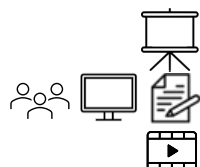


Masterclass Session Script



This icon refers to the supporting slide in the presentation.

These icons indicate there is an activity to do, or a worksheet to complete.

This icon indicates there is a video to watch.

Football Manager OTS Masterclass	Slides/ Activity
Introduction (5 minutes) Welcome to our Football Manager computer science masterclass today! Today you will step into the shoes of a football manager and make use of decision trees and logic to make important decisions. To start us off, let's think about what decisions you have made today before arriving at this masterclass. Perhaps you made decision on getting ready in the morning, on what to eat or wear, or which direction to go to get here! We make decisions all the time, sometimes without even realising we're deciding. Think about why you made the decision you did, and what impacted that decision. • Did the weather play a part? • Did it involve thinking about other people? To make good decisions, we need to have information on which to base our decision. Imagine you wake up in the morning to a cold, snowy day. You wouldn't put on a pair of shorts and sandals and go outside. You would take in the information about your surroundings and make a good decision to wrap up warm. Humans are constant decision makers, and computers are too! They decide whether to allow someone into an account after receiving a password, when to turn on a phone's alarm, or which route to suggest depending on the traffic. But computers are only able to make these decisions because a human has programmed them which decision to take given certain information. Today we're going to investigate how computers make decisions, by stepping into the shoes of a robot football manager.	1
Stick or Twist? (15 minutes) Imagine you are managing a team playing football. This time they are humans! You have a series of items on playing cards. To start, you will need to pick one item from the cards that you think will help you the best to win the game. Each round, I will give you some information about the football game, and you will need to use this information to decide whether to stick with your item, or twist and choose another item. But be careful, once you twist you cannot choose that item again! There are five rounds, and each round some items will give you a point, and some will take points away. Count up your points after each round. • Have you chosen your first item? Then we are ready to begin. Round 1 – Here is your first piece of information. The other team has weaker attackers, so they may find it harder to score goals. Their defence however is very strong, which means your team may also find it hard to score against them, or to keep possession of the ball. Decide whether you will stick with your current item, or twist to something new.	2 3

Remember, if you twist you cannot pick up that item later in the game and must discard it. If you have a magic energy drink or lightweight shorts, add one point to your score. If you have new football gloves or bright red boots, remove one point from your score. If you have any other item, your score stays the same. Round 2 – You have checked the weather forecast for the match, and it looks like rain! It is going to be cold, wet and windy out there. • Do you want something warm, or perhaps something that would improve your ball control on a slippery wet pitch? Decide whether you will stick with your current item, or twist to something new. If you have sticky boot spray or a rain jacket, add one point to your score. If you have lightweight shorts or sporty sunglasses, remove one point from your score. If you have any other item, your score stays the same. Round 3 – By half time, a lot of your players have been injured due to the slippery pitch conditions. You have only one substitution left, which means most of your players will need to stay on the pitch for the whole second half of the game. • Will you stick, or twist your item? If you have a protein packed snack or a magic energy drink, add one point to your score. If you have lightweight shorts or a coach earpiece, remove one point from your score. If you have any other item, your score stays the same. Round 4 – You have decided to update your strategy, and have your attackers push harder. • Will you stick, or twist your item? If you have a sticky boot spray or your coach's earpiece, add one point to your score. If you have sporty sunglasses or new football gloves, remove one point from your score. If you have any other item, your score stays the same. Round 5 – Your team are in the lead with five minutes to go. • Which item out of the ones you have left do you think will be the best to keep you in the lead? If you have a magic energy drink, new football gloves, bright red boots, or sticky boot add one point to your score. If you have any other item, your score stays the same. • Add up all your points – who has the most points? Congratulations on your debut football managing experience! • Did anyone feel confident in their item from the start and keep their item the whole way through? • Did the information provided change your mind? • If you were going to manage a football team again, what questions might you need to ask to gain the information you need to make good decisions?	
Robots playing football (5 minutes) You might be thinking... what does football have to do with computers and robots?! Well, there's lots of ways that computing and technology helps football teams, but let's look at an even closer example of the two things working together – RoboCup. RoboCup is an international competition where teams compete to build the best robot football team! Their end goal is to build a team of robots who are able to beat the most recent winners of the Football World Cup.	

- **Do we think this is possible?**
- **How long do you think it will be until this could happen?**

Well, we're not quite there yet, let's have a look at some of the best bloopers from the competition.

We've just seen how you made decisions in your teams, with limited information. Computers don't think like us — they don't 'guess' or 'feel' like we do. Instead, they follow a set of instructions to help them choose the best action.

For example, imagine a robot footballer. It gets told 'If no one is blocking the goal, then shoot, but if a defender is close and a teammate is open, then pass'. We call these 'if' statements, or conditionals – as the next action is dependent on if the first action has taken place.

- **Are these rules enough for the robots to play a complete game of football?** We need to build quite a complex set of rules in order for computers to be able to function without our constant supervision and involvement.

These rules can be written down and given to computers using something called a **decision tree** — a flowchart of rules that helps the computer make smart choices.



Decision Trees (20 minutes)

Decision trees are named for the common features they share with real trees. The root of a real tree is where it starts growing, just like a root node, where the computer starts its decision-making journey – in our case, the robot could ask the question 'Do I have the ball?'. From there, the trunk grows and forms branches, which go off in different direction. In a decision tree, branches are the paths the computer can follow depending on what the data says

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At some points, the tree splits again, and in the decision tree that would be decision node, where the computer asks another question. Finally, the branches end in leaves, just like a decision tree ends in leaf nodes, which are the final decisions like 'Pass', 'Shoot', or 'Defend'.

A decision tree starts with a question and ends in an action, just like a football player making a smart choice!

We can visualise these decisions like this, with different arrows to follow our paths. This is what a simple decision tree might look like. This time, we turn the tree upside down, and start with the root node at the top, with branches coming down to decisions nodes, leading finally to leaf nodes.

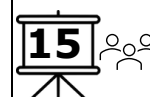
We will now have a go at building our own decision trees. Follow the worksheet questions, by first labelling the different parts of the decision tree, then filling in the blanks, and then build your very own decision tree.

Let's share our decisions trees with each other.

- **What do we think makes a good decision tree?** We need some clear questions, with at least two branch options (yes or no), and leaf nodes that follow on from the logic.



What decisions do football managers need to make during a game? (10 minutes)



For the next part of the session, you're going to be stepping into the role of a football manager.

- **What decisions do you think football managers need to make during a game of football?** They need to decide which players to play, bench and rest, when to substitute players on and off the pitch, when to change tactics and formations, and which players to pick to take a penalty shot.

One of the most high-pressure moments a player might face in a football match is having to take a penalty shot, and managers need to choose someone they can trust to get the ball in the net. We're going to focus on the penalty choice for the next activity.

Here we have some data about football players, their skill, confidence, hair style, and whether or not they scored their most recent penalty shot.

- **If we look at who scored, and who didn't score - is there a category where it always leads to them scoring?** Yes, from this data set we could conclude that if a player had spiky hair, then they should score. And, if a player's hair is not spiky, then they did not score.
- **What might our decision tree look like if we were trying to programme our robot to pick the best penalty takers?**

Our robot's decision tree might look like this. We're now going to test our decision tree by giving it some more data – some new players to pick penalty takers from!

Using your decision tree, which players would the robot pick to take a penalty score?

It would pick Morgan, and Frankie! This means someone who does not have a high shooting skill or confidence (Morgan), was picked to take a penalty, whilst someone with high shooting skill and confidence (Taylor) was not picked to take the penalty. They have both wrongly been classified. The robot's decisions are not reliable for new data (new players). It has been trained on spiky hair, which actually is not a very meaningful feature compared to the other two features.

What are some of the limitations with using a single decision tree?

- We can overfit the initial data we are given, so that any new data does not work with the classification we give.
- You may have to put in every factor possible into one tree.
- Also, as long as our input stays the same, our output will always be the same. This leaves no room for creativity or novel ideas. We would never have any footballers creating new celebrations or coming up with new plays.

Random Forests (5 minutes)

What can we do to make our decision trees better?

- **If we have been looking at one decision tree, what do you think the term 'random forests' means?** It is used to describe lots of decision trees working together!

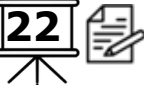
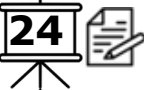
Imagine, if instead of us using one robot, we had lots of robots, and we trained each one to use a slightly different set of features to decide who will take a penalty kick. Then we asked them all which players they would pick. If a majority of the robots said we should pick a player, then we would pick them. But if a majority said we should not pick them, they we would not. This is exactly what a random forest does!

Rather than us using one decision tree based on a player's hair style, we could also have two more decision trees – one deciding based on the players skill level, and one based on the player's confidence level.

In this case, if a player passed two or more of the decision trees by reaching two or more leaf nodes that say to pick the player, then they would be picked. This protects us from data that has been overfit.

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Using this method, both Taylor and Morgan would be picked to take the penalty, and the other players would not be picked.	
Choosing our lineup (15 minutes) You are now going to build your own 5-a-side football team using decision trees that you will build yourselves. You will be given a pack of 18 cards, but you will only end up with 5 of these in your team. Each card has four statistics on them relating to the players' speed, defence, accuracy, and stamina. A well-rounded team is best, and ideally you want the highest scores. In order to build our team, we have to design our decision tree lineup picker first. In this activity, when you are picking the two cards and deciding who you would rather have in your team, this does not mean they are going to be in your team. Your random forest of decision trees will decide your team in our next activity. To build the lineup picker, you will need to pick two random cards and decide which of the two of them you would select for your team, if you had the choice. Once you have decided, you then need to create a decision tree that would mean a robot would pick your chosen player and not pick the other player. Once you have created this decision tree, put those two cards aside, pick two new cards and do the same. Keep doing this until you have filled out your five decision trees to be your lineup picker. Our first decision tree might look something like this. In this scenario, our decision tree would pick Sprintah over Messi, since Sprintah's speed is 9, which is greater than 8. Messi would not get picked, as his speed is only 8.	  
Let's test our lineup picker (10 minutes) Now we get to put our lineup picker to the test! To do this, we will shuffle all our cards, pick one up, and use this card to go through your five decision trees. In your table, note the name of the player, and the result of each decision tree on whether it suggested to pick or not pick the player. After you have gone through each decision tree with that player, count up the number of results that said yes to picking the player. If 3 or more decision trees said the player should be picked, then add that player to your team. If three or more decision trees said the player should not be picked, that player will not join your team. Keep drawing random cards and repeating the process until you have 5 players who can join your team. Stop here, and come up with your team's name, ready for a 5-a-side trump card football match.	
Trump card time! (15 minutes) Now you all have your 5-a-side teams, we are going to put them to the test. Turn over your worksheet and you will see a table that we can use to record the results of the game we will play. In this game, the aim to win is to have the highest number against your opponent. You will find an opponent team to play against and write their team name in the table. Then, shuffle your five player cards and place them face down in a pile. Pick up the card on top and keep it to yourself. For the first round, both teams should read aloud the number for defence. Whoever has the highest number will win that round. Make a note on the sheet in the round if you win, lose, or draw. If both numbers are the same, then the person who won the last round should pick a new feature to compare and take the round result based on who has the highest of this value (or in the case that it is the first round, both can read the number for stamina). If all your numbers are the same, you probably both have the same player, so that round will be considered a draw.	

After you've noted the result, both teams will put their own card on the bottom of their pile, pick the next card on top of their pile, and whoever won will pick the next feature to compare. Keep going until you have played 5 rounds and used all your players. Whoever won the most rounds, will win the match. Note whether you won, drew or lost the match at the end of the table. Then pick a new opponent team, shuffle your cards, and go again!	
Scratch (5 minutes) Now you've had an experience of what using logic and decision trees might look like in a football manager role, what could this look like in computing? Here we have an example of block code in Scratch, that controls a character in a game's movements depending on whether an arrow key is pressed on a keyboard. • What would the decision tree look like in this case if we were to draw it? We would have our root node at the top, with 'Was the left arrow pressed?', then a branch coming off it with 'Yes', and a leaf node with the end result, which is to make the character 'turn left and move 10 steps'. • But what happens if we do not press the left arrow key? What do we think the decision tree will look like if we added in the no branch? Our decision tree will now look like this, with a leaf node saying to 'stay still' after the no branch. • And what about this example? What might our decision tree look like now we have some extra code? We now have a decision node – was the right arrow pressed? And we have two branches leading off this, one that follows yes and makes our character turn right and move 10 steps, and one that follows no and makes our character stay still. So that's what a decision tree might look like in real code!	
End of session – recap and feedback (10 minutes) Thank you very much for joining this masterclass today, we hope you enjoyed it and learnt a lot about decision making in computing and football! If you would like to continue to explore decision tree building in Scratch, try the Top Trumps activity at www.machinelearningforkids.co.uk/worksheets. If you have any questions, comments or thoughts we would be happy to hear them now. You can also ask the Ri, by emailing them to masterclasses@ri.ac.uk.	