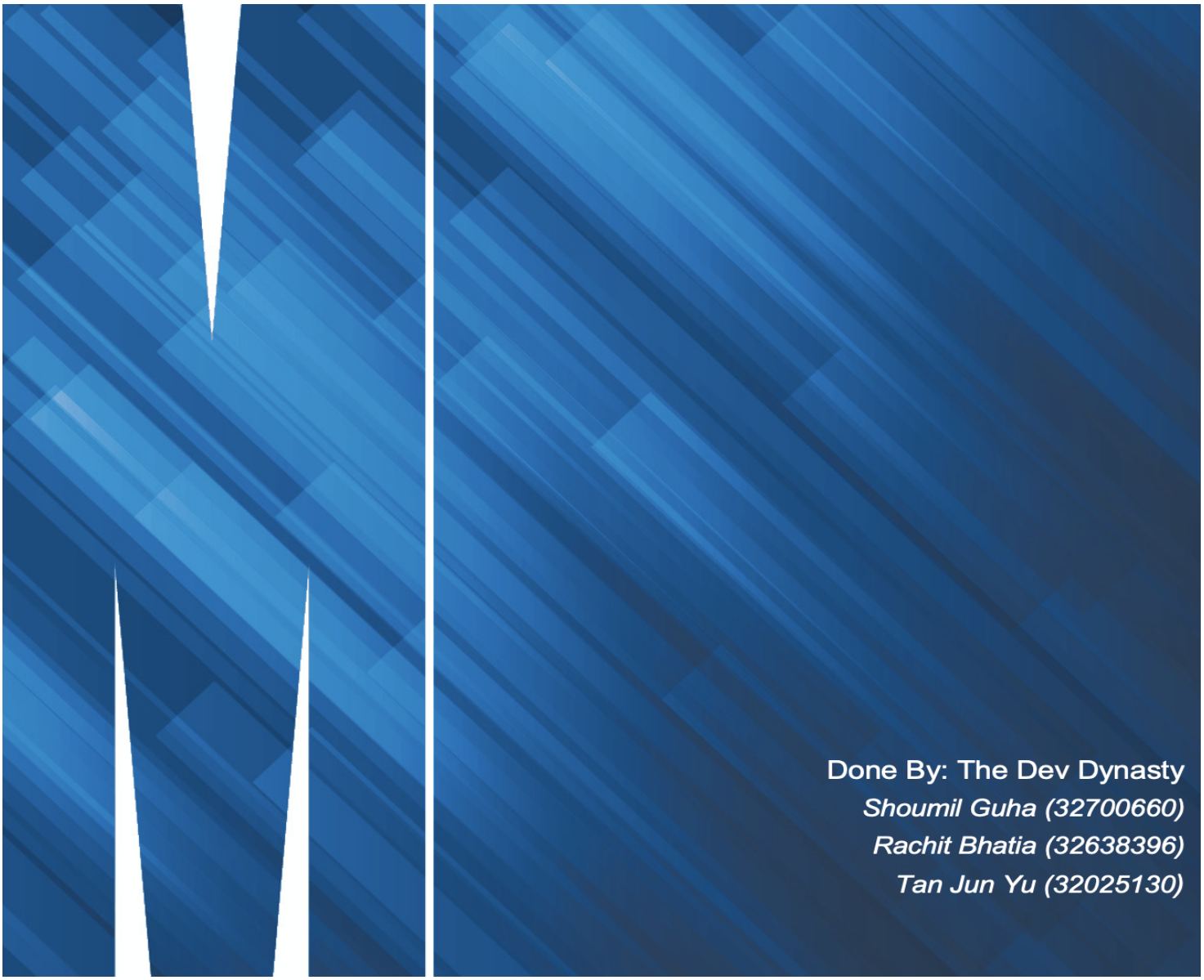
MONASH University

FIT3077
SPRINT 4: FINAL PRODUCT DELIVERY



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Choice of Advanced Requirement

Playing against Computer Feature:
“A single player may play against the computer, where the computer will randomly play a move among all of the currently valid moves for the computer, or any other set of heuristics of your choice”

9MM: User Stories

The user stories have been modified from Sprint 1 and listed below. The user stories for the *advanced feature of playing against the computer* have been provided with task descriptions to give more details.

1. As a game client, I want each player to be allocated with 9 tokens initially, so that they can use these tokens to make their moves throughout the game.
2. As a game board, I want to have 24 intersection points, so that the players can place their respective tokens on them and track the progress of the game.
3. As a token, I want to be differently coloured from the opponent player’s tokens, so that my player can distinctly track their moves.
4. As a player, I want to take alternate turns with my opponent, so that the game is fair and each player gets an equal number of moves.
5. As a game client, I want a mill to be formed when 3 tokens are placed together along a line on the board, so that the player with the mill gets an advantage.
6. As a token, I want to be able to slide along the board line to an adjacent empty intersection, so that my player can position me strategically.
7. As a game client, I want a player to be declared as the winner when the opponent has less than 3 tokens left on the board, so that the game can come to a conclusion.
8. As a player, I want to remove one of my opponent's tokens from the board after forming a mill, so that I can reduce my opponent’s winning chances.
9. As a token, I want to be able to fly to any empty intersection when there are only 3 of my instances left on the board, so that it becomes more challenging for the opposing tokens to block my mill.
10. As a player, I want to be able to play the game with an opponent on the same device and application, so that I can enjoy a streamlined multiplayer game experience.

Advanced Feature: Play against Computer

11. **As a player, I want to be able to start a game against a computer bot, so that I can practice and enjoy playing individually**

    Tasks Involved:

    a. Create a new separate game board view for playing with CPU
    b. Create a button which loads this view and add it to home page

12. **As a computer bot, I want to be able to make every possible valid move in the game and take completely random decisions to ensure a fair and simple gaming experience**

    Tasks Involved:

    a. Create methods for generating random moves of each valid move type in the game (placing, sliding, flying, removing)
    b. Add mill formation functionality to Computer Player's tokens

13. **As a computer bot, I want to take a fixed response time before every move, so that the player gets a more realistic experience while being able to observe the state of the game clearly**

    Tasks Involved:

    a. Ensure that the game loop is running in a separate background thread to allow UI changes to happen smoothly without overloading the main thread
    b. Add a time delay before each move Computer Player makes a move by forcing the background thread to sleep for a fixed amount of seconds (2 seconds)
    c. Add an additional delay between formation of mill by Computer Player and removal of random token (5 seconds)

UML CLASS DIAGRAM

Note: New additions have been shown in green, while deletions/replacements have been shown in red. All the other colours used in the arrow lines are merely for clear distinction between overlapping lines and do not signify anything specific

ARCHITECTURE & DESIGN RATIONALE

1. What has changed and Why has it changed?

Type of Change	Changes	Justification
New Method	Added addImage() function as a new method in MainPagePanel class	This method is added to remove code duplication in the class. The MainPagePanel is responsible for the homepage of the application, and it contains 2 different images (one for background and one for title). Since the addition of an image has the exact same code with a few different parameters like size and positioning, the code block was converted into a method to prevent code repetition, thus following the DRY principle.
New Attribute	Added millLabel as a new attribute in MainWindow class	This is needed to display a message to inform the user that a mill is formed. The message regarding mill formation is displayed to avoid confusion and inform the players about the state of the game. It is made a static variable so that its value can be modified via MillChecker class where it is actually needed to be displayed. It is an attribute of MainWindow because all the display elements are inside this class. So to ensure consistency, millLabel was also added in MainWindow.
New Method	Added voidInstance() as a new method in the following classes: MainWindow, GameBoard, Game	This function is added as a result of adding the new feature of returning back to homepage and then starting a new game. This function nullifies the states of the current instances of MainWindow, GameBoard, and Game Since all 3 of these classes use singleton instances, setting their instance to null is a way to reset their state so that whenever a new game is started, getInstance() will be called and that will create a new instance. This state reset helps to enable the feature of returning to the homepage and starting a new game.
New Method	Added generateButton() as a new method in MainWindow class	This method is used to create a new button. Although this method is only used once to create the ‘Return’ button, the code block was still put inside a method to enhance modularity. Since

		this is a newly added button, the code was put inside the addAllItems() function initially, however, that function already handles addition of several components. Thus, to avoid a god method, the code for creating a button with the reset function was modularised into a separate method.
New Method	Added getMillLabel() as a new method in MainWindow class	Getter method for newly created JLabel millLabel
New Attribute	Added protected attribute isComputer in Player class	This attribute is added to recognise if the player is a computer player or not. A True value is used to identify a computer player. Its visibility is set to protected to ensure it is shared with the child class i.e. ComputerPlayer. The need for the attribute arose when specific actions had to be modified when the current player was a computer player type.
New Method	Added typeIsComputer() method in Player class	The getter method for isComputer
New Method	Added generateRandomNumber(int) as a new method in ComputerPlayer class	This method is required to generate a random number within a given range in order to perform a random move including SLIDING,FLYING and PLACING. The random number is used to select a random intersection point among the valid intersection points. This is needed as a method as its implementation is used in two different places which are the generateRandomSlidingMove() and generateRandomFlyingPlacingMove(). Hence, repeated code can be avoided and DRY principle will not be violated.
New Method	Added new method produceDelay(int) in ComputerPlayer class	This method is added to make the background thread sleep for a fixed amount of seconds to introduce fixed time delays between computer player's moves. The time delays were introduced to make the player's experience with computer more engaging and easier to follow
New Signature of Method	Added a new parameter to an existing method checkMill(intersectionPoint) to checkMill(intersectionPoint,boolean)	The boolean parameter is needed to identify if the mill is formed by a normal Player or ComputerPlayer. This differentiates the display message to be shown when a mill is formed as the display message is different when a ComputerPlayer forms a mill.

Class Removed	HumanPlayer class removed from the architecture	It was realised that this class was redundant as it did not have any of its own unique implementations and completely used inherited components from the Player class. Hence, this class was removed from the architecture and the usage of HumanPlayer was replaced with Player by converting the Player class from abstract to concrete and shifting the entire implementation of setPlayerTurn() inside the Player class itself.
Dependency Relationships removed	The dependencies of RemoveMove to MillChecker, IntersectionPoint, and GameBoard were removed	These dependencies were removed by introducing a new interface TokenRemoval and shifting the token removal code block inside this interface.
New Interface Created	TokenRemoval interface created with new default method performRemoval(Token)	New interface created to contain the method responsible for removal of a token. The interface contains a default method performRemoval which is responsible for token removal from the game. This method was shifted from RemoveMove to a new interface because the exact same code block was used by the ComputerPlayer class for token removal. ComputerPlayer couldn't have had a dependency to RemoveMove because RemoveMove is created for Token type only, and creating dependencies using dummy instances is a bad practice as it leads to unnecessary coupling. Furthermore, according to the Dependency-Inversion Principle, high-level modules should depend on abstractions rather than low level modules, hence creating a new interface is a better design choice since a lot of dependencies between RemoveMove and other concrete classes are now removed. This could have been done using an abstract class because ComputerClass already inherits from Player class, and since there can be only 1 inheritance but multiple interface implementation, the interface design was chosen over an abstract class.

New implement interface relationships	ComputerPlayer and RemoveMove implement the TokenRemoval interface	The interface is implemented by both of these classes because both use the functionality in the performRemoval function for token removal.
New Dependency Relationships	The interface TokenRemoval has dependencies to Player, Token, Game, GameBoard, IntersectionPoint, MillChecker	These dependencies are there for the token removal part since communication is needed between multiple classes to remove a token. However, these dependencies are from an abstraction, hence, the coupling is not very strong.

2. Why was the advanced requirement designed this way?

The advanced requirement of being able to play against the computer was designed to be a singular class ComputerPlayer which would extend from a Player class. It was designed in this manner because a computer player performs the exact same operations as a human player, hence it was clear that human player and computer player would have several similarities in their implementations. Making ComputerPlayer a child class helped in easy extension of Player functionalities through inheritance. The setPlayerTurn() function was overridden from the Player class to create a unique implementation suiting the random moves generated by the Computer. Implementing it as a child class had an advantage of reusing a scaffold already developed for Player. Since the Player class was already developed with all of its uses, it was easy to follow the same structure and include the relevant methods into the ComputerPlayer class.

Furthermore, the implementation of the Computer function through its own separate class allowed for further re-usage of already developed features for the normal mode. By modelling it into a class, we were able to reuse the interfaces that were developed for the normal functionality of the game. For example, NeighbourPositionFinder was reused so that a random sliding move could be generated easily by just reusing the code. This greatly reduced code redundancy and duplication, and made it easier to manage the entire codebase.

An alternative design would be breaking down the class into smaller child classes which inherit from an abstract class which in turn inherits from the Player class. Each child class would then be responsible for its own random generation function. While this follows the Single Responsibility principle, it makes the code more complex due to the addition of multiple unnecessary classes. Not having all functions in a single class makes the system harder to maintain since multiple extra classes will need to be documented and there will be greater dependencies within the system from one class to multiple child classes of ComputerPlayer. Hence, the design we implemented is a better option since its more maintainable.

3. When was the advanced feature finalised and How Easy was it to implement?

The advanced feature remains the same as the one we had finalised in Sprint 1 which is having an additional option of playing against a Computer other than just player against player. It was very easy to implement this advanced feature in this final Sprint as our earlier code design accommodates the extensibility of the application very well .

Evidence :

1. Player and ComputerPlayer are separated into the different classes
   In order to implement the features of the ComputerPlayer, new code implementations are only needed to be added into the ComputerPlayer class without interfering with the current code base. No changes were made to the code of Player which ensures that the existing system behaviour is not disrupted even if new bugs were introduced from the new implementations.

2. MillChecker as an interface
   Since whenever ComputerPlayer makes a move, a mill formed detection is needed. Having MillChecker as an interface was a great design as all we needed to do was just calling the methods from the MillChecker interface that is previously only used by the normal Player without having to repeat any redundant code or re-implementing code of similar operations .

3. NeighbourPositionFinder as an interface
   In order for the ComputerPlayer to perform a random sliding move, it is required to identify the adjacent intersection points of the intersection point that the randomly selected token is in. This is done by just calling the findNeighbouringIntersections(IntersectionPoint) method in the NeighbourPositionFinder interface without having to repeat any redundant code or re-implementing code of similar operations.

4. Why is there a self-reference in the Game class?

The Game class is using the singleton design pattern due to which it stores a static variable ‘instance’ of type Game. It needs this instance of itself so that the same instance of Game is used throughout the Game. The Game class methods and attributes are accessed by other classes and are needed in multiple different operations of the Game. For example, both the Player attributes need to be accessed to check which Player a particular token belongs to (this check is done in between the Moves). The incrementTurn() function is used by Move and ComputerPlayer classes to increment the current turn number so that the next player can make their move. In order to access these methods and attributes, the Game class instance needs to be accessed and the same instance should be accessed to ensure consistent state throughout a particular game. Hence, using a singleton instance by maintaining Game class to have an instance of itself is necessary.

The alternative would be to make all methods and attributes static inside the Game class so that they belong to the class rather than a particular attribute, however, that reduces maintainability since the dependencies between instances is easier to track and manage as compared to dependencies directly to a class. Additionally, having too many static variables and methods also violates the Object-Oriented programming style since static methods are harder to extend in the future which limits flexibility.

GAME SCENARIO SCREENSHOTS