

## CLASSIFICATION AND BIODIVERSITY

### Introduction

Biologists study different plants, animals and other organisms around us and make classification trees based on their observed features. Biological classification has multiple purposes. Classification makes the study of biodiversity easier by ensuring that newly found organisms are assigned to appropriate groups. Based on what we know about other organisms in that group, we can predict the characteristics of these newly discovered organisms. These classification trees often also give us clues to how evolution might have occurred over millions of years!

But classification is a concept not just limited to biology. We all often organise objects into groups based on similarities and differences in their properties. You may have recently organized or classified everyday objects around without even realizing it.

For example, maybe you recently were looking in your cupboard for clothes to wear. How are the clothes arranged in the cupboard? The clothes might be organized based on their utility (daily wear / special occasions/school) or based on what weather they are for (summer/monsoon/winter) or based on whose clothes they are (yours / your parents / your siblings). These sorts of organization of clothes make it easier to find what you want.

Can you think of any place (other than clothes in the cupboard) where you use classification?

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### Materials required

Paper / Pen / Pencil

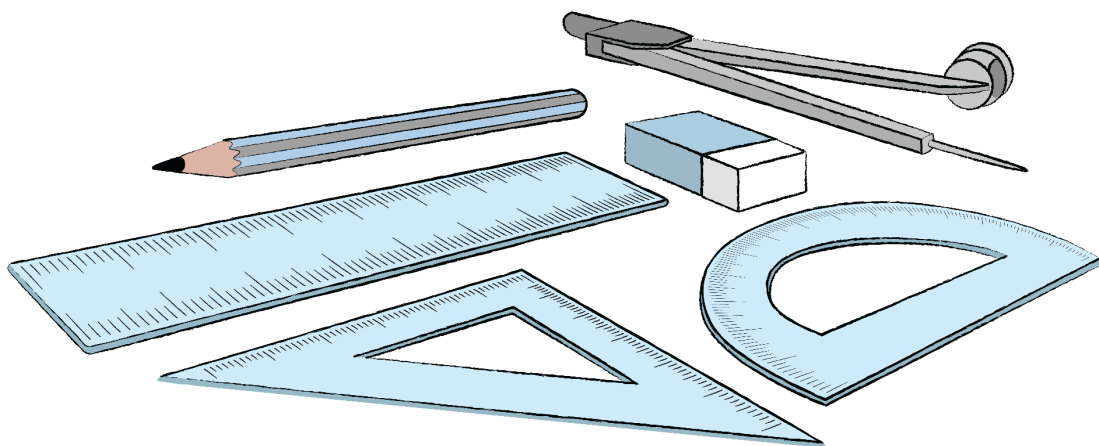
Geometry box

In the task below, we will classify objects we commonly find in our geometry boxes.

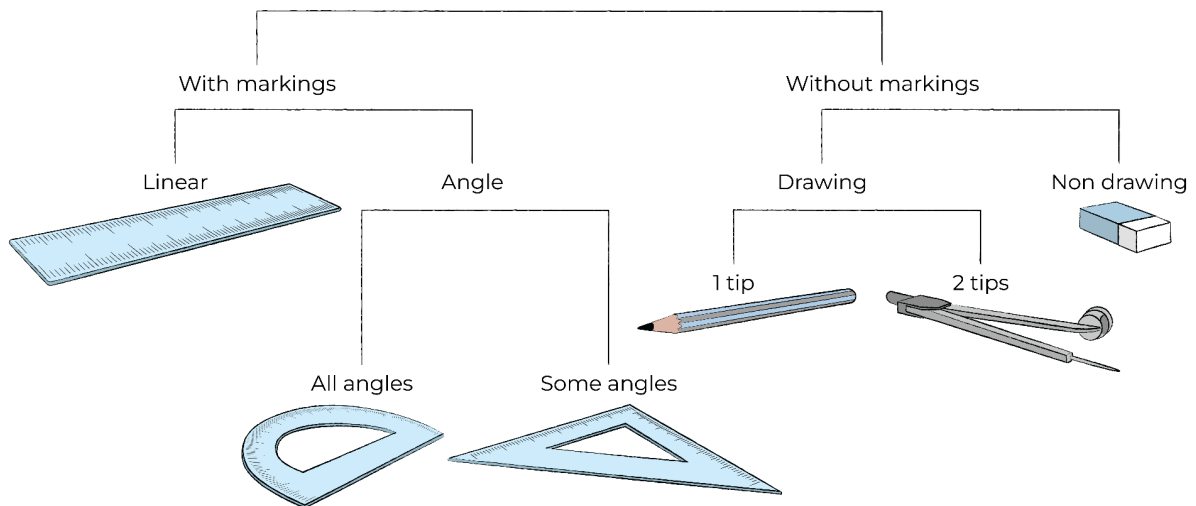
### Task 1: Make a classification tree

Find the following objects from your geometry box:

Pencil, Ruler, Set square, Eraser, Protractor, Compass



To classify objects, observe them carefully and identify differences and similarities between them. You might notice that two objects share some properties but differ in other properties. For example, a common feature of the scale, set square and protractor have markings. However, they measure different things. Then, you can choose a property to divide the objects you have into groups. Whatever property you choose, note that each object should fit into *one and only one group*. You can continue this process within each group to further organize objects. For example, here is one possible classification of these objects:



So here, objects are first divided into groups based on the property of markings: scale, protractor and set square have markings while pencil, compass and eraser are without markings.

Within the group of objects with markings, we choose to divide them into subgroups based on the property of what they measure: scale measures linear objects and protractor and set square measures angles.

Can you try to draw a different classification tree with the same objects?

In what ways do you think the classification tree provided is useful? In what ways do you think your classification tree is helpful?

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## Task 2: Draw some organisms

Biodiversity comes from two words: biology and diversity. Biological diversity is the variety of living organisms found on earth. Each of these organisms differ in the shape, size, color, body parts, habitat, behaviour etc. This diversity has evolved over millions of years since life first originated on earth. Biological classification can help us understand how this process occurred.



Just like for the objects in your compass box, classification of biological organisms is based on differences and similarities of organisms. One way to classify organisms is externally visible features, i.e. the shape, number and type of body parts. To study this, early naturalists and biologists used to observe and make detailed drawings of organisms.

Maria Sibylla Merian (1647–1717) was a Dutch<sup>1</sup> scientific illustrator<sup>2</sup>. As a young student, Maria collected insects. She went on to travel to Suriname<sup>3</sup> to observe and make detailed drawings of the biodiversity there. Her work mainly focused on insects, their life cycle and their plant hosts.

The earliest biological classifications were based on detailed drawings by scientific illustrators like Maria. In fact, years after her expeditions, Carl Linnaeus in the 1730s, used Maria's drawings to describe and identify about one hundred new species!

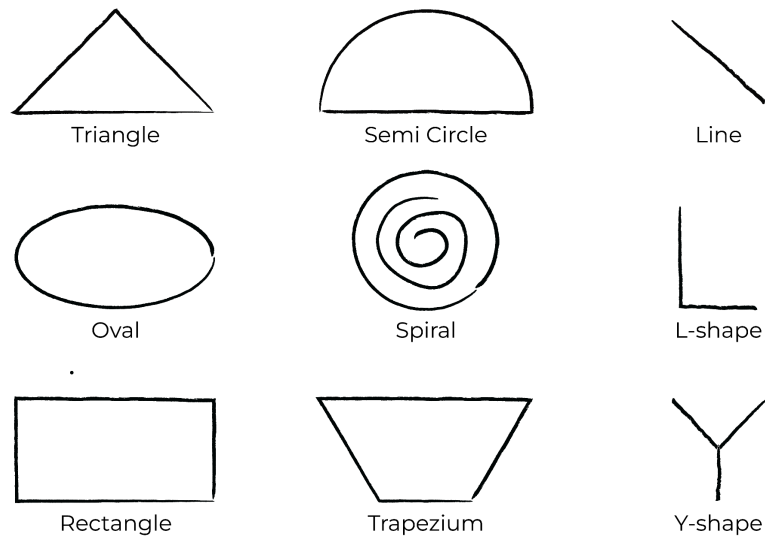


<sup>1</sup> Dutch: person from the Netherlands

<sup>2</sup> Scientific illustrator: Someone who creates detailed, accurate visual depictions of living organisms or natural phenomena. Historically, scientific illustrations were detailed drawings made by hand by directly observing the collected sample or specimen, which often became the sole source of scientific information on that specimen.

<sup>3</sup> Suriname: a country in South America

So, let us also draw and classify some organisms! For our drawings, we are going to use these simple shapes:



Here are instructions below to draw some organisms:

### Organism 1

1. Draw 3 non-overlapping ovals, in increasing order of size, attached to each other at the narrow ends. The smallest oval shape represents the **head**. The middle oval represents the **thorax** and the last oval represents the **abdomen**.
2. Draw 3 L-shapes on each side of the thorax. These represent **legs**.
3. Draw 2 straight long lines from the head pointing away from the rest of the body. These represent **antennae**.
4. Draw a line starting from the point between the head and the thorax and ending at the end of the abdomen. Draw two semi-circles, one on either side of this line. These semi-circles represent **wings**.

### Organism 2

1. Draw a semi-circle. This represents the **head**.
2. Draw a long rectangle, using the flat side of the semi-circle as the shorter side of

the rectangle. Divide the rectangle into smaller rectangles using straight lines perpendicular to the longer side of the rectangle. The long rectangle represents the **trunk**.

3. For each smaller rectangle, draw 2 L-shapes on each side. These represent **legs**.
4. Draw 2 straight short lines from the head pointing away from the rest of the body. These represent **antennae**.

### Organism 3

1. Draw a long thin oval. This is the **body**.
2. Divide the oval into many parts using lines perpendicular to the longer sides of the oval.
3. Shade one of the rectangles near (but not at) one end of the oval. This is the clitellum.

### Organism 4

1. Draw 3 non-overlapping ovals in increasing order of size, attached to each other on the narrow end. The smallest oval shape represents the **head**. The middle oval represents the **thorax** and the last oval represents the **abdomen**.
2. Draw 3 L-shapes on the thorax on each side. These represent **legs**.
3. Draw two lines from the head pointing away from the rest of the body. These represent **antennae**.

### Organism 5

1. Draw a long oval. This oval contains the **foot**. One end of this oval contains the **head**.
2. Draw a spiral on top of the oval away from the head. This is the outer covering (or shell) that contains the **body organs**.

3. Draw 2 short lines and 2 long lines on the head pointing away from the rest of the body. These represent **antennae**.

### Organism 6

1. Draw a trapezium (a quadrilateral with two parallel but unequal sides). This represents the **abdomen**.
2. Draw a triangle, with the longer parallel side of the trapezium as the base pointing away from the trapezium. (And not overlapping with the trapezium) . This triangle represents the **cephalothorax**: a fusion of the head and the thorax.
3. Draw 3 L-shapes on either side of the abdomen, close to the cephalothorax. These represent the **legs**.
4. Draw 2 L-shapes, one on either side of the cephalothorax, close to the abdomen. These also represent **legs**.
5. Draw large 2 Y-shapes, one on either side of the cephalothorax, towards the middle. These represent **modified legs**, also called appendages or pincers.
6. Draw two small lines near the tip of the cephalothorax pointing away from the rest of the body. These represent the **antennae**.

Can you guess which animals you have drawn?

Organism 1: \_\_\_\_\_

Organism 2: \_\_\_\_\_

Organism 3: \_\_\_\_\_

Organism 4: \_\_\_\_\_

Organism 5: \_\_\_\_\_

Organism 6: \_\_\_\_\_

**Task 3: Organize information and make a classification tree**

Let us organise the information we have about these animals into a table. Here is a table to help you organize information. Look at the instructions and your drawings of the organisms to fill in the table. A few of the features have been added to help you.

Table of features								
No.	Organism	No. body parts	Body parts	No. of Antennae	No. of wings	No. of legs		
1	Organism 1 _____	3 parts	Head, thorax, abdomen	1 pair	1 pair	3 pairs		
2	Organism 2 _____		Head, trunk			many		
3	Organism 3 _____	1 part	Body not divided					
4	Organism 4 _____		Head, thorax, abdomen					
5	Organism 5 Snail		Head, body organs (in shell), foot			1 muscular foot		
6	Organism 6 _____		Cephalothorax, abdomen	1 pair				
7								
8								

(Note: The last two columns and last few rows can be left empty for now. They will be used later.)



Using only the features from this table, draw a classification tree of the organisms. You can choose any division feature to start the classification tree but remember that each organism, at each division, should fit into exactly one branch.

What are the features you used as divisions in your tree?

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Remember, each organism can be in one, and only one, division at each stage. Your classmates might have drawn a different tree even with the same information. More information about the organisms might help us understand which tree is better.

#### **Task 4: Challenge your classification tree**

##### **a) New information**

Many years of observation and research reveal information about organisms that might not have been directly observable. For example, many animals are 'segmented', i.e. consisting of many repeated parts or 'segments'. Some of the organisms we have drawn are segmented. Sometimes these segments are easily identifiable like in the many parts of a centipede and sometimes not so visible, like the internal parts of a cockroach. Other animals like the snail are not segmented.

Organism 1 – segmented

Organism 2 – segmented

Organism 3 – segmented

Organism 4 – segmented

Organism 5 – not segmented

Organism 6 – segmented

In a new column for “segmented”, fill in this new information in your table of features.

Now, let us see how this new information looks on our classification tree.

Circle all of the animals that are segmented. Are all the animals that are segmented in one group or are they spread across groups?

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Draw a new classification tree that also includes segmentation as a feature.

What are the features you used as divisions in your tree?

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How is your new tree different? In this new tree, are there other features that are split across groups?

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Currently, biological classification trees are based not just on physical features but on many other features, most importantly DNA sequences. These sequences are used to make “phylogenetic trees” to understand how species evolve. These trees have divisions just like the trees you made, but use differences in DNA sequences as features. These types of classification trees can also be used to estimate when and how a species evolved. This is not an easy task: scientists often have many different trees based on the same DNA sequences and it is difficult to understand which one shows what might have actually happened evolutionarily.

You now have multiple trees that could represent your organisms. Select one of the trees you have drawn for the following tasks.

Are there other properties of this tree that you prefer and why? Which of your classification trees do you think is ‘better’ and why?

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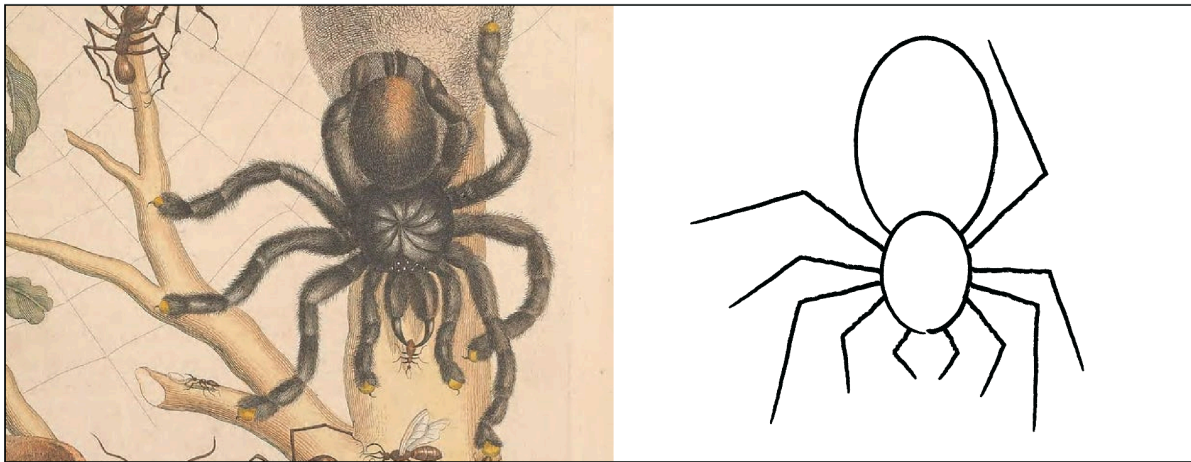
**b) New animals**

Maria was especially fond of the silkworms and observed and studied them in detail. Here is one of her scientific illustrations of the silkworm life cycle.



For now, let us focus on the adult form.

She also studied some spiders. Here is her drawing of a type of a big spider called a tarantula:



Look at Maria's drawings and the simplified versions to fill out the table of features.

Note that both the silk moth and spider are segmented.

Place these organisms in your classification tree.

Did these animals fit easily in your classification tree? Did you have to make any changes / new divisions for these animals?

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Maria made significant contributions to understanding biodiversity, ecology and classification. Long after Maria's death, a number of taxa and genera have been named after her, including recently, in 2018, a newly reported butterfly in South America: *Catantixia sibyllae*.

The Indian subcontinent is one of the most biologically diverse regions of the world. New organisms are being reported and studied all the time. For example, there is a purple frog found in the western ghats of India which was only studied, reported and named *Nasikabatrachus sahyadrensis* in 2003! This led to changes in how we understand the evolution of certain species of frogs. You can read more about it here:

<https://www.saevus.in/the-purple-frog-living-in-the-shadow-of-the-dinosaurs/>

A systematic understanding of such biodiversity and its classification is necessary for effective conservation efforts.

## Task 5: Observing organisms in soil

### Precautions

- Wash your hands (before and) after this exercise.
- Observe insects from a safe distance: DO NOT touch them with your hands! Do not try to poke them with sticks etc either.
- Observe insects in their natural habitat: DO NOT remove them from where they are.

### Where to find insects to observe?

soil: under a stone

soil: a few cm under the surface

trees: under the bark of the tree

trees: in branches

garden: around flowering plants

homes: near a light at night

homes: masala box/rice/grains/kitchen supplies

Choose one of these locations (or another of your choice):

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### Draw some insects

Observe the insects carefully.

Choose 4 insects and draw them using simple shapes (like you did in Task 2)

Do any of these insects look similar to the ones you have already drawn in Task 2?

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**Classify your insects:**

Add the organisms you have just drawn to new rows in your table of features from Task 3. Try to identify the same features: number of legs, antennae, body parts etc.

Are there any other features that you have noticed? You can add these as new columns to your table of features from Task 3.

Can you try to place these insects in your current classification tree? If you like, you can try drawing a different classification tree that includes your set of insects.

**References:**

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5. The Great Indian Nature Trail with Uncle Bikky - Author and illustrator: Rohan Chakravarty and Essays by Bijal Vachharajani (Available with WWF – India: <https://shop.wwfindia.org/books/the-great-indian-nature-trail-with-uncle-bikky.html>)
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7. More about Maria Merian :  
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<https://www.lannoo.be/sites/default/files/books/issuu/9789401433785.pdf>  
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