THE MATHEMATICAL ASSOCIATION OF VICTORIA

Biarri COMMERCIAL MATHEMATICS

MATHEMATICS IN CAREERS

Investigation - Panel cutting problem

Key career focus for this investigation: Software engineer, coding, information technology
Related career areas: Operations research, mathematical modelling, decision support systems

THINKING ABOUT CAREERS

- Brainstorm information technology professions you can think of where maths is frequently used. Use https://joboutlook.gov.au to explore information technology related career pathways that include use of mathematics. *How is maths used in these scenarios? What maths is used in these scenarios?*
- This task focuses on how maths is used in planning or operations.
- Explore careers such as software engineer, robotics engineer, to discover how maths is used in these. For a more extensive list of careers related to this task, with a maths/science focus, refer to the table at the end of the task and explore the maths used in these jobs.

MATHEMATICS IN EVERYDAY LIFE AND CAREERS

Mathematical focus for this investigation

- Using formulas to solve problems.
- Implement algorithms
- Using authentic situations to apply knowledge to solve real world problems

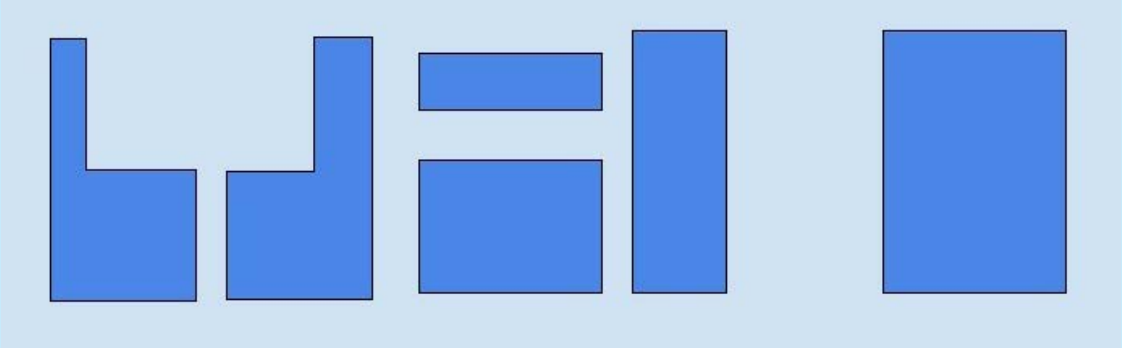
Scientists including information technology professionals use various formulae and algorithms. They apply their mathematical thinking and problem-solving skills in various situations. In this case specifically using mathematical modelling in planning and operations.

- Many people use various formulae and algorithms every day. For example, cooking recipes, long division and using a computer search engine all utilise algorithms. An algorithm is a well-defined set of instructions designed to perform a particular task or solve a type of problem. Anything that follows a set of specified instructions is an algorithm.
- Brainstorm and share scenarios where this mathematics may be used in information technology professions to solve problems.

MATHEMATICAL INVESTIGATION
PANEL CUTTING PROBLEM

INVESTIGATION BACKGROUND

Your customer imports large prefabricated panels which are used for building walls. These panels provide very high insulation and buildings constructed with this material are very energy efficient. These panels need to be cut to size before they can be used in construction. The panels arrive in shipping containers and can be sized up to 2.4m x 6m. The panels must be cut into segments defined by the construction plans. The shapes of the panels will vary based on the construction job and could be cut to go above and below windows as well as non-rectangular shapes where the panel overlaps with window and door positions. The objective of pre-cutting these panels is that builders will simply attach panels to the building frame and no onsite modifications of the panels will be required.



YOUR INVESTIGATION

A given job could use many panels therefore there could be many ways in which we could cut the smaller panels from the larger blanks. You need to bear in mind that your customer would like you to:

- Complete a job while using the minimal number of blanks
- Minimise cost (inefficiently cut panels will mean that material is wasted and the cost of providing the pre-cut panels will increase)

There are several stages that need to be considered when providing a solution to this problem. When providing your solution, consider:

- Efficiency: Given a blank and a set of panels to be cut, what is the efficiency of the usage of the blank
- Feasibility: Given a blank and a set of panels to be cut, is there a feasible way to layout the panels so they can be cut. Even when the panel isn't fully utilised, it might be impossible to place the panels in a way where they can be cut.
    - Can you create an algorithm to search for feasible layouts?
- Optimality: Given an order that requires multiple panels (and multiple blanks) can you produce a cutting guide (like the above diagram) that use the fewest number of blanks.
    - Consider designing an algorithm that can produce these cutting guides so these guides can be produced in an automated way.

The key part of this investigation is developing the concept of the algorithm, not coding it up.
You can use some python coding to answer some of these questions.

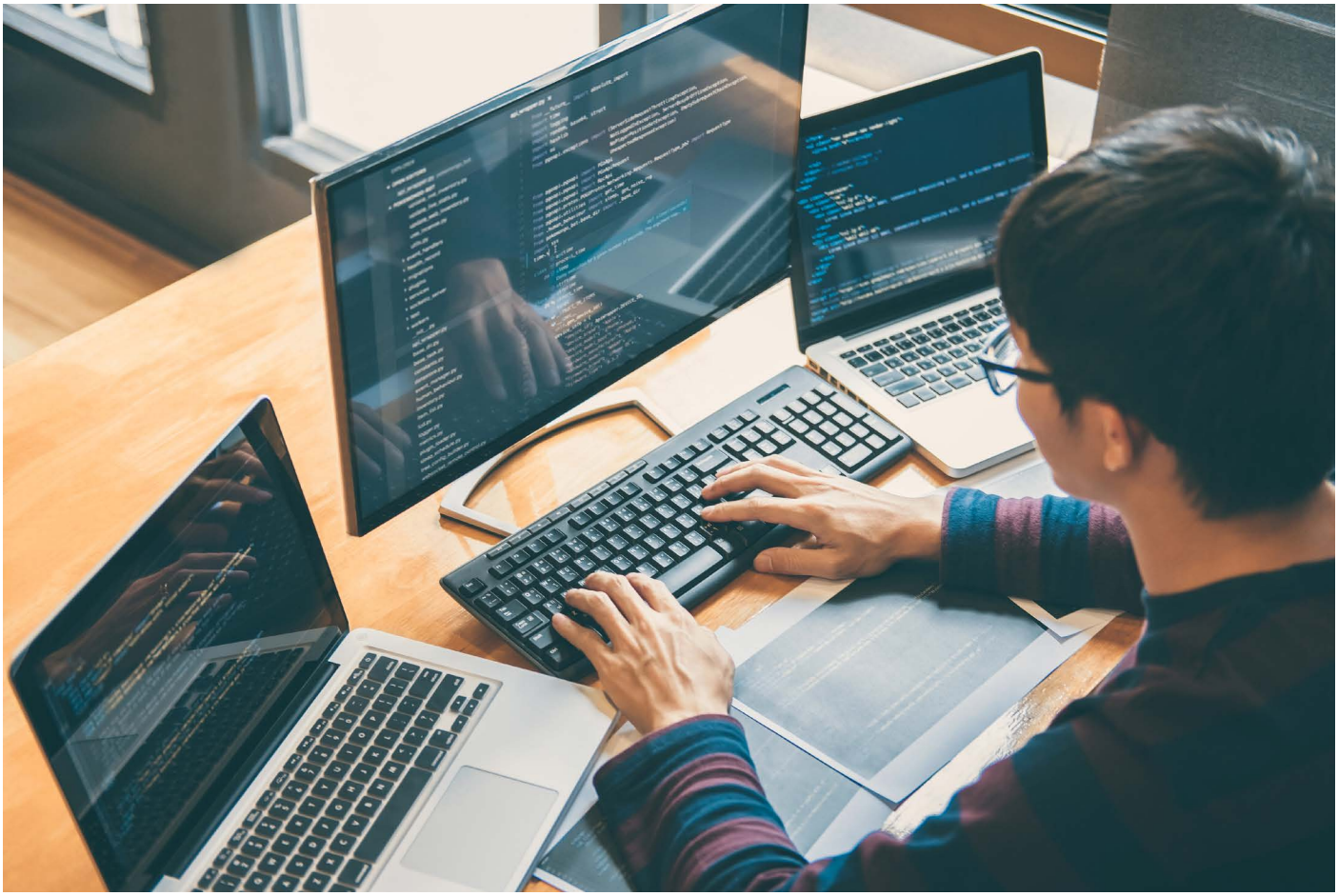
MATHEMATICAL INVESTIGATION
PANEL CUTTING PROBLEM

EXTENSION OR ADVANCED INVESTIGATION

The customer has some additional requirements. When cutting panels these panels are stacked on pallets which are then shipped to the building site. The builders require that panels are in order of installation. For example, if panel 1 and 2 are located next to each other when installed, then panel 1 and 2 are stacked next to each other on the pallet. Given the manufacturer does not have unlimited warehouse space, panels that are installed close by need to be cut close by (for example, on the same blank or the one after it). How does this impact the solution approach, does it make it a harder problem to solve?

REFERENCE MATERIAL

Python coding.



MATHEMATICAL INVESTIGATION
PANEL CUTTING PROBLEM

CAREERS RELATED TO THIS INVESTIGATION

SOFTWARE ENGINEER

Career description	Key skills required	More information
Software engineering is a branch of computer science that includes the development and building of computer systems software and applications software. Careers include: • IT Consultant • Game developer • Web designer	• Coding and computer programming skills • Competent software development skills • Good communication • Precision and attention to detail	https://careerswithstem.com.au/science-careers-list/

DATA ANALYST

Career description	Key skills required	More information
Data analysts use the tools of data engineers to analyse data and report on what they find – identifying trends, creating charts and visual representations of the data. They can work in various fields, such as sport data analyst. A sports data analyst can provide data to various athletes, eg. runners pace information, rowers – distance or loading rowed stats.	• Mathematics • Communication	https://careerswithstem.com.au/profiles/sports-data-analyst/

MATHEMATICAL MODELLER

Career description	Key skills required	More information
Mathematical modelers use mathematical models to illustrate processes or solve complex problems. These skills can be applied to a number of fields including animation. Many mathematical modelers use their mathematical modeling skills along with software technology to create and animate 3D representations of processes. They work in many different industries from aerospace to zoology. In entertainment industries, mathematical modelers may work in technical teams in animation, video game design, video game programming, and film and video.	• Mathematics • Good communication • Competent software development skills	https://www.indeed.com/career-advice/career-development/mathematical-modeling

MATHEMATICAL INVESTIGATION
PANEL CUTTING PROBLEM

CAREERS RELATED TO THIS INVESTIGATION

OPERATIONS RESEARCH ANALYST

Career description	Key skills required	More information
Operations research analysts advise managers and other decision makers on the appropriate course of action to solve a problem. Operations research analysts use advanced mathematical and analytical methods to help organiSations solve problems and make better decisions.	• Mathematics • Good communication • Solve complex problems • Scientific method • Statistical analysis	https://science.unimelb.edu.au/students/careers/careers-in-science/maths-and-stats/operations_research_analyst

CYBER SECURITY SPECIALIST

Career description	Key skills required	More information
The job of a Cyber security specialist includes: • Identify instances when a customer/client has been attacked but doesn't know it • Other cyber security measures. • How industries (eg. Banks) can better prepare for the cyber security threats they'll be facing in future (eg. five years).	• Analysis and representation of data • Reasoning and problem solving • Scientific method • Software development • Analytical thinking • Creative thinking • Technical skills	https://careerswithstem.com.au/profiles/cba-daniel-lekic//

ROBOTICS ENGINEER

Career description	Key skills required	More information
A robotics engineer will design and develop robotic equipment. They construct, configure, test, and debug robots and robotic systems. Careers include: • Robotics technician • Robotics software engineer • Toy designer	• Scientific method • Collaboration and communication • Thorough understanding of electrical wiring and computer software engineering. • Proficient with computer-aided drafting (CAD) software to create accurate drawings and schematics.	https://careerswithstem.com.au/profiles/mahonri-owen/

SITE RELIABILITY ENGINEER

Career description	Key skills required	More information
Companies such as google employ site reliability engineers. A site reliability engineer, is responsible for the effortless performance of products like for example, Google Photos.	• Scientific method • Coding • Reasoning and problem solving • Analytical thinking • Creative thinking	https://careerswithstem.com.au/profiles/anna-emmerson/

MATHEMATICAL INVESTIGATION
PANEL CUTTING PROBLEM

OTHER RELATED CAREERS TO EXPLORE

• Data scientist • App developer • Game developer	• Data engineer • Automation consultant • Blockchain developer	• Artifical intelligence specialist • Machine learning engineer • Decision support systems

For an overview of digital technologies being a priority industry and sector:
https://djpr.vic.gov.au/priority-industries-sectors/digital-technologies
https://careerswithstem.com.au/future-tech-jobs-in-australia/

For an overview of construction technologies being a priority industry and sector:
https://djpr.vic.gov.au/priority-industries-sectors/construction-technologies

CAREERS ACTIVITIES

THE 10 BEST RATED JOBS OF 2021

Rank	Career	Median salary	Projected growth
1	Data Scientist	$98 230	33%
2	Genetic Counsellor	$85 700	21%
3	Statistician	$92 270	35%
4	Medical Services Manager	$104 280	32%
5	Mathematician	$110 860	33%
6	University Professor	$80 790	9%
7	Operations Research Analyst	$86 200	25%
8	Information Security Analyst	$99 730	31%
9	Actuary	$111 030	18%
10	Software Engineer	$110 140	22%

Data from Careercast.com.

Select one of the careers, from either of the tables above, that interests you and find out:

- What are the tasks involved in this career? What may a typical day look like?
- What level of education or qualifications do you need to do this career?
- What are some other similar or related careers?
- What mathematics skills would be used in this career?
- Where does the career you have selected, to investigate, rank according to careercast.com?
- How many people in Australia are currently employed in this career (or field)?

MATHEMATICAL INVESTIGATION
PANEL CUTTING PROBLEM

INDUSTRY PARTNER

This project was produced collaboratively between The Mathematical Association of Victoria (MAV) and Biarri.

Biarri uses mathematical modelling to support better business decisions. The team at Biarri work on the most challenging business intelligence and analytical problems, from using Mathematics and Operations Research, to using advanced web development approaches and user experience design to provide simplified solutions. We solve the most diverse problems whether it is helping a customer to maximise revenue or to minimise scheduling delays.

At Biarri, we are an innovation hub and invest in the development of intellectual property. The team at Biarri love to challenge the status quo and the more challenging the problem, the better. In less than ten years, Biarri Optimisation has already spun off a few different businesses as we are a hub for innovation.

Biarri works with many industries including:
Supply chain — automate and optimise each stage of supply chain
Transport and logistics — keeping multi modal fleet utilised and efficient
Workforce — productive and efficient
Oils and gas — operations efficient and profitable
Banking and finance — using data to improve efficiency, and manage risk
Mining — efficient mine and assets
Telecommunications — automate and optimise the design of networks
Healthcare — improve planning, scheduling and predictive decisions
Predictive analysis — using data in a more effective and predictable way.

MATHEMATICAL INVESTIGATION
PANEL CUTTING PROBLEM

FURTHER CAREER REFERENCES

Australian Jobs Report 2021

www.nationalskillscommission.gov.au/australian-jobs-report
An overview of trends in the Australian labour market to support job seekers and employment service providers, career advisers, those considering future training and people interested in labour market issues.

Business Victoria Future Industries

https://business.vic.gov.au/grants-and-programs/future-industries
Future Industries is about supporting investment in high-growth industries through industry excellence and development projects, including establishing collaborative networks and building supply chain readiness capabilities.

Career Education

www.education.vic.gov.au/school/teachers/teachingresources/careers/Pages/default.aspx
Career Education teaching resources to help teach students to make informed career decisions and equip themselves for the world of work.

CEAV Online Learning Resources

https://ceav.vic.edu.au/media/250615/careers-in-the-construction-technology-industries-student-resource.pdf
Designed to enable students to attend a virtual Industry Immersion Experience, these online resources will help students discover more about Victoria's priority growth industries and give them the opportunity to reflect on their skills, interests and undertake career planning and exploration.

Jobs Victoria

www.jobs.vic.gov.au

JobOutlook

www.joboutlook.gov.au
Relevant and current labour market trends and career information.

MyFuture

www.myfuture.edu.au
A database of over 600 careers.

National Careers Institute

www.dese.gov.au/nci
The National Careers Institute (NCI) ensures Australians have access to reliable and accurate careers information, resources, and support.