     fire = 1;
8 end

```

B.50 tMC_FP_Move_Siphon_pre.m

```

1 function [fire, transition] = tMC_FP_Move_Siphon_pre(transition)
2
3 % Siphon for the FP Move command. Checks the length of the command, and if
4 % the length is valid, it will check if the destination is valid.
5
6 global global_info;
7
8 fire = 0;
9 moveToken = tokenArrivedLate('pMC_FP_Move',1);
10 [moveCmd, ~] = splitCommand(get_color('pMC_FP_Move',moveToken));
11
12 if(length(moveCmd) < 3 || ~ismember(moveCmd{3}, global_info.FP.PILES)),
13     transition.selected_tokens = moveToken;
14     fire = 1;
15 end

```

B.51 tMC_Out_Buffer_Siphon_pre.m

```

1 function [fire, transition] = tMC_Out_Buffer_Siphon_pre(transition)
2
3 % Siphon for the Out command from all modules. Will first check if the
4 % length of the command is correct, and then if the destination is valid.
5
6 global global_info;
7
8 fire = 0;
9 if global_info.CARDS_DEALT < global_info.INITIAL_DEAL_MOVE_LENGTH,
10     return;
11 end;
12
13 moveToken = tokenArrivedEarly('pMC_Out_Buffer',1);
14 tokenColor = get_color('pMC_Out_Buffer',moveToken);
15 [command, ~] = splitCommand(tokenColor);
16
17 if length(tokenColor) ~= 2 || ~ismember(command{2}, global_info.FP_TP.PILES),
18     transition.selected_tokens = moveToken;
19     fire = 1;
20     return;
21 end;

```

B.52 tMC_TP_Move_Siphon_pre.m

```

1 function [fire, transition] = tMC_TP_Move_Siphon_pre(transition)
2
3 % Siphon for the TP Move command. Checks the length of the command, and if
4 % the length is valid, it will check if the destination is valid.
5
6 global global_info;
7
8 fire = 0;
9 moveToken = tokenArrivedLate('pMC_TP_Move',1);
10 moveColor = get_color('pMC_TP_Move',moveToken);
11 [moveCmd, ~] = splitCommand(moveColor);
12
13 if length(moveCmd) < 4 || ~ismember(moveCmd{3}, global_info.TP.PILES),
14     transition.selected_tokens = moveToken;
15     fire = 1;
16 end;

```

B.53 tMC_TP_Turn_Siphon_pre.m

```

1 function [fire, transition] = tMC_TP_Turn_Siphon_pre(transition)
2
3 % Siphon for the TP Turn command. Checks the length of the command, and if
4 % the length is valid, it will check if the destination is valid.
5
6 global global_info;
7
8 fire = 0;
9 moveToken = tokenArrivedLate('pMC_TP_Turn',1);
10 moveCmd = get_color('pMC_TP_Turn',moveToken);
11
12 if length(moveCmd) < 1,
13     fire = 1;
14 else,
15     cmdSplit = strsplit(moveCmd{1},':');
16     if length(cmdSplit) ~= 2 || ~ismember(cmdSplit{2}, global_info.TP.PILES),
17         transition.selected_tokens = moveToken;
18         fire = 1;
19     end;
20 end;

```

B.54 tPBe_DP_Move_pre.m

```

1 function [fire, transition] = tPBe_DP_Move_pre(transition)
2
3 global global_info;
4 fire = 0;
5 if global_info.CARDS_DEALT < global_info.INITIAL_DEAL_MOVE_LENGTH,
6     return;
7 end;
8 moveToken = tokenArrivedLate('pPB_Cmd', 1);
9 if isempty(moveToken),
10     return;
11 end;
12 moveColor = get_color('pPB_Cmd', moveToken);
13
14 [playerAction] = request(transition.name, {'playerAction', 1});
15 if strcmp(moveColor, 'DP_Move') && playerAction,
16     movesLeft = length(global_info.BOT_DP_MOVES);
17     if movesLeft == 0,
18         global_info.BOT_ACTIONS.NEW_CMD = 1;
19         return;
20     end
21
22     vistoken = tokenArrivedLate('pDP_Draw_FaceUp_Pile',1);
23     if ~vistoken,
24         global_info.BOT_ACTIONS.NEW_CMD = 1;
25         return;
26     end;
27     moveTo = randi(movesLeft);
28     dest = global_info.BOT_DP_MOVES{moveTo};
29     command = strcat('Move:',dest,':DP');
30
31     color = get_color('pDP_Draw_FaceUp_Pile',vistoken);
32     color = color{1};
33
34     if checkCommand.Move({command;color},' ', transition.name, 'DP_ErrorMsg'),
35         transition.selected_tokens = moveToken;
36         transition.new_color = command;
37         transition.override = 1;
38         fire = 1;
39         return;
40     end;
41     global_info.BOT_DP_MOVES(moveTo) = [];
42 end;

```

B.55 tPBe_DP_Turn_pre.m

```

1 function [fire, transition] = tPBe_DP_Turn_pre(transition)
2
3 global global_info;
4 fire = 0;
5 if global_info.CARDS_DEALT < global_info.INITIAL_DEAL_MOVE_LENGTH,
6     return;
7 end;
8 moveToken = tokenArrivedLate('pPB_Cmd', 1);
9 if isempty(moveToken),
10     return;
11 end;
12 moveColor = get_color('pPB_Cmd', moveToken);
13
14 [playerAction] = request(transition.name, {'playerAction', 1});
15 if strcmp(moveColor, 'DP_Turn') && playerAction,
16     if isempty(tokIDs('pDP_Draw_FaceDown_Pile')) && ...
17         isempty(tokIDs('pDP_Draw_FaceUp_Pile')),
18         global_info.BOT_ACTIONS.NEW_CMD = 1;
19         return;
20     end;
21     global_info.last_command_source = transition.name;
22     transition.selected_tokens = moveToken;
23     transition.override = 1;
24     fire = 1;
25 end;

```

B.56 tPBe_FP_Move_pre.m

```

1 function [fire, transition] = tPBe_FP_Move_pre(transition)
2
3 global global_info;
4 fire = 0;
5 if global_info.CARDS_DEALT < global_info.INITIAL_DEAL_MOVE_LENGTH,
6     return;
7 end;
8 moveToken = tokenArrivedLate('pPB_Cmd', 1);
9 if isempty(moveToken),
10     return;
11 end;
12 moveColor = get_color('pPB_Cmd', moveToken);
13 moveColor = moveColor{1};
14 [playerAction] = request(transition.name, {'playerAction', 1});
15 if ~isempty(strfind(moveColor, 'FP_Move')) && playerAction,
16     movesLeft = length(global_info.BOT_FP_MOVES);
17     if movesLeft == 0,
18         global_info.BOT_ACTIONS.NEW_CMD = 1;
19         return;
20     end
21     cmd_split = strsplit(moveColor, ':');
22     suit_abbr = cmd_split{2};
23     global_suit = global_info.SUITS.(suit_abbr);
24     vistoken = tokenArrivedLate(strcat('pFP_', global_suit{1}, '_Pile'), 1);
25     if ~vistoken,
26         global_info.BOT_ACTIONS.NEW_CMD = 1;
27         return;
28     end;
29     moveTo = randi(movesLeft);
30     dest = global_info.BOT_FP_MOVES{moveTo};
31
32     command = strcat('Move:', dest, strcat(':', suit_abbr));
33
34     color = get_color(strcat('pFP_', global_suit{1}, '_Pile'), vistoken);
35     color = color{1};
36     if checkCommand_Move({command; color}, '', transition.name, strcat('FP_',
37         suit_abbr, '_ErrorMsg')),
38         transition.selected_tokens = moveToken;
39         transition.new_color = command;
40         transition.override = 1;
41         fire = 1;
42         return;

```

```

42     end;
43     global_info.BOT_FP_MOVES(moveTo) = [];
44 end;

```

B.57 tPBe_TP_Move_pre.m

```

1  function [fire , transition] = tPBe_TP_Move_pre(transition)
2
3  global global_info;
4  fire = 0;
5  if global_info.CARDS_DEALT < global_info.INITIAL_DEAL_MOVE_LENGTH,
6      return;
7  end;
8  moveToken = tokenArrivedLate('pPB_Cmd', 1);
9  if isempty(moveToken),
10     return;
11 end;
12 moveColor = get_color('pPB_Cmd', moveToken);
13 moveColor = moveColor{1};
14 [playerAction] = request(transition.name, {'playerAction', 1});
15 if ~isempty(strfind(moveColor, 'TP_Move')) && playerAction,
16     movesLeft = length(global_info.BOT_TP_MOVES);
17     if movesLeft == 0,
18         global_info.BOT_ACTIONS.NEW_CMD = 1;
19         return;
20     end
21     cmd_split = strsplit(moveColor, ':');
22     tableau = cmd_split{2};
23     lenTokens = length(tokIDs(strcat('pTP_', tableau, '_FaceUp_Pile')));
24
25     if lenTokens == 0,
26         if ~isempty(tokIDs(strcat('pTP_', tableau, '_FaceDown_Pile'))),
27             global_info.BOT_NEXT_CMD = strcat('TP_Turn:', tableau);
28         end;
29         global_info.BOT_ACTIONS.NEW_CMD = 1;
30         return;
31     end;
32     moveTo = randi(movesLeft);
33     dest = global_info.BOT_TP_MOVES{moveTo};
34     if strcmp(dest, tableau),
35         global_info.BOT_TP_MOVES(moveTo) = [];
36         moveTo = randi(movesLeft);
37         dest = global_info.BOT_TP_MOVES{moveTo};
38     end;
39
40     % 20% of the time the bot will attempt to move partial amount of cards.
41     % 80% of the time it will attempt to move all.
42     if lenTokens > 1 && ismember(dest, global_info.TP_PILES),
43         if randi(100) <= global_info.BOT_ACTIONS.TP_FULL_PARTIAL_MOVE,
44             amount = lenTokens;
45         else,
46             amount = randi(lenTokens-1);
47         end
48     else,
49         amount = 1;
50     end;
51     command = strcat('Move:', dest, ':TP', tableau, ':', num2str(amount));
52
53     % The top card to be moved is used to check validity of the command.
54     vistoken = tokenArrivedLate(strcat('pTP_', tableau, '_FaceUp_Pile'), amount);
55     ;
56     vistoken = vistoken(amount);
57     color = get_color(strcat('pTP_', tableau, '_FaceUp_Pile'), vistoken);
58     color = color{1};
59     if checkCommand.Move({command; color}, '', transition.name, strcat('TP_',
60         tableau, '_ErrorMsg')),
61         transition.selected_tokens = moveToken;
62         transition.new_color = command;
63         transition.override = 1;
64         fire = 1;
65         return;
66     end;

```

```

66     global_info.BOT_TP_MOVES(moveTo) = [];
67 end;

```

B.58 tPBe_TP_Turn_pre.m

```

1 function [fire, transition] = tPBe_TP_Turn_pre(transition)
2
3 global global_info;
4 fire = 0;
5 if global_info.CARDS.DEALT < global_info.INITIAL_DEAL_MOVE_LENGTH,
6     return;
7 end;
8 moveToken = tokenArrivedLate('pPB_Cmd', 1);
9 if isempty(moveToken),
10     return;
11 end;
12
13 moveColor = get_color('pPB_Cmd', moveToken);
14 moveColor = moveColor{1};
15
16 [playerAction] = request(transition.name, {'playerAction', 1});
17 if ~isempty(strfind(moveColor, 'TP_Turn')) && playerAction,
18
19     cmd_split = strsplit(moveColor, ':');
20     tableau = cmd_split{2};
21     if ~isempty(tokIDs(strcat('pTP_', tableau, '_FaceUp_Pile')) || ...
22         isempty(tokIDs(strcat('pTP_', tableau, '_FaceDown_Pile'))),
23
24         global_info.BOT_ACTIONS.NEW_CMD = 1;
25         return;
26     end;
27
28     command = strcat('Turn:TP', tableau);
29
30     global_info.last_command_source = transition.name;
31     transition.selected_tokens = moveToken;
32     transition.new_color = command;
33     transition.override = 1;
34     fire = 1;
35     return;
36 end;

```

B.59 tPBi_Gen_pre.m

```

1 function [fire, transition] = tPBi_Gen_pre(transition)
2
3 fire = 0;
4 global global_info;
5 global PN;
6 if global_info.CARDS.DEALT < global_info.INITIAL_DEAL_MOVE_LENGTH,
7     return;
8 end;
9 % Only one resource used, thus we can check directly in the internal
10 % data structure of the resource.
11 if global_info.BOT_ENABLED && global_info.BOT_ACTIONS.NEW_CMD && ...
12     PN.system_resources.instance_usage(1,1) == 0,
13     if isempty(global_info.BOT_NEXT_CMD),
14         rndNum = randi(100);
15         source = '';
16         if rndNum <= global_info.BOT_ACTIONS(1) && ...
17             ~strcmp(global_info.BOT_LAST_CMD, 'DP_Turn'),
18             action = 'DP_Turn';
19         elseif rndNum <= global_info.BOT_ACTIONS(2) && ...
20             ~strcmp(global_info.BOT_LAST_CMD, 'DP_Move'),
21             action = 'DP_Move';
22
23         if randi(100) <= global_info.BOT_ACTIONS.TP_FP,
24             global_info.BOT_DP_MOVES = global_info.TP_PILES;
25         else,

```

```

26         global_info.BOT_DP_MOVES = global_info.FP_PILES;
27     end
28     elseif rndNum <= global_info.BOT_ACTIONS(3) && ...
29         ~strcmp(global_info.BOT_LAST_CMD, 'FP_Move'),
30         action = 'FP_Move';
31         suits = {'C', 'D', 'H', 'S'};
32         source = suits(randi(length(suits)));
33         global_info.BOT_FP_MOVES = global_info.TP_PILES;
34     elseif rndNum <= global_info.BOT_ACTIONS(4) && ...
35         ~strcmp(global_info.BOT_LAST_CMD, 'TP_Turn'),
36         action = 'TP_Turn';
37         source = strcat(':', num2str(randi(7)));
38     else
39         action = 'TP_Move';
40         source = strcat(':', num2str(randi(7)));
41         if randi(100) <= global_info.BOT_ACTIONS_TP_FP,
42             global_info.BOT_TP_MOVES = global_info.TP_PILES;
43         else,
44             global_info.BOT_TP_MOVES = global_info.FP_PILES;
45         end
46     end;
47     transition.new_color = strcat(action, source);
48 else,
49     transition.new_color = global_info.BOT_NEXT_CMD;
50 end;
51
52 % Reset ongoing commands.
53 global_info.BOT_ACTIONS_NEW_CMD = 0;
54 global_info.BOT_NEXT_CMD = '';
55
56 transition.override = 1;
57 fire = 1;
58 end;

```

B.60 tPBi_Gen_Stop_pre.m

```

1 function [fire, transition] = tPBi_Gen_pre(transition)
2
3 global global_info;
4 fire = 0;
5 if ~global_info.BOT_ENABLED,
6     fire = 1;
7 end;

```

B.61 tPBi_Siphon_pre.m

```

1 function [fire, transition] = tPBi_Siphon_pre(transition)
2
3 % Remove unused commands from pPB_Cmd.
4 global global_info;
5 fire = 0;
6 if length(tokIDs('pPB_Cmd')) > 1 || ~global_info.BOT_ENABLED,
7     transition.selected_tokens = tokenArrivedEarly('pPB_Cmd', 1);
8     fire = 1;
9 end;

```

B.62 tPe_DP_Move_pre.m

```

1 function [fire, transition] = tPe_DP_Move_pre(transition)
2
3
4 global global_info;
5 fire = 0;
6 if global_info.CARDS_DEALT < global_info.INITIAL_DEAL_MOVE_LENGTH,

```



```

7         return;
8     end;
9
10    [playerAction] = request(transition.name, {'playerAction', 1});
11    if global_info.DP_Move.Btn ~= false && playerAction,
12        global_info.DP_Move.Btn = false;
13        dest = upper(get_handle('DP_Move_Location','String'));
14        command = strcat('Move:',dest,':DP');
15        vistoken = tokenArrivedLate('pDP_Draw_FaceUp_Pile',1);
16        if vistoken,
17            color = get_color('pDP_Draw_FaceUp_Pile',vistoken);
18            color = color{1};
19
20            if checkCommand.Move({command;color},' ',transition.name,'DP_ErrorMsg')
21                ,
22                transition.new_color = command;
23                fire = 1;
24            end;
25        end;
26    end
27end

```

B.63 tPe_DP_Turn_pre.m

```

1 function [fire, transition] = tPe_DP_Turn_pre(transition)
2
3 global global_info;
4 pause(0.01); % Halts execution in the main loop to allow to check for events.
5 fire = 0;
6 if global_info.CARDS_DEALT < global_info.INITIAL_DEAL_MOVE_LENGTH,
7     return;
8 end;
9
10 [playerAction] = request(transition.name, {'playerAction', 1});
11 if global_info.DP_Turn.Btn ~= false && playerAction,
12     global_info.DP_Turn.Btn = false;
13     global_info.last_command_source = transition.name;
14     fire = 1;
15 end;

```