Application of Decision Tree to Win at Five Nights at Freddy's Video Game

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Abstract—**Five Nights at Freddy's is a video game where the player tries to survive without being attacked by the five enemies in the game until a certain amount of time. Each of these five enemies have their own pattern of behaviors and the player can do certain actions based on the enemies' behaviors to prevent them from attacking. A decision tree is a decision support tool to help in making decisions for a problem by listing the conditions and the decisions that would follow those conditions for that certain problem. This paper discusses the application of decision tree to help the player win at the video game Five Nights at Freddy's.**

Keywords—**Decision tree, Five Nights at Freddy's, Tree, Video Game**

I. Introduction

Five Nights at Freddy's is a survival horror video game developed and published by Scott Cawthon. In this game, the player acts as a night security guard for a restaurant where they must guard themselves from the haunted animatronics roaming the restaurant. In order to win at the game, the player must survive their night shift that lasts from midnight to 6:00 a.m. without being attacked by any of the five animatronics in the game.

Figure 1. Screenshot of Five Nights at Freddy's gameplay (store.steampowered.com/app/319510/Five_Nights_at_Freddy, accessed on December 10, 2020)

The players can only do few actions in this game which are activating the camera monitor to look through security cameras, deactivating the camera monitor, pressing the light button on the left or right door to turn on the light on the left or right hall, and pressing the door button to close and open the left or right door.

These actions will be crucial to prevent the animatronics in the game from attacking the player.

There are five animatronics in the game and each of them have their own pattern of behaviors. These patterns can be recognized by the player and the player can prevent the animatronics from attacking them by doing certain actions during certain animatronic behaviors. For example, closing the right door when an animatronic appears when the player press the right light button as shown in Figure 1 will prevent the animatronic from attacking the player.

Because all of the animatronics have their own pattern of behaviors and that there are actions the player can do for every behavior to prevent the player from losing, a decision tree can be created with the animatronics behaviors as the conditions and the player's actions as the decision. In this paper, the author will discuss using decision trees to help the player win at the video game Five Nights at Freddy's.

II. Theoretical Framework

A. Graph

A graph is a structure amounting to a set of objects in which some pair of those objects are connected. In a graph, the objects are represented through something called vertices or nodes and each of the connected pair of vertices are represented through something called edge or line.
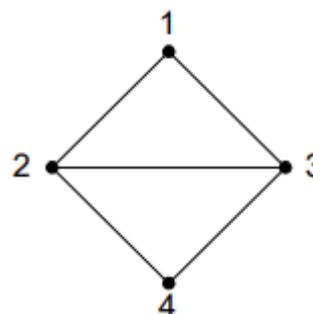

Figure 2. A graph with 4 vertices and 5 edges (informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2020-2021/Graf-2020-Bagian1.pdf, accessed on December 10, 2020)

There are two basic types of graphs which are the undirected graph and directed graph. A directed graph is a graph that is

made up of a set of vertices and edges where the edges have directions associated with them. This means that for every edge, there is a starting node and an end node. For example, in Figure 3, the edge between node 1 and node 3 starts at node 3 and ends at node 1. An undirected graph is graph that is made up of a set of nodes and edges but unlike the directed graph, its edges don't have directions associated with them just like the graph shown in Figure 2.
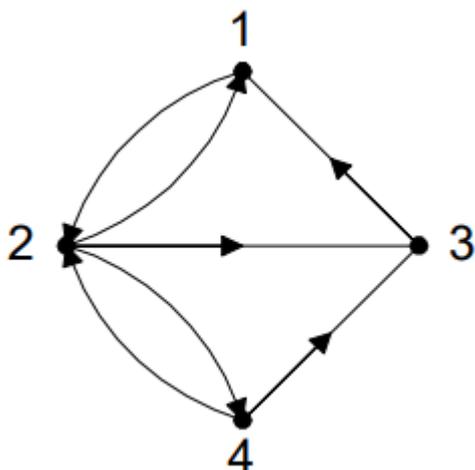

Figure 3. Example of a directed graph
(informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2020-2021/Graf-2020-Bagian1.pdf, accessed on December 10, 2020)

A path in a graph is a sequence of edges that connects a series of vertices that are all distinct. A circuit in a graph is a path that starts and ends on the same node. An example of a path from the graph in Figure 2 is 1, 2, 3 while an example of a circuit from the same graph is 1, 2, 3, 1 with the numbers representing the nodes in the graph. A connected graph is defined as a graph where there is at least one path for every pair of nodes in the graph.

B. Tree

A tree is an undirected connected graph that doesn't have a circuit in it. This means in a tree, every pair of nodes only have one path to connect them to each other. A forest is defined as a group of trees that are not connected to each other.
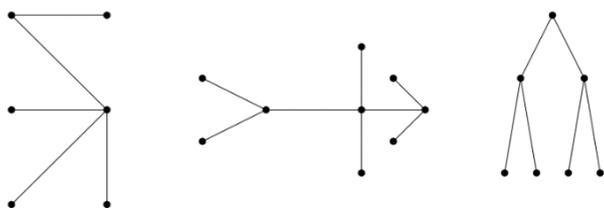

Figure 4. Examples of trees
(informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2020-2021/Pohon-2020-Bag1.pdf, accessed on December 10, 2020)

A rooted tree is a tree where one of the nodes is treated a root and all of the other edges in the tree are directed away from the root, turning the rooted tree into a directed graph, unlike a normal tree which is an undirected graph.
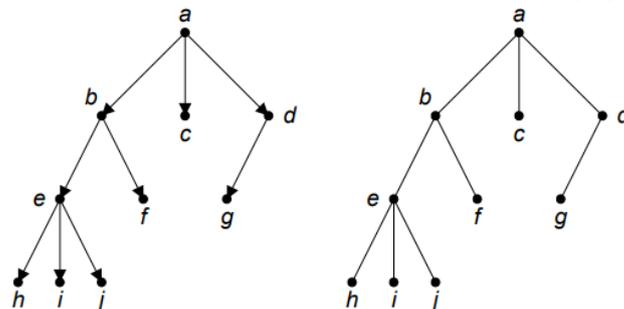

Figure 5. Example of rooted trees
(informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2020-2021/Pohon-2020-Bag2.pdf, accessed on December 10, 2020)

For the rooted tree in Figure 5, the root is the node 'a' with the rest of the edges in the tree directed away from node 'a'. Usually a rooted tree is drawn without the arrows found in directed graphs as shown in the right graph in Figure 4. A leaf is node in a rooted tree that is not the starting not of any edges, meaning that there are no paths left to go from that node.

A node in a rooted tree that is on the end of an edge is called the child of the node that is on the start of the edge. The node on the start of the edge is called the parent of the node on the end of the edge. For example, in Figure 5, node 'e' is the child of node 'b' and node 'b' is the parent of node 'e'.

An n-ary tree is a rooted tree where all of the nodes have a maximum of n amount of children. There are two special cases in the naming for n-ary tree which are for n-ary tree where the value of the n is equal to two and three with the tree being named binary tree and ternary tree respectively.

C. Decision Tree

A decision tree an example of the application of trees. A decision tree is a decision support tool that uses the n-ary tree structure to model decisions and their consequences. There are many ways to create a decision tree, but the way the author will do it is to create an n-ary tree where every leaf node represents a decision taken, every node that is not a leaf represents a condition, and every edge represents the possible results of the condition of the node that edge started from.
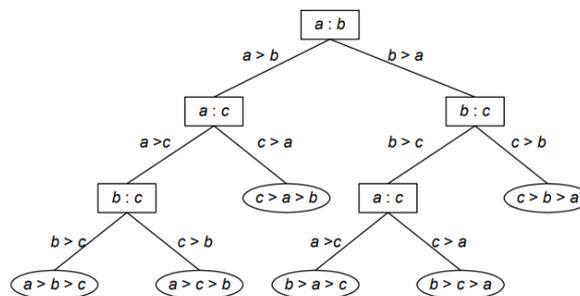

Figure 6. Example of a decision tree
(informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2020-2021/Pohon-2020-Bag2.pdf, accessed on December 10, 2020)

In Figure 6 is shown a decision tree that compares three variables then shows the result for every possible conditions. The node represents the conditions which in this case is which variables are being compared, the edges represents which path to go for every possible result of that condition, and the leaf node represents the decision which in this case is the conclusion of the comparison between the three variables.

As decision tree is a decision support tool, it makes it easier and simpler for people to come to a conclusion based on certain conditions and variables by putting those conditions and the decision that corresponds to that condition in a decision tree and then testing the variables through that decision tree. Decision trees' simplicity and effectiveness make them often used to help identify a strategy most likely to reach a goal, machine learning, and many other applications.

D. Game Mechanics in Five Nights at Freddy's

The enemies in Five Nights at Freddy's are the five animatronics roaming the game area throughout the game. Each of them follow their own pattern as they roam the game, approach the player, and attack the player which could lead to the player losing. Even though the game has different levels of difficulty, these patterns don't change, only the speed in which the enemies move and the randomness factor in the enemies' behaviors patterns. The enemies in the game are known by the names of Bonnie, Chica, Foxy, Freddy, and Golden Freddy.

Figure 7. Bonnie, Freddy, and Chica (from left to right)
(store.steampowered.com/app/319510/Five_Nights_at_Freddy, accessed on December 10, 2020)

How the game works is that the player is stuck in an office room, unable to move away from there, with only three tools available which are the camera monitor, the door button, and the light button. The player can use the camera monitor to look through the security cameras all around the game area to look for the animatronics roaming the area. By using this the player can pick up on the animatronics behaviors and take actions accordingly to prevent the enemies from attacking them. Every action the player takes uses up power as it shows in the power indicator shown in Figure 1 on the bottom left corner. If the power indicator reaches zero, then the player will lose as there's nothing that can prevent the enemies from attacking them.

Figure 8. Screenshot of the player using the camera monitor to look at CAM 1A
(store.steampowered.com/app/319510/Five_Nights_at_Freddy, accessed on December 10, 2020)

Using the camera monitor allows the player to look though the security cameras spread around the game. The player uses these cameras to look for roaming enemies and spotting their behaviors. By identifying where the enemy is and what they're doing through the camera, the player will be able to prevent the enemy from attacking them by doing the appropriate actions. These security cameras are shown in the map that can be seen when the player activates the camera monitor such as in Figure 8. The player can switch from a security camera to another camera by clicking the blocks labelled with the name of the security camera in the map. For example, by clicking on the label CAM 1B on the map, the player will change the camera monitor to look through the security camera on CAM 1B.
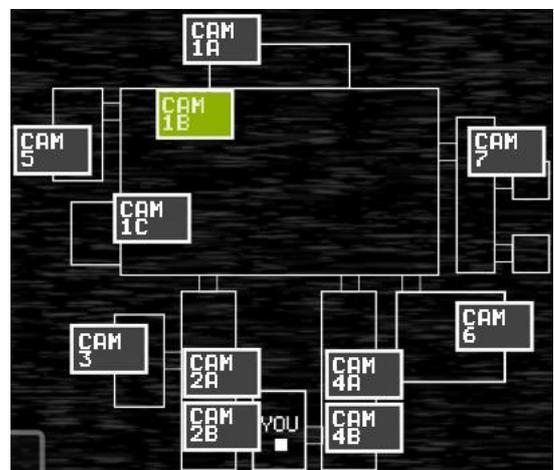

Figure 9. The camera map with CAM 1B selected
(freddy-fazbears-pizza.fandom.com/wiki/Camera_Monitor, accessed on December 10, 2020)

When switching to another security camera, the block representing the security camera on the camera map will change color for a moment, telling the player that they have switched to that security camera, as shown in Figure 9. The player needs to use the camera monitor a lot in the game as it's vital to identifying the enemy's behavior so that they can counter it properly.

The office in which the player resides, as shown in Figure 9 with the 'YOU' label on the map, have two halls on the office's left and right side and two doors from those halls leading into the office. There are two door buttons and light buttons for each side of the office. Pressing a door button will cause the left or right door to close depending on which door button the player pressed. If the player pressed the right door button then the right door will close and vice versa. The door will close until the player presses that button again. By closing the door, enemies cannot enter the office to attack the player through that door as it is closed but closing the door will drain power.

Figure 10. The left door being closed
(freddy-fazbears-pizza.fandom.com/wiki/Doors, accessed on December 10, 2020)

The light button if pressed will turn on the light on the left or the right halls depending on which side the light button is on. The light will turn on until the player presses the same light button again. Turning on the light will drain power, but it is useful to spot animatronics that are no longer spotted in the security cameras as they are right outside the office. This is shown in Figure 1 and Figure 11. In Figure 1, the right light button is pressed so the light turns on the right hall and it shows Chica in the right hall, close to attacking the player. In Figure 11, the left light button is pressed so the light on the left hall turns on and it shows Bonnie in the left hall.

As power is a big factor in the game, the player cannot just close all doors for the entire game but instead needs to learn the enemy behaviors to respond accordingly so they don't waste power and so is able to win the game.
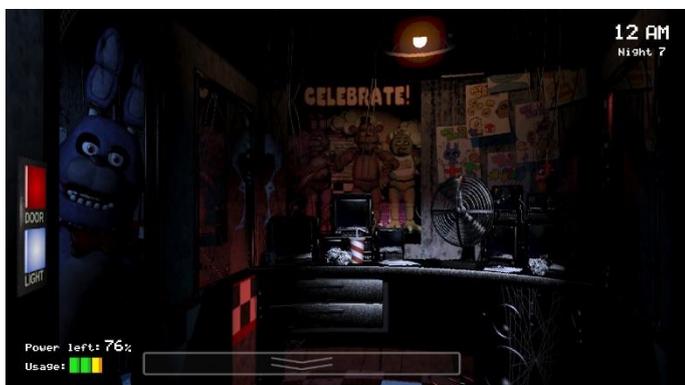

Figure 11. The light on the left hall being turned on, showing Bonnie
(freddy-fazbears-pizza.fandom.com/wiki/The_Office, accessed on December 10, 2020)

By using the camera monitor, door buttons, and light buttons, the player can see the behaviors the animatronics, identify their behaviors, and take proper actions to prevent each enemies from attacking. So a decision tree can be created to map out all the possible behaviors of the animatronics and the actions the player needs to take to respond to that behavior.

III. IMPLEMENTATION OF USING DECISION TREE IN CHOOSING THE APPROPRIATE ACTIONS FOR THE PLAYER BASED ON ENEMY BEHAVIORS

A decision tree can be created to help the player respond to the enemies' behaviors so the player can just test what they see to the decision tree to find out what they need to do. As every animatronics in the game have their own unique pattern of behaviors, a decision tree is created for each animatronics, totaling at five decision trees to help the player win at the game. These decision trees can be combined into one decision tree, but for the sake of simplicity and visibility in this paper, it will not be combined in this paper.

A. Bonnie

Bonnie is most likely the first enemy the player encounters in the game. Bonnie starts in the game in area CAM 1A alongside Freddy and Chica. He moves pretty randomly along the left part of the map except when he's about to attack which is when he can be seen by turning on the light on the left hall, therefore it's more efficient and effective to just check the left hall light every time the player hears sound of footsteps. The sound of footsteps is an audio cue in the game that indicates that either Bonnie or Chica is moving.

When Bonnie gets to the area where he can be seen by turning on the left hall, he's only seconds away from jamming the door and entering the office, so the player only has few seconds of reaction time to check the left hall light and close the door. If he manages to jam the door and enter the office, the player won't be able to close the left door or turn on the left hall light anymore. Bonnie will only attack the player if they activate the camera monitor when Bonnie is in the office. Therefore, if Bonnie is in the office, the player should stop doing anything, limit power consumption, and hope that they will survive until the time limit.

The decision tree to counter Bonnie first checks if Bonnie has started moving or not by checking on CAM 1A. If Bonnie has started moving then check for footstep noises then check the light to see if he's outside the office. If he's outside then try to close the left door immediately. If the door manages to be closed then the player must wait until Bonnie leaves then open the door again to limit power consumption. To check on whether Bonnies has left or not, the player must turn on the left hall light and check for Bonnie's shadow on the light. If the player fails to close the door in time, then they must deactivate everything so that they have the best chance to survive.
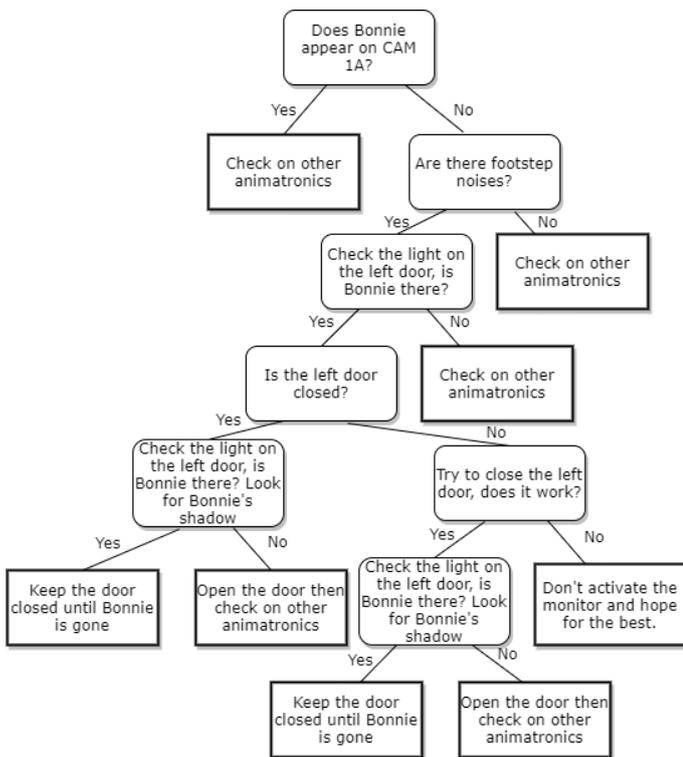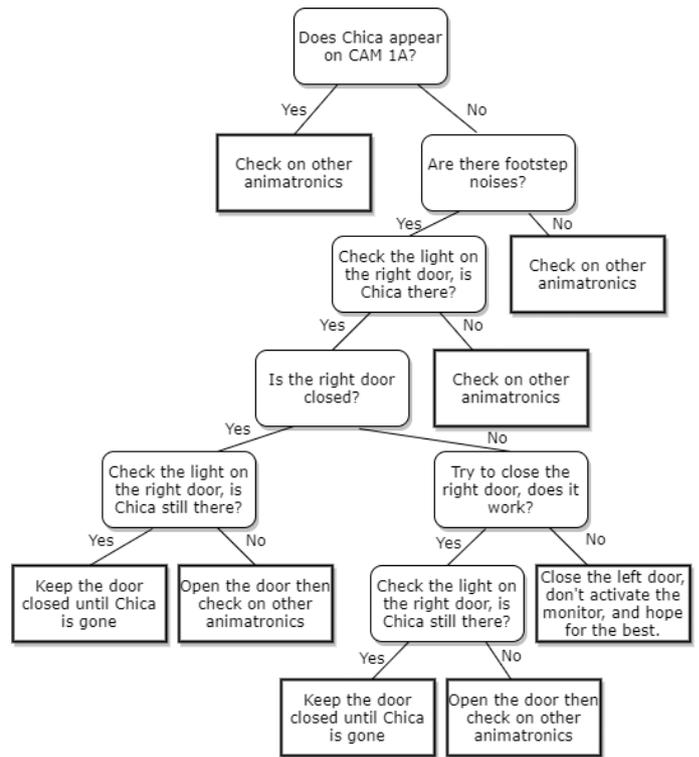
Figure 12. Decision tree to counter Bonnie

Figure 13. Decision tree to counter Chica

On Figure 12 is the decision tree the player can use to effectively and efficiently counter Bonnie so that the player won't be attacked by Bonnie. The decision tree uses Bonnie's pattern of behaviors as the conditions and the player's action to counter Bonnie as the decision.

B. Chica

Chica is likely the second enemy the player encounters in the game after Bonnie. Chica moves pretty similarly to Bonnie but she's slower in moving from area to area and that she moves in the right part of the map. Chica starts in the game in area CAM 1A alongside Bonnie and Freddy. She moves randomly alongside the right part the map except when she's about to attack which is when she can be seen on the right hall by turning on the light on the right hall. Just like with Bonnie, it's far more effective and efficient to just check for the sound of footsteps and then check for the light on the right hall for Chica.

Also similarly to Bonnie, if Chica enters the office, she can also jam the door and will attack the player if the player activates the camera monitor. Therefore, the player should just close the left door then deactivate everything else to have the best survival chance when Chica has entered the office. The player should close the left door unlike the case with Bonnie where the player doesn't need to close the right door because there's an enemy that can enter the office and attack the player immediately through the left door which is Foxy. By closing the left door, the player will remove all possibility of being attacked other than running out of power.

As seen in Figure 13, the decision tree to counter Chica is pretty similar to one to counter Bonnie with the only difference being that Chica comes through the right hall and that the player should close the left door if Chica manages to jam the right door.

C. Foxy

Foxy is likely the third enemy the player encounters in the game. Unlike all the other enemies, Foxy starts in area CAM 1C and stays there until he attempts to attack the player.

Figure 14. Foxy appearing on CAM 1C
(store.steampowered.com/app/319510/Five_Nights_at_Freddy, accessed on December 10, 2020)

With Foxy, the player only needs to pay attention to CAM 1C. Over time, Foxy's state on CAM 1C will change, from being completely hidden behind the curtains to being completely out of the curtain. If he's completely out of the curtains then Foxy is only one step away from running to the office to attack the player so the player should check on CAM 1C more. When Foxy disappears from CAM 1C, that means he's already on the way to attack the player. Unlike Bonnie and Chica, Foxy cannot be spotted outside the office in halls and he doesn't wait until the player activates the camera monitor to attack. He will appear to run on CAM 2A and then attack the player immediately when he enters the office. The only way to stop Foxy is to close the left door quickly when the player spots him away from CAM 1C and running on CAM 2A. If the door is not closed on time then the player will lose. Foxy will go back to CAM 1C after causing
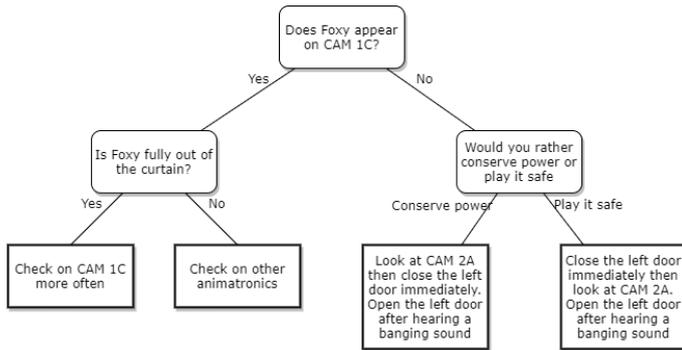
a banging sound.

Figure 15. Decision tree to counter Foxy

One thing to note is that Foxy being not appearing on CAM 1C will not immediately trigger him running to the office. Foxy will run when he's not on CAM 1C and the player looks at CAM 2A or hasn't looked at CAM 2A for a while. This means that the player can close the left door first before triggering Foxy to run. This is safer as this will ensure that the player can close the door in time before Foxy finishes his run. But, this tactic will drain more power so if the player wants to conserve power, they should look at CAM 2A to trigger Foxy's run then close the left door immediately. So this is implemented in the decision tree in Figure 15 by giving the player options to conserve power or play it safe if Foxy is not found on CAM 1C.

D. Freddy

Freddy is the titular enemy of the game. He is likely the fourth enemy the player encounters in the game. Freddy starts in CAM 1A alongside Bonnie and Chica. After moving out of CAM 1A he'll move in a linear path to the office, never moving back. Every time Freddy moves, an audio of a laughter will play. Most of the time only Freddy's glowing white eyes can be seen in the cameras. Freddy will move through CAM 1A, Cam 1B, CAM 7, CAM 6, CAM 4A, CAM 4B, and the office in order. It should be noted that CAM 6 is an audio only CAM so the player will instead hear a jingle playing if Freddy's in CAM 6.

Figure 16. Freddy on CAM 4B
(freddy-fazbears-pizza.fandom.com/wiki/East_Hall, accessed on December 10, 2020)

Spotting Freddy in the cameras will halt him from moving to another room, so finding Freddy through the camera monitor is important to halt him as Freddy never goes back to previous rooms unlike other enemies. Once Freddy appears on CAM 4B, like shown in Figure 16, he's only one step away from attacking

the player. Freddy can only enter the office from CAM 4B if the player activates the camera monitor and that it wasn't looking on CAM 4B. Freddy also can't enter the office if the right door is closed. So, the effective strategy to counter Freddy is to keep tabs on him all the time and when he's on CAM 4B, always close the right door before activating the camera monitor. On Figure 17 is the decision tree to counter Freddy.
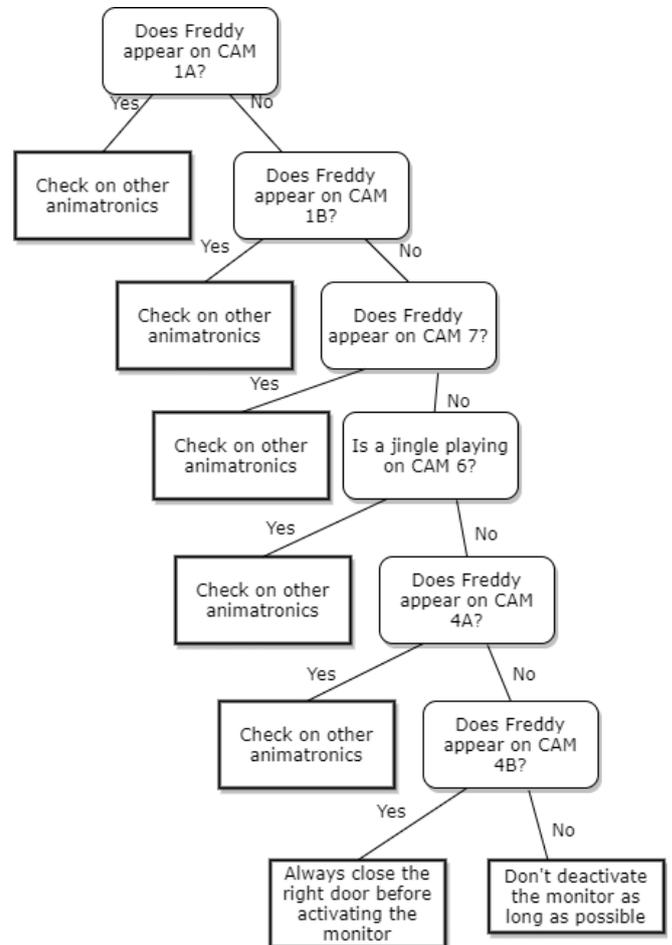

Figure 17. Decision tree to counter Freddy

E. Golden Freddy

Golden Freddy is a rare enemy that can be encountered in the game. The chances of encountering Golden Freddy is low and Golden Freddy can only be encountered once per night. Golden Freddy can only be encountered if the player looks at CAM 2B and the poster that appears on CAM 2B is a poster of Golden Freddy as shown in Figure 18.

Figure 18. Poster of Golden Freddy on CAM 2B
(freddy-fazbears-pizza.fandom.com/wiki/West_Hall, accessed on December 10, 2020)

As Golden Freddy can only has a chance to be encountered if the player looks at CAM 2B, not looking at CAM 2B at all would completely erase the chance of the player encountering Golden Freddy. This is possible as CAM 2B can be ignored to win the game as it's not vital.

If the player encounters the Golden Freddy poster, the next time the player deactivates the camera monitor, Golden Freddy will appear in the office. If they player doesn't activate the camera monitor again in 5 seconds, Golden Freddy will attack the player and the game will crash, causing the player to lose. On Figure 19 is the Decision tree to counter Golden Freddy.
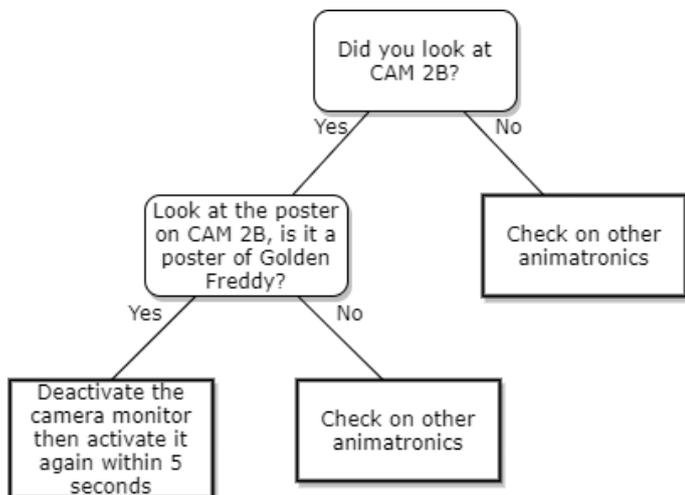

Figure 19. Decision tree to counter Golden Freddy

All of these decision trees are for each specific enemies. In the application of these decision trees, it should be noted that the enemies in the video game Five Nights at Freddy's act in conjunction with each other a lot of the time. So, the way to implement these decision trees to win at the game is to continuously apply these decision trees in conjunction with each other in the player's decision during the game. By continuously going through all of the decision trees, the player should be able to play the game in a more effective way so that they have a much higher chance of winning. As with the nature of the game also requiring the player to have a good reaction time and decent mechanical skills, using these decision trees cannot guarantee the player to win the game. But, using these decision trees will greatly increase the player's chance of winning the game.

IV. CONCLUSION

In conclusion, graphs and trees are useful tools that can be used for many things. One of this application of graphs and trees is the decision tree which is a decision support tool that is used to help in making decisions. The decision tree's usefulness and structure made it very useful and able to be implemented in a lot of situations like helping to win at video games such as Five Nights at Freddy's. This has been shown in this paper through the implementation of using decision trees to help the player in making decisions based on the enemy behaviors in the game so that the player has a much better chance of winning.

This paper has shown that decision trees can be used to help players to win at a video game. I hope that in the future more people will use decision trees to help them in their daily life such as playing video game.

V. ACKNOWLEDGMENT

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PERNYATAAN

Dengan ini saya menyatakan bahwa makalah yang saya tulis ini adalah tulisan saya sendiri, bukan saduran, atau terjemahan dari makalah orang lain, dan bukan plagiasi.

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