

**Minor Challenge Set #1****STEM Field:** Mathematics**Level:** Junior**Challenge Name:** Sort Your Christmas Presents**Project cost:** 0-20 USD**Materials required:**

- Pen and paper
- Printing (optional but convenient)

Duration:

- This challenge takes approximately 3 hours to finish, however, the time guideline is an estimation only, and students and mentors can complete the tasks around their schedules.

Introduction

It's the start of a new year and you are sorting the many presents you may have received from your birthday, Christmas or other celebrations. There are 9 presents in total.



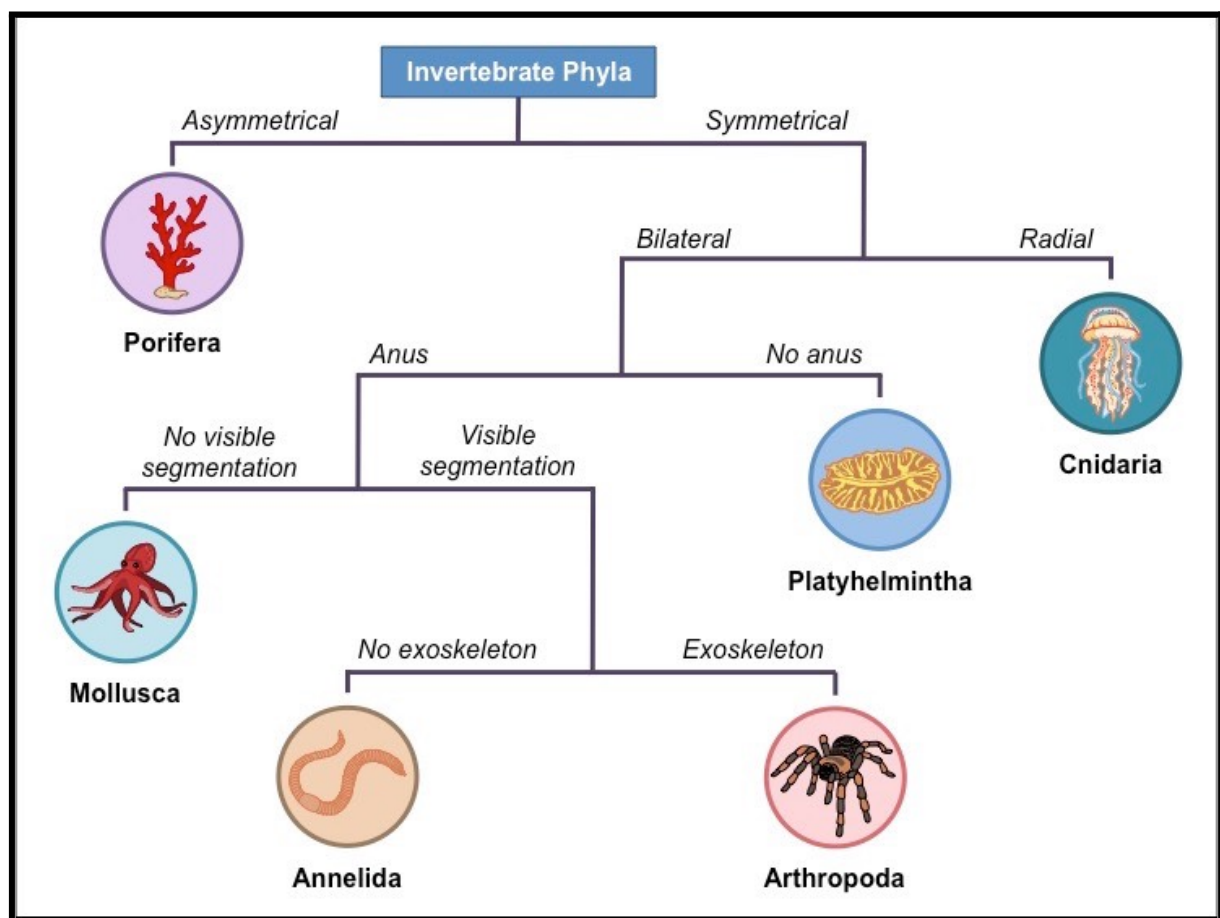
Figure 1: A picture showing 9 present boxes with different characteristics for students to sort into different groups.

Your goal is to find as many different ways to sort them into groups as you can!

For example, you may sort these boxes into groups depending on the boxes' heights. There will be two groups in this case: one group of tall present boxes, and one group of short present boxes.

While this is not a typical mathematics problem you may encounter in your class, this is an example of a computational problem that relies on your logical thinking skills. An application of this sorting problem can be found in biological or environmental sciences! Scientists who create a dichotomous key to identify unknown animals or plants will need to sort and divide existing animals or plants into two categories based on their features.

An example of a dichotomous key is shown below.



Caption: An example of a dichotomous key used to identify phyla of invertebrates.

This problem draws from NRICH website's "Sort the Street" problem (link cited in the bibliography). This is part of the low threshold high ceiling problems, meaning anyone can attempt the puzzle and anyone may find it difficult. These problems are open-ended so students can show their reasoning skills and inventive thinking!

Instruction

1. Print the worksheet [here](#) and cut out the 9 cards with present boxes.

Note: If you have difficulty opening the linked worksheet, please send us an email at scichal@robogals.org and we will send you a PDF copy of the worksheet.

2. Find as many different ways to sort them into groups as you can!
3. Answer the questions below in a different worksheet and submit along with your reflection!
 - a. How many groups were you able to sort the boxes into?
(Note: All the boxes in any particular group must share some specific feature. E.g. all have an orange lid.)
 - b. Is it possible to sort the boxes into groups where all the boxes in every group share exactly two features? For example, one group will only have boxes with dark blue bows and an orange lid.
 - c. Is it possible to sort the boxes into groups where all the boxes in every group share exactly three features? If it's possible, can you show us the group you found?

Extension

When you opened these present boxes, you found that some of them were empty, and some still had a present inside! Boxes with a present inside are marked with a star at the top of the card.



Caption: A picture showing 9 present boxes. Some present boxes included a gold star, which indicates that a present is still inside the box.

Print the worksheet [here](#), cut out the 9 cards and sort the boxes into as many groups as possible!

Reflection Questions

- Are there any improvements you would make to this challenge?
- What real world application can you apply this challenge to?
- Is this puzzle easier or harder than you expected?
- Can you explain how you solved this problem?
- If you attempted the extension tasks, answer the following questions:
 - Is it possible to sort the boxes into groups where each group has boxes that share 3 or more features? Can you show us the groups?
 - Is it possible to sort the boxes into groups where each group has boxes that share exactly 3 features?
 - Is it possible to sort the boxes into groups where each group has boxes that share exactly 4 features?

Submission Guidelines

- Submit your solutions to **questions 3a, 3b and 3c** in the **Instructions** section. Your solution can be in the form of a diagram, mind-map, or pictures of the groups you sorted the present boxes into. Please label your pictures and diagrams so we can better understand your solution!
- Submit your answers to the reflection questions.

Note: Remember, if you want to upload pictures of your Minor Challenge that also include you, please check if it is OK with your mentor first.

- If you attempted the extension task: Submit your solution to the extension task and answers to the questions. Please label your pictures and diagrams so we can better understand your solution!
- The submission form is on the Minor Challenges page:
<https://sciencechallenge.org.au/index.php/minor-challenges/>
 Fill out the details and make sure you upload your submission.

Learn More! Resources

- If you want to attempt another similar puzzle, NRICH has a problem called “Teddy Town”, where you match teddy bears to a house.
<https://nrich.maths.org/108>
- If you want to find more information on low threshold high ceiling problems, you can read here.
<https://nrich.maths.org/10345>
- If you want to find more information on dichotomous keys, here is one resource that explains in more detail.
<https://ib.bioninja.com.au/standard-level/topic-5-evolution-and-biodi/53-classification-of-biodiv/dichotomous-keys.html>

Bibliography

- Ib.bioninja.com.au. 2022. Dichotomous Keys | BioNinja. [online] Available at: <<https://ib.bioninja.com.au/standard-level/topic-5-evolution-and-biodi/53-classification-of-biodiv/dichotomous-keys.html>> [Accessed 11 January 2022].
- Nrich.maths.org. 2022. Sort the Street. [online] Available at: <<https://nrich.maths.org/5157>> [Accessed 11 January 2022].