

Sports Matching: Teacher Notes

Materials Required

Each student/pair of students will need:

- Pen and paper,
- Four pieces of card with names on (see below)

Preparation Required:

- The cards (below) for the game will need to be cut up appropriately.

<u>Ann</u> Hockey Rugby Swimming	<u>Ben</u> Hockey Swimming	<u>Caroline</u> Hockey Swimming Tennis	<u>Darren</u> Rugby Swimming
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Supporting Resources Available

The following resources support this session and are free to download from www.LearnAboutOR.co.uk :

- PPT, Board game, YouTube Video, Career Profiles, Introduction to O.R.
http://www.learnaboutor.co.uk/teachers_materials/ORAiS/teachers_ORAiS_careerladder.htm

Session Duration Guide

- For Year 10-11 / Average ability groups: Allow 45-50 minutes
- For Year 12-13 / High ability groups: Allow 30-45 minutes

Introduction: "Your Task – Task 1"

Slides 2

(approximately 10-15 minutes)

Introduce the scenario to the students. Encourage them to work in pairs for 10 minutes to think of different options for possible matchings, using the information given to them on the "task" slide. Tell students to think of how they present their investigation. State that their matching process is called a **one-to-one mapping**

because they have to match one person from the first group, to one and only one sport from the second group.

Discuss with the students their different ideas and how they came up with the solutions. State that these are called **complete matchings**. A complete matching is when each and every node in the first set is matched up with one and only one node in the second set (where all nodes are reached).

There are three possible matchings to be found:

Ann = Hockey
Ben = Swimming
Caroline = Tennis
Darren = Rugby

Ann = Rugby
Ben = Hockey
Caroline = Tennis
Darren = Swimming

Ann = Swimming
Ben = Hockey
Caroline = Tennis
Darren = Rugby

Bipartite Graphs

Slides 3 & 4

(approximately 5-10 minutes)

Explain to the students what a **bipartite graph** is, using the slide entitled "bipartite graphs". Allow the students to then spend 5 to 10 minutes drawing bipartite graphs for their complete matchings.

Show them the slide entitled "your bipartite graphs" and get them to check their answers against the graphs shown.

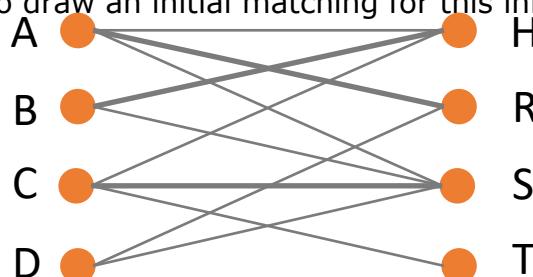
Initial Matching – Task 2

Slide 5

(approximately 20mins)

Explain the task to the students. Define that an **"initial matching"** is a matching which is not complete (i.e. a node is not reached in set Y), and an **"improved matching"** is a complete matching which has been created through altering the initial matching.

Ask the students to draw an initial matching for this information. This should look like the following:



Please note: The lines that are in bold show the initial matching. The thinner lines show the other preferences of each student.

Pick four volunteers to stand up in front of the class to represent Ann, Ben, Caroline and Darren in the scenario. They must each hold the appropriate piece of paper which lists their preferences. Allow the students still sat down to experiment with how they could find a complete matching, without asking too many students to swap teams.

Maximum Matching Algorithm

Slides 6 to 10

(approximately 5-10 minutes)

State that there is an easier way to find an improved matching. This method involves applying the “**maximum matching algorithm**” to the initial matching. Explain what this method is, using the “maximum matching algorithm” slide.

Encourage brief discussion over the fact that a maximum matching may not be a complete matching if there are not an equal number of nodes in each set.

Additionally, even if there are equal nodes in both sets, a complete matching may not be possible (e.g. if three nodes in set X can only be matched to either one of the same 2 choices of nodes in set Y). In this case, the maximal matching has the largest number of possible edges.

Complete task 2 with the class, using the slides given to help explain each step. Encourage the students to think of the answer first, before displaying the answers: see if they come up with the same solutions.

Evaluation

Slide 11

(approximately 10 minutes: 5 minutes evaluation; 5 minutes discussion)

This section is to encourage students to reflect on the work they have done this lesson, therefore it is important that they work individually here.

Discuss the answers with the students. In particular, focus on the question involving real-life examples (question 4). Answers here could include:

- Creating a staff rota: when applying for a job, staff may only be able to work certain days of the week, for example.
- If managers want to decide when staff are allowed to take holiday, based on their preferences and whether anyone else requests the time off at the same time.

Inform students that the idea of finding appropriate matchings relates to the discipline of Operational Research. **Operational Research** involves applying often advanced and analytical methods to real life problems, in order to help make better decisions.

OPERATIONAL RESEARCH

Presentation Slide 12

2 minutes

Ask the students if they have heard of operational research. Often not many people have. (Text appears on click/moving forward).

The answer on the slide can also be stated as "OR involves using maths to solve problems or make better decisions". It is a little unspecific as an answer – that's because OR is useful in many real-world situations!

OR is used today by many businesses – shops, airlines, architects, hospitals, local government and central government.

There are some in depth examples of OR on the following slides. Feel free to include your own.

OR IN DETAIL - SUPERMARKETS

Presentation Slide 13

2 minutes

Supermarkets use teams of OR professionals to solve problems and make decisions, such as understanding consumer buying patterns, deciding how many staff they should allocate to a shift and calculating the optimal quantity and delivery times of their products.

Supermarket loyalty cards, like a Tesco's Clubcard, are a great example of OR in action. Loyalty cards let supermarkets track what their customers are buying, creating huge amounts of data for operational researchers to work with. They can use statistics to search for patterns in the data, attempting to predict how customers will behave in the future.

For example, the data might show that people buy lots of milk on a Saturday, in which case the supermarket would know to stock up on Friday evening. It might also show that lots of people shop at certain times, or on a particular day, so the store managers would know to have more staff members working at that time.

Most supermarkets also incorporate weather forecasting data, obtained from weather stations near each of their stores to optimise this further by making sure they have extra BBQ food in towns that are expecting sunny weekends.

It's easy to see what a big impact OR has on making the right decisions for supermarkets – helping them keep customers happy and make profits!

OR IN DETAIL - AIRLINES

Presentation Slide 14

2 minutes

Operational researchers at places like British Airways are involved in a lot of decision-making.

When you book a holiday, OR has been used to decide where an airline will fly to and how much they charge you for your ticket, using customer buying patterns and forecasting to predict demand.

When you arrive at the airport, OR has been used to minimise queueing times, and simulations are used to model the flow of passengers through the terminal to ensure staff members and equipment are in the right places at the right time.

When you board the plane, OR has helped choose a boarding strategy and ensure your plane leaves on time. OR is even used to forecast how many passengers are likely to cancel their holiday!

Just like supermarkets, airlines rely heavily on OR to make better, more informed decisions that result in better outcomes for their business.

OR IN DETAIL - HEALTHCARE

Presentation Slide 15

2 minutes

Some hospitals have dedicated OR teams to help with resource allocation – especially if they have multiple specialities. The OR staff allocate patients, equipment and surgical teams to operating theatres based on the urgency and specific requirements of each patient – some operations need specialist equipment and others do not and it's not very efficient to have a 'general' patient in a 'specialist' surgery.

The OR team have to set a schedule, which is made complicated by the fact that how long an operation takes can be hard to predict and an emergency patient might need immediate attention and throw off the rest of the rota!

OR researchers designed an algorithm to optimise kidney transplant surgery – imagine somebody needs a kidney transplant and their family member is willing to be a donor, but is incompatible. The algorithm identifies patients in this situation and matches them up so they can swap donors, and both patients receive the kidney that they need.

The surgery has to take place simultaneously to prevent anybody from backing out at the last minute, so the algorithm also has to take into account the nearest hospital

with enough resources (theatres and surgical teams) to carry out the transplant when matching patients.

WHEN IS OR USED?

Presentation Slide 16

2 minutes

Decision-making and problem-solving in business can be complicated and messy. It may not be clear what the main problem is, what the outcome of different actions may be or how well things are currently working, and there may be lots of different factors to consider.

For example, if things don't go well when businesses make big changes, they might upset customers, slow down production, or create a need for extra staff training. Any of these could have a negative impact on the business. OR can help to reduce the chances of this happening.

WHAT OR TECHNIQUES ARE USED?

Presentation Slide 17

2 minutes

Some commonly used OR techniques include:

Optimisation – making something more effective - depending on what variable is most important (manufacturing something quickly, or maximising profit?), optimisation will find the best use of limited resources.

Simulation – this modelling tool is fantastic when there are a lot of different ways to solve a problem as you can try lots of different solutions until you find the best one. It also allows something to be tested in a safe way, for example, organisations like the NHS have to be careful when making changes as lives could be at risk!

Forecasting – forecasting can be used to try and predict unknown factors, to help keep a business running smoothly. For example, estimating customer demand so companies know which goods to produce or forecasting the impact of rush hour traffic on a delivery route, so the driver can stay on schedule.

Also many more techniques – including algorithms!

WHERE CAN OR TAKE YOU?

Presentation Slide 18

2 minutes

So where can OR take you? Employers who recruit for O.R. analyst are large and varied, spanning across all different industries.

So this is a non-exhaustive list of businesses that use OR. These are not endorsed by the OR Society but are designed to show the variety of careers in OR.

As you can see from the slide, there are various organisations across so many industries that use OR. For example, the government is a big employer of OR analysts, with more than 25 government departments and agencies relying on OR analysts to help them find solutions to complex managements problems. Other organisations from other industries also rely on OR analysts like, EY, British Airways, IBM and the Royal Bank of Scotland just to name a few!

OR analysis will typically work with colleagues in areas such as economics, statistics, social research and science.

INTERESTED?

Presentation Slide 19

2 minutes

If you are interested in OR here are a few next steps. You can continue studying Maths at GCSE and A Level and then further on into university.

Not many universities offer OR degrees, although some offer maths and OR degrees or similar. OR is often a module in a maths or business studies degree and can be hard to find on its own.

STEM degrees (science, technology, engineering and maths) show a skill set and analytical way of thinking that is often beneficial to people working in OR and are a good alternative to an (often elusive) OR degree.

FIND OUT MORE

Presentation Slide 20

2 minutes

For more information on OR and how to get into OR, visit the OR Society website or twitter. Any questions?