Statistics and Probability

TABLE OF CONTENTS

Sorting and Classifying I

1

Overview

Mathematical Focus

- Descriptions of objects' attributes
- Data gathering about objects
- Classification of objects according to attributes

In this activity, students create a set of animals that vary according to type, color, and pattern (i.e., striped or spotted). To create the set, students color an assortment of animals that are provided on Student Pages 1 – 4. Students then play sorting games to organize the animals into groups, and "Guess My Rule" games to determine the ways these animals could be sorted, according to rules. When the animals are organized into groups by a rule, students play a game—an animal that doesn't belong is added to a group, and students have to find it and determine why it doesn't belong.

Preparation and Materials

Before the session, gather the following materials:

- Student Page 1 (cut out ahead of time)
- Student Page 2 (cut out ahead of time)
- Student Page 3 (cut out ahead of time)
- Student Page 4 (cut out ahead of time)
- Blue, red, and green crayons

Activity

Creating Different Animals

1. Answer questions about animals cut from Student Pages 1, 2, 3, and 4.

Ask students to answer the following questions:

- *Which animals are the same?*
- *How are they the same?*
- *Which animals are different?*
- *How are they different?*
- *What parts of the animals can you use to tell them apart?*

2. Create a set of 24 animals by drawing spots and stripes and using three different colors.

Explain that there are four different types of animals and that the students are going to create six of each of these types. The final set should include 24 animals, based on the chart shown below. For the six cows of Type A, have students draw stripes on three of the cows and spots on the other three. Then have students choose three colors, and use a different color on each of the three spotted cows and a different color on each of the three striped cows. Have students repeat this process with the horses, dogs, and cats.

Cows	Spotted	Blue	Dogs	Spotted	Blue
		Red			Red
		Green			Green
	Striped	Blue		Striped	Blue
		Red			Red
		Green			Green
Horses	Spotted	Blue	Cats	Spotted	Blue
		Red			Red
		Green			Green
	Striped	Blue		Striped	Blue
		Red			Red
		Green			Green

3. Sort the animals into groups, according to color.

Ask:

- *Would the animals be in the same groups if we sorted them according to a different characteristic?*

4. Brainstorm ways to sort the animals into groups and sort them into those groups.

Ask:

- *How else could we sort the animals?* As students sort the animals, they should explain how they know to which group each animal belongs.

Sorting Games

Guess My Rule

Goal: To guess the rule for sorting animals

Players: 2 or more

Materials: Cut-out animals with different characteristics

Instructions: Choose a sorter and a guesser. The sorter picks a rule and sorts the animals (or other objects) into groups according to that rule, keeping the rule a secret. The guesser tries to guess the rule. The guesser can also guess which group any leftover animals fit into in order to test the predictions about the rule.

Which Animal Doesn't Belong?

Goal: To guess which animal is not in the correct group

Players: 2 or more

Materials: Cut-out animals with different characteristics

Instructions: One person sorts most of the animals into two groups, but places one animal in the wrong group. The sorter then shares the sorting rule he or she used, and the other person must figure out which animal is out of place and why.

Gatekeepers

Goal: To guess the rule that the Gatekeeper is using to allow animals through the gate

Players: 2 or more

Materials: Cut-out animals with different characteristics; a piece of paper to serve as the gate

Instructions: The Gatekeeper operates the gates that let animals pass through. The Gatekeeper determines a rule for passing through the gate

(such as, "Animals with stripes/red animals/blue spotted animals may pass through). Other players choose animals and ask if they can pass through the gate. The Gatekeeper allows only the animals that satisfy his or her rule to pass through. When a player thinks he or she knows the rule, that player says it aloud or passes all of the animals that fit the rule through the gate.

Sorting and Classifying II

2

Overview

Mathematical Focus

- Sorting and classifying of objects
- Venn diagrams (sorting bins)

In this activity, students continue their exploration of sorting and classifying objects. Students begin to explore Venn diagrams by placing the animals they made during Activity 1. Students talk about how many different circles a particular animal can be in and what it means for an animal to be outside a particular circle.

Preparation and Materials

Before the session, gather the following materials:

- Cut-out and colored animals from Student Pages 1 – 4
- Large pieces of paper
- String

If you didn't do Activity 1, you will need to start this activity by having students color each of the animals, according to the directions in Activity 1.

Activity

Animal Pens

1. **Use the rules you used during Activity 1 to sort the animals you created.**

   Remind students that they used different rules to sort the animals they colored during the first activity. Ask if students can remember some of the different sorting rules they used.

2. **Place all of the animals that belong in the "Spotted Animals" pen and then place all of the animals that belong in the "Red Animals" pen.**

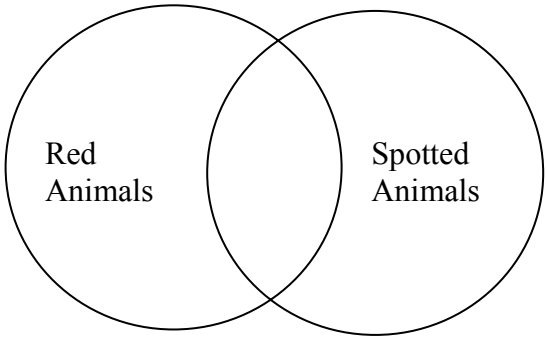
   Draw a large circle and write "Spotted Animals." Draw a large circle, write "Red Animals," and explain that this is a pen for all of the red animals. Ask:

   - *Did you need to take some animals out of the "Spotted Animals" pen to put them in the "Red Animals" pen?*
   - *Do those animals really belong in both pens?*
   - *Are there any animals that do not belong in either pen? Which ones?*

3. **Show where you would place animals that are spotted but not red, animals that red animals that don't have spots, and red spotted animals if the two pens overlapped.**

   There is a way to create two pens that overlap so that the animals that belong in more than one pen can be inside both of them. Draw two overlapping circles (similar to those below) and write "Spotted Animals" and "Red Animals" inside the two circles. (Students should place the last group—the red spotted animals in the overlapping part of the circles.)

4. **Place the animals in the appropriate places within a "Green**



5. **Animals" pen and a "Blue Animals" pen that overlap.**

   Draw two more overlapping circles, and this time write "Green Animals" in one and "Blue Animals" in the other. Have students place the appropriate animals in the two pens. When they are finished, ask:

   - *Why are there no animals in the overlapping part of the pens?* If students did place animals in the overlapping part, ask them to explain why.

6. **Create your own pens and sort the animals into the proper places.**

   Ask students to think of two different kinds of pens. Write the name of each pen on a piece of paper and place it inside the pen. Have students sort the animals into the pens, or leave them outside the pens. Remind students that they can make the two pens overlap if they need to in order to get all of the animals into the proper pens. Ask students to explain how they know where to place each animal.

7. **Answer questions about how you have placed the animals in the pens.**

   Ask them the following questions:

   - *What does it mean if an animal is outside all of the circles?*
   - *What can you say about animals that are inside the overlapping part of the circles?*
   - *What do you know about the animals that are just inside this circle? (Point to one of the circles.)*
   - *What about the animals that are just inside the other circle?*

8. **Take turns creating pens for the animals and placing the animals in the appropriate places.**

   Have students explain how they choose where to place the animals.

Extension

Challenge students to create more sorting pens for animals, but this time using three different kinds of pens. Ask students how they will make the three pens overlap. Ask: *Are there any animals that need to be in all three pens? Are there any animals that are in two of the pens but not the third?*

3

Data Gathering and Representation I

Overview

Mathematical Focus

- Data gathering
- Data representation, using concrete objects, pictures, and numbers
- Data description
- Special characteristics of data

In this activity, students explore data gathering by working with 20 crayons in 4 different colors. They sort the crayons by color and fill in a graph to determine how many there are of each. Students discuss what the graph tells them and whether they would get different results with different crayons. Students then make their predictions, based on the graph, about what color crayon they would pull out of a bag if they pulled out one crayon at a time. Students test their predictions, first by pulling out crayons and leaving them outside the bag, then by pulling out crayons and returning them to the bag each time. Finally, students come up with a sorting question for the animals from Student Pages 1 – 4; they make a graph and then sort the animals onto the graph in order to answer their question.

Preparation and Materials

Before the session, gather the following materials:

- Twenty crayons in red, blue, green, and purple, an assorted number of each color
- Non-transparent bag
- Graph paper
- Cut-out and colored animals from Student Pages 1 – 4

Activity

Sorting Crayons

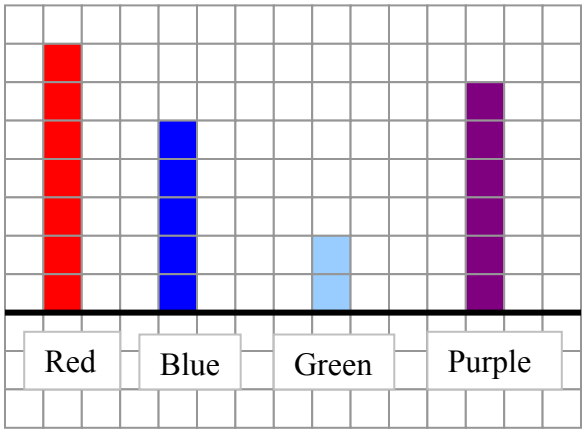
1. Sort crayons into piles by color.

Explain that they are going to use the crayons to make a graph that shows how many there are of each color.

2. Create a graph of the colors of the crayons.

Use graph paper to set up a graph like the one below. Ask students to choose a crayon and then to color in a square above the line in the column for that color. Have students repeat this process with each of the crayons, coloring each new square directly above the last square of that color.

Example:



3. Answer questions about your crayon color graph.

Ask questions such as the following:

- *Which color crayons are there the most of? How can you tell?*
- *Which are there the least of? How can you tell?*
- *Are any colors tied?*
- *What might the graph look like with a different set of crayons? Would it be the same? Why or why not?*
- *What would the graph look like if you re-drew it with the same set of crayons? Why?*

4. **Predict then check what color crayon you will pull out if all the crayons shown on your graph are placed in a bag.**

   Explain that students are going to play a probability game. Place the crayons in the bag and shake it. Ask students to look at the graph and then to predict which color crayon they think they are most likely to pull out, and which color they are least likely to pull out. Ask if there are any colors it would be impossible to pull out. Have students explain their thinking for each of these questions. Give each student a chance to pull a crayon out of the bag. Ask whether their predictions were correct. Have students continue to guess which color they will pull out to test their predictions, each time leaving the crayon out of the bag once it has been pulled.

5. **Predict, then check how many crayons of each color you will pull out if you try drawing a crayon out of the bag 10 times, each time returning the crayon to the bag.**

   Have students predict how many of each color they think they might pull out. (Be sure to mix up the bag between draws.) As students pull out each crayon, have them keep track of the colors. When students have finished, ask if they are surprised by the results, and why or why not.

Animal Data

1. **Pick a question about animals that can be answered by sorting those animals.**

   Bring out the pile of animals from Student Pages 1 – 4. Use 12 of the animals, chosen at random. Questions the students could use include the following:

   - *How many animals are striped and how many are spotted?*
   - *How many animals are red? How many are blue, and how many are green?*
   - *How many cows, horses, cats, and dogs are there?*

2. **Create a graph to answer your question about the animals.**

   Use a large piece of graph paper and label the x-axes (the bottom line) with the different kinds of animals. Have students place each animal in a stack on top of the category into which it falls. When all of the animals have been placed, ask students what they can learn about the animals by looking at the graph they created. Ask which type of animal there is the most of and which type there is the least of.

4

Data Gathering and Representation II

Overview

Mathematical Focus

- Data gathering
- Data representation
- Data description
- Special characteristics of data

In this activity, students gather types of data from three activities: drawing X's and O's in a circle, completing several mazes, and hopping on one leg. Students represent the data from these activities in bar and picto-graphs.

Preparation and Materials

Before the session, gather the following materials:

- Student Page 5, three copies per student
- Student Page 6, one copy per student
- Student Page 7, one copy per student
- Stopwatch or other timing device
- Scissors
- Graph paper, several pieces
- Tape
- Crayons or markers

Activity

Collecting Data

1. **Estimate then check how many X's you can draw in a minute.**

   Give students a copy of Student Page 5. Estimate how many X's they can draw inside the circle during one minute. When students have made their estimates, time them for a minute, and then have them count how many X's they drew. Are they surprised by the number they drew?

2. **Try the experiment again.**

   Repeat the experiment. When students have made their estimates, draw X's for one minute. Ask students to compare the number of X's they drew the first time to the number they drew this time and to explain why the number is the same, nearly the same, or different.

3. **Explain whether and why you think the number of O's you can draw in one minute will be the same or different from the number of X's you drew in a minute and then try it.**

   Have students draw the O's for one minute, and then count how many they drew. Ask them to compare this number with the numbers of X's and to explain why the number of O's is similar to or different from the number of X's.

Graphing Data

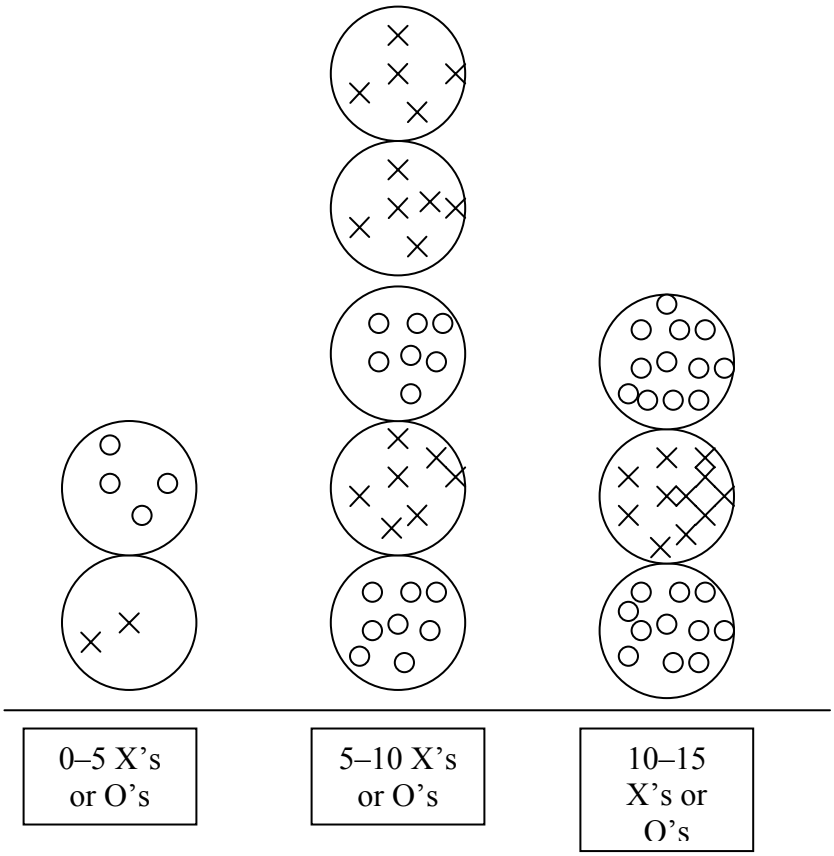
1. **Conduct the X and O drawing experiment 10 times.**

   Students draw the X's or O's for 10 trials each time.

2. **Cut out all of the circles that were used for drawing X's and O's and use them to create a graph.**

   Tape several pieces of graph paper together. On the bottom of the graph paper, draw a line at different points, write all the numbers of X's or O's the students drew, leaving a space the width of one circle between each category. (It will work better for the categories along this line to be ranges of numbers, such as 10–15, 15–20, 20–25, 25–30, and 30–35 X's or O's.) Ask students to place each circle above the appropriate category on the line. If more than one circle fits in a particular category, have students stack them in a column, heading toward the top of the piece of paper.

Example:



3. Answer questions about your graph.

Ask students:

- *What numbers of X's and O's were most likely to be drawn in one minute?*
- *What numbers of X's and O's were least likely to be drawn in one minute?*
- *What was the smallest number of X's or O's drawn?*
- *What was the largest number of X's or O's drawn?*

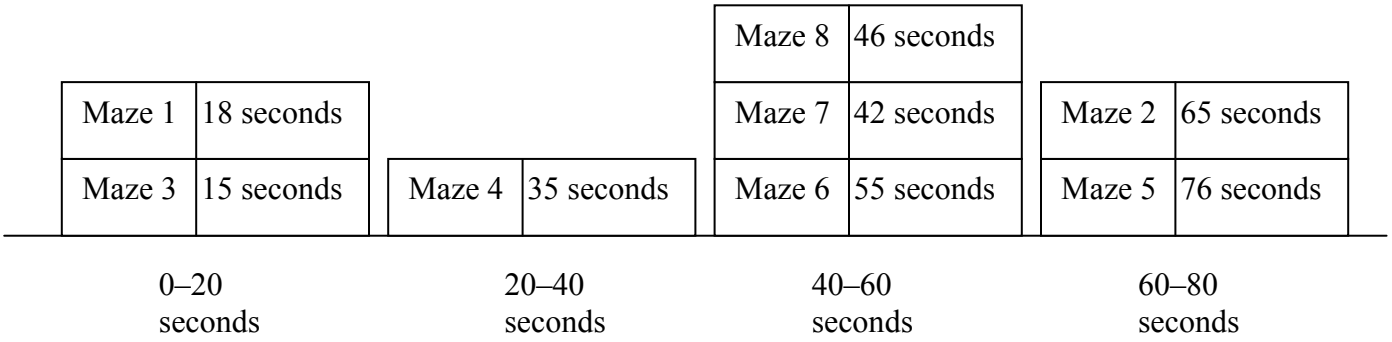
Mazes

1. Record in a chart how long it takes you to complete each maze on Student Pages 6 and 7.

Have students each make a chart to record the name of each maze and how long it took to complete it. Time each student as he or she works through each maze, and have them record their time on the chart.

2. Make a graph of the maze completion times using cut-out data from your chart.

Cut out the name of each maze and the time it took to complete from the chart. Create a graph for each student by listing the ranges of completion times as categories. Ask students to place the cut-out strips of paper over the appropriate category. If more than one maze falls into the same range of completion times, place the mazes in a column on top of each other. The graph should look something like this:



3. Answer questions about your maze completion time graph.

Ask questions such as the following:

- *Which maze was most difficult to do? How can you use the graph you made to explain your reasoning?*
- *Which maze was least difficult to do? How can you use the graph to explain your reasoning?*
- *In which amount of time were the most mazes completed?*
- *In which amount of time were the fewest mazes completed?*

Hopping on One Foot

1. Run ten trials to see how many times you can hop on one foot.

They should choose either their left foot or their right foot and then hop on this same foot for each of the trials. Have students run 10 trials of this experiment, recording the result each time.

2. Make a bar graph to show the results of your hopping experiment.

Use graph paper and label it with Trials 1 through 10. For each trial, ask students to color in one square for each hop they made during that trial.

3. Answer questions about your hopping graph.

Ask questions such as the following

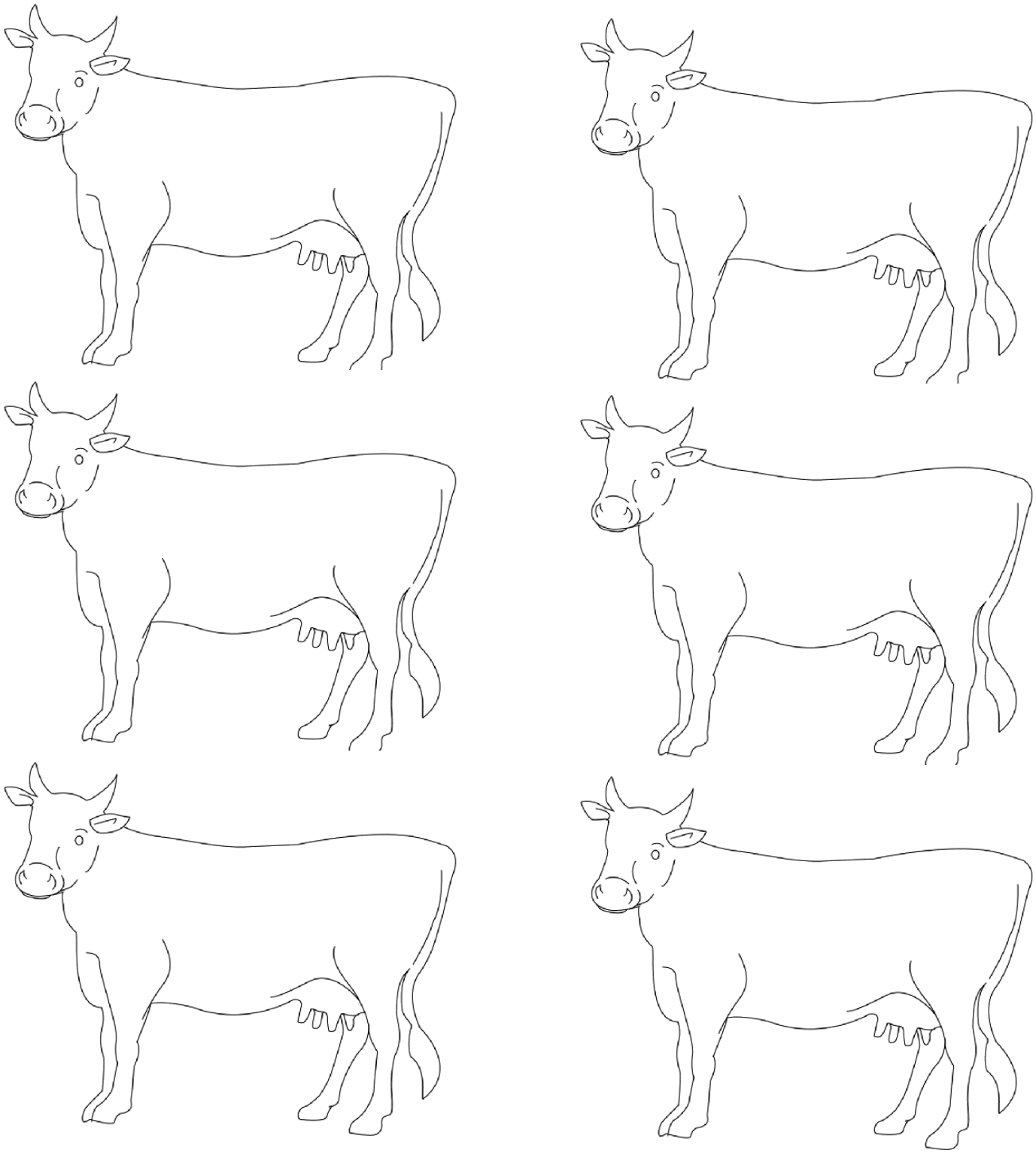
- *On which trial could you hop the most times? How many times did you hop during that trial?*
- *How many hops did you do during the trial where you hopped the fewest times?*
- *Do you think the differences between later trials and earlier trials are because you got tired (or because you had more practice in how to hop)?*
- *What do you think a graph would look like if you tried the same experiment, but hopping on your other leg? Why?*

4. Repeat the foot-hopping experiment with the other leg, and create a new graph.

Ask students to compare and contrast the graphs made from hopping on each foot.

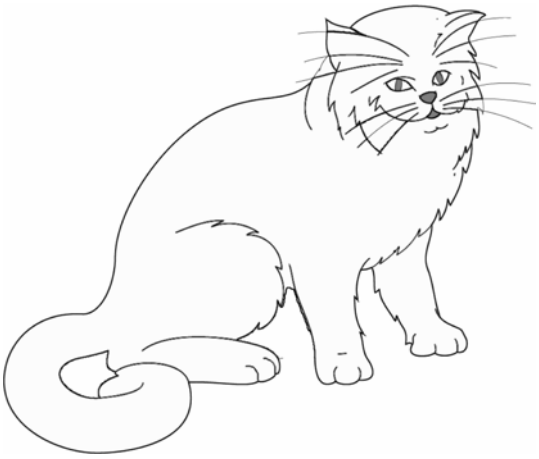
1

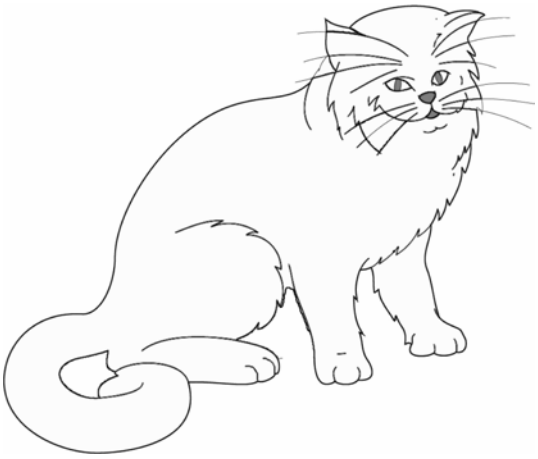
Cows

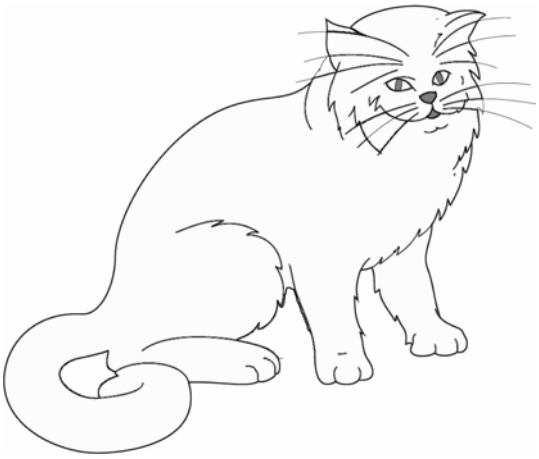


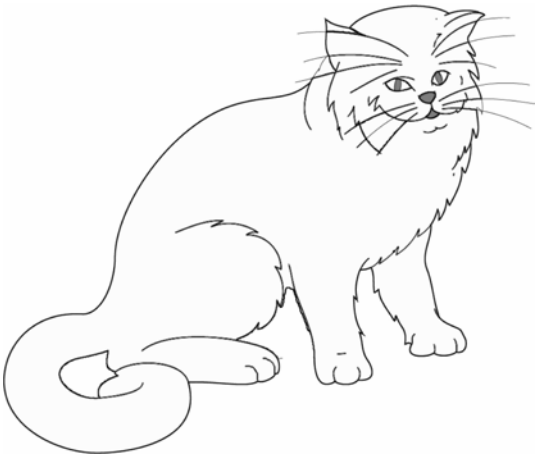
2

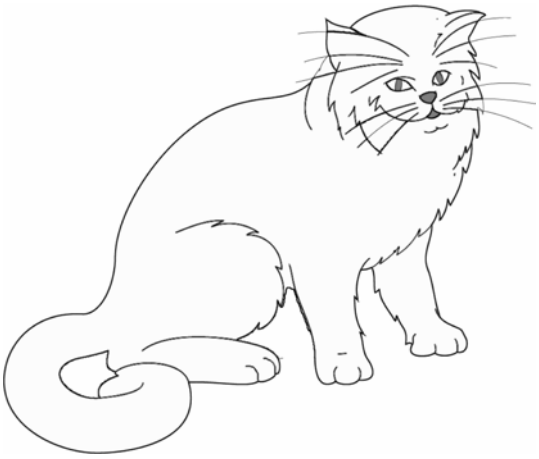
Cats

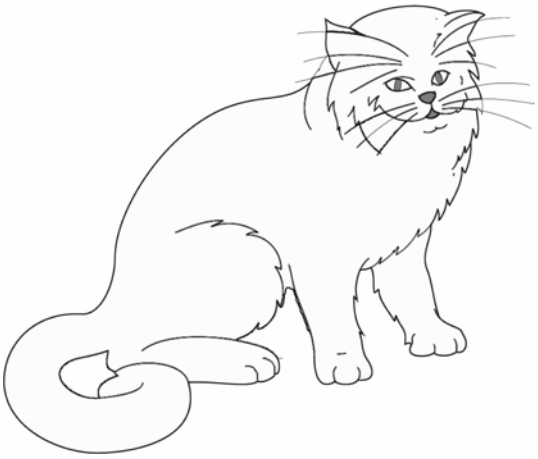




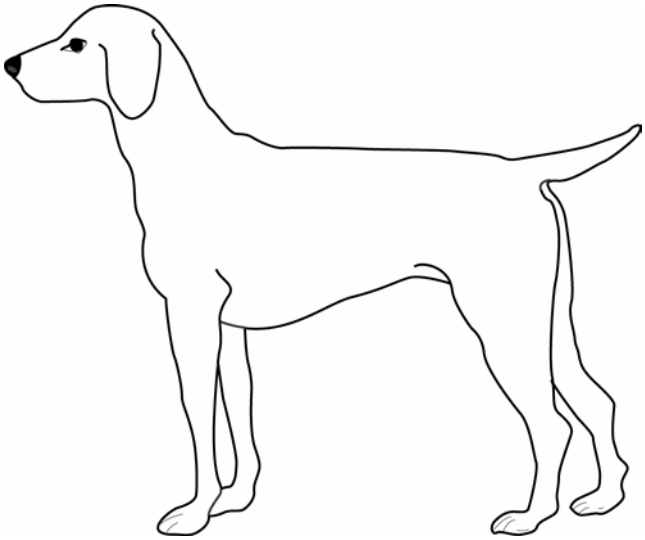


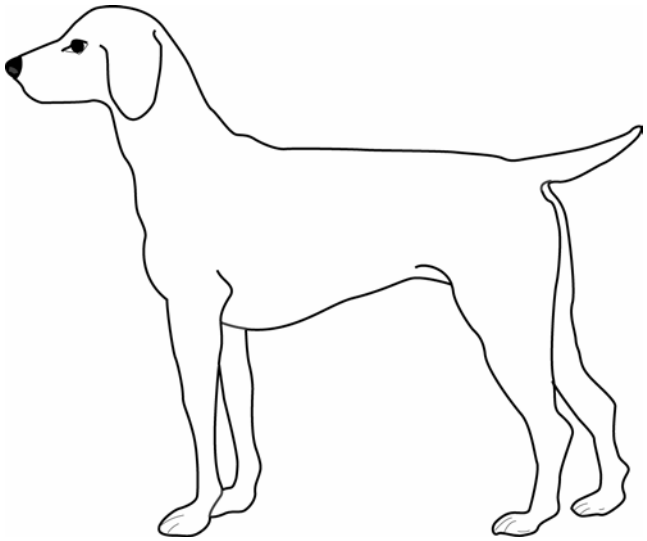


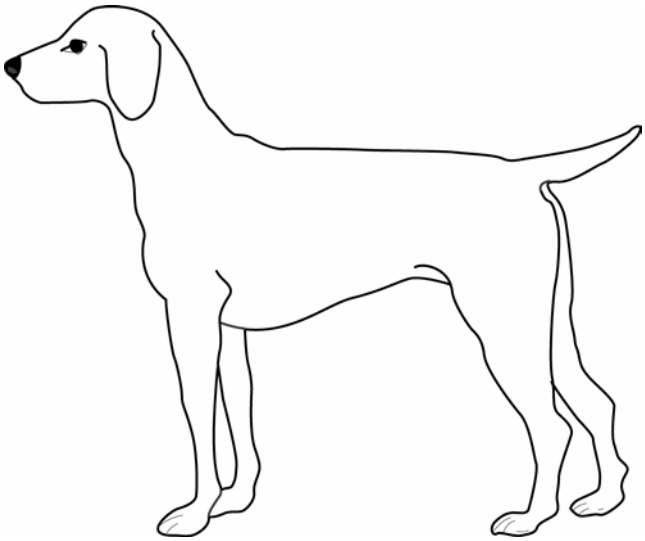


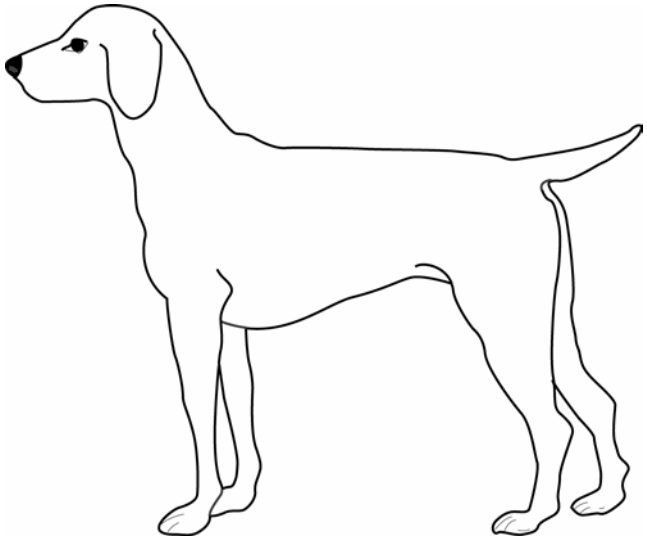


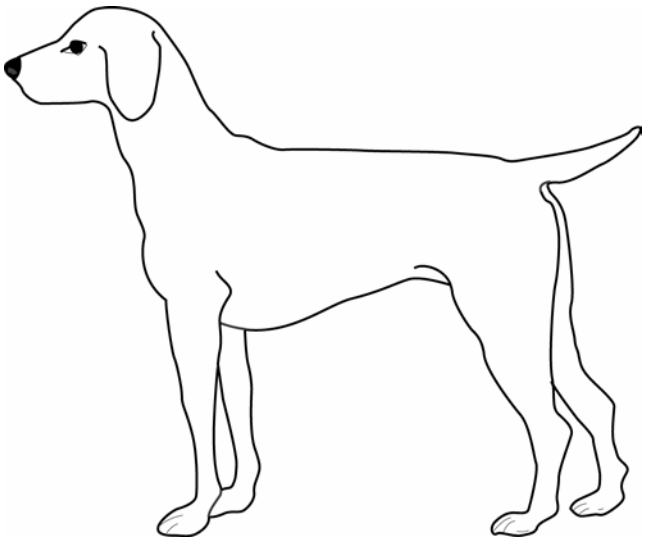
Dogs

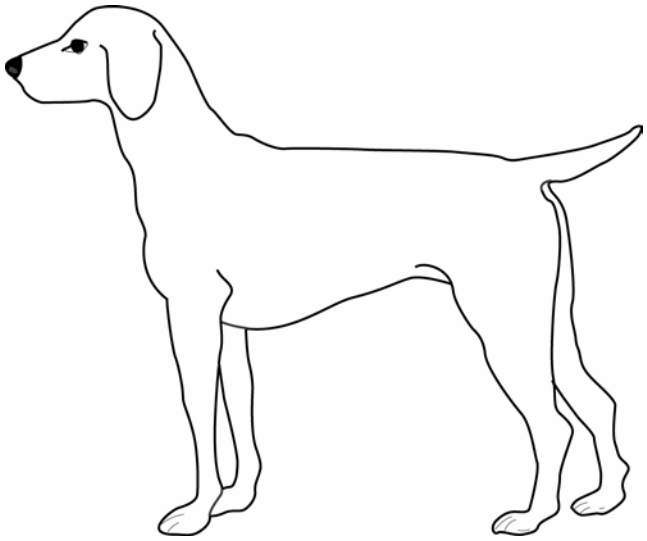






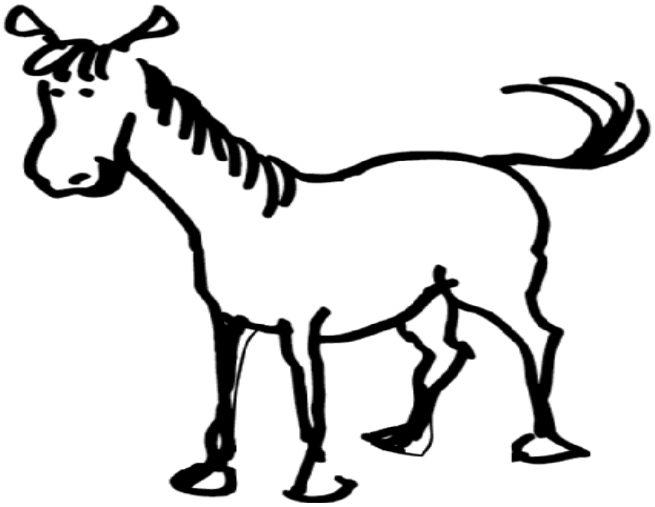
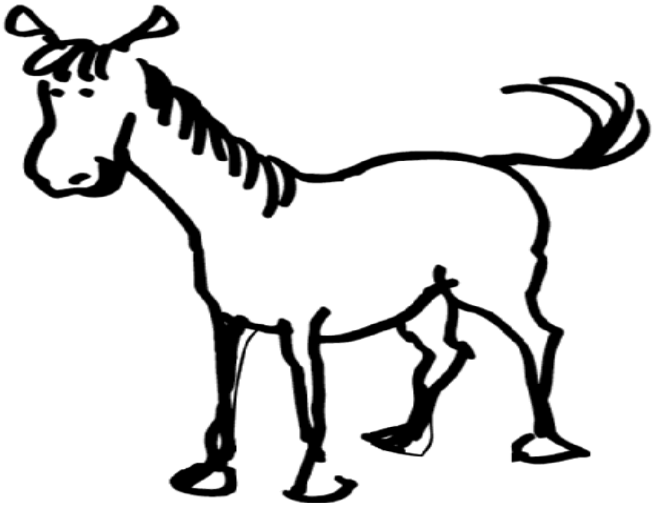
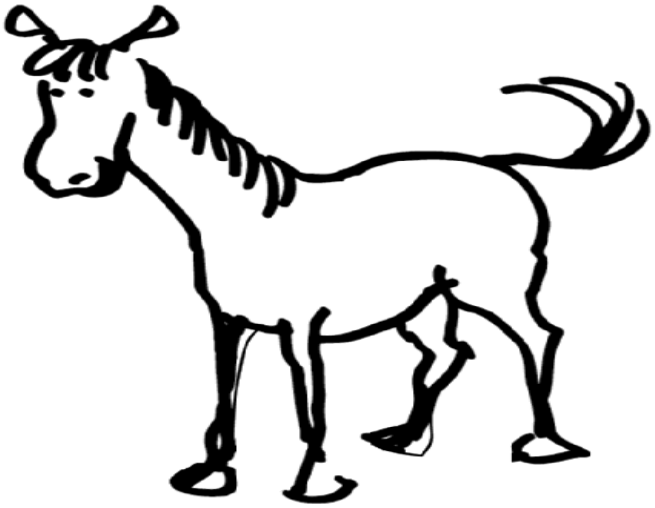
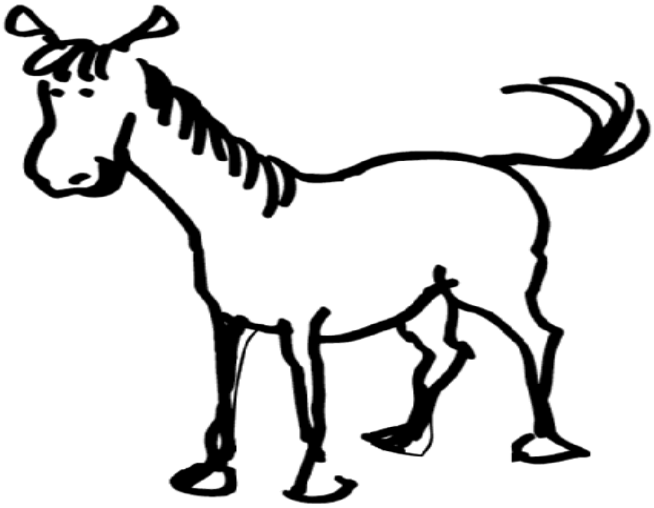
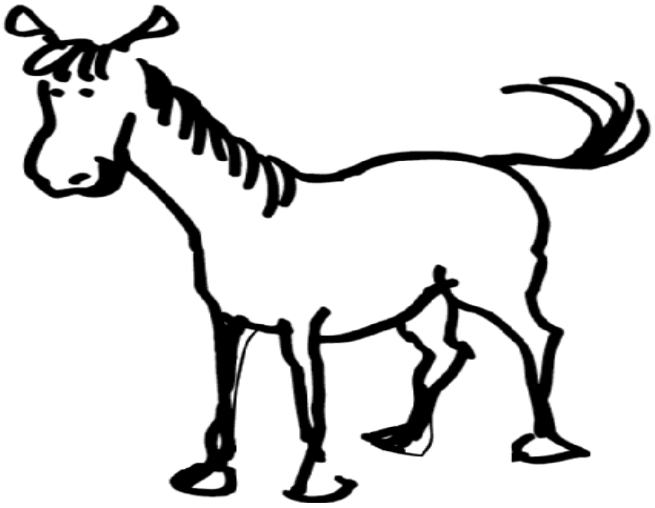
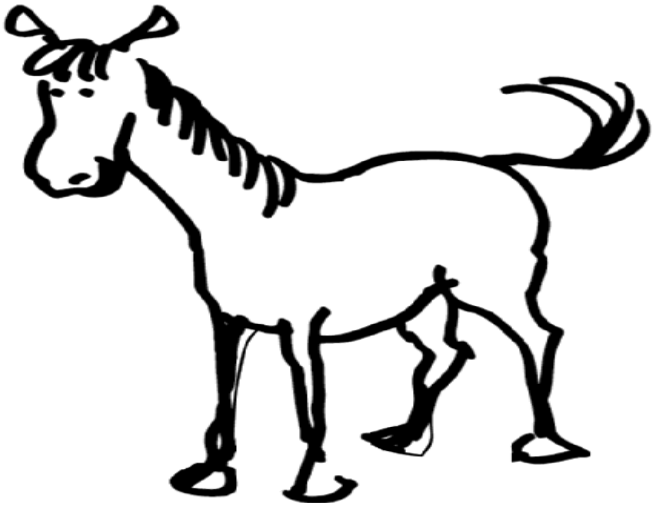




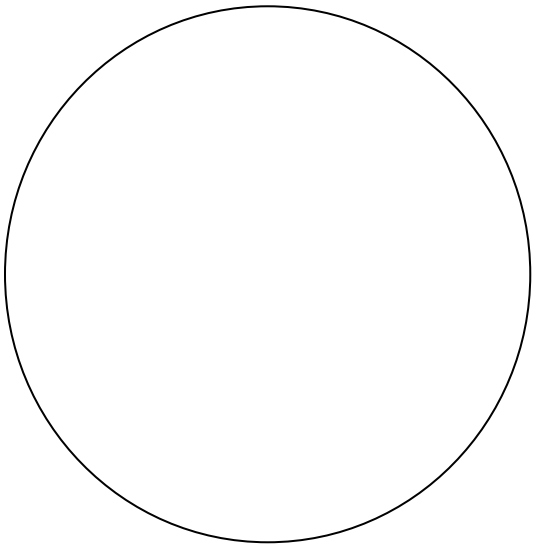


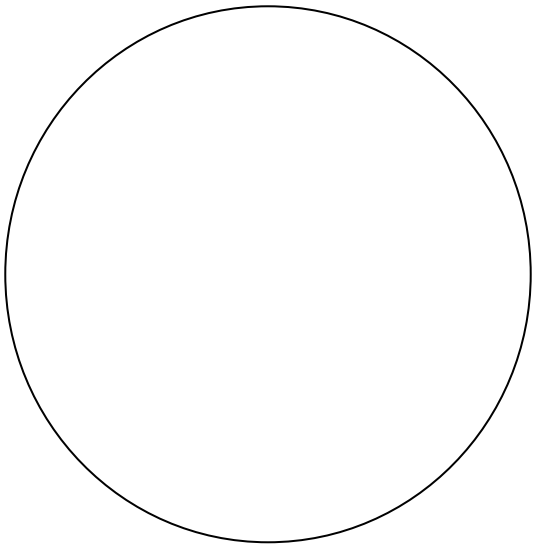
4

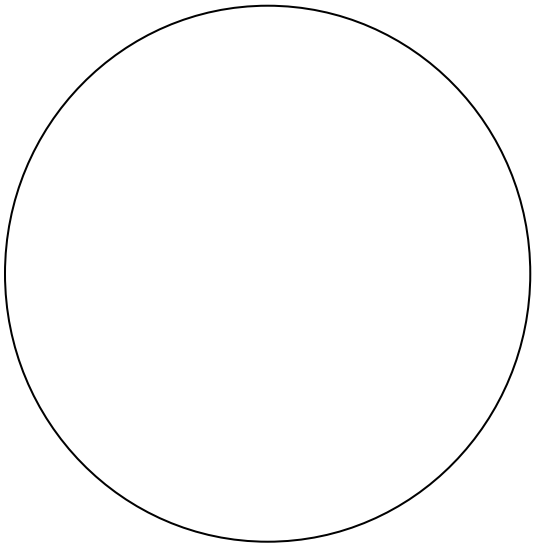
Horses

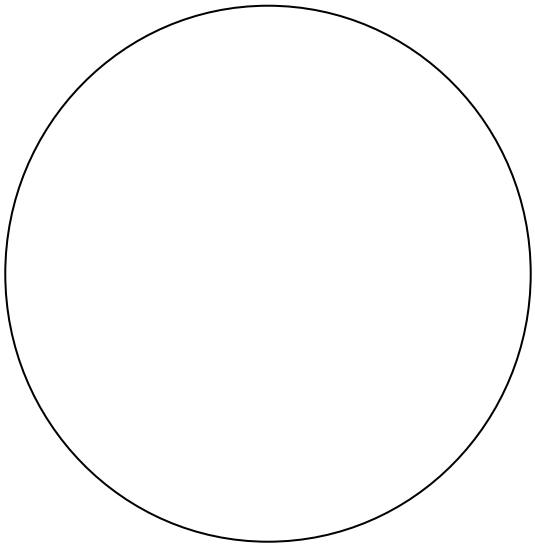







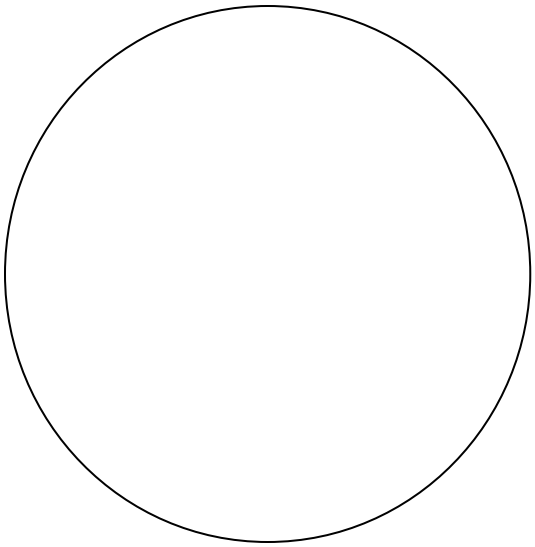
Circles

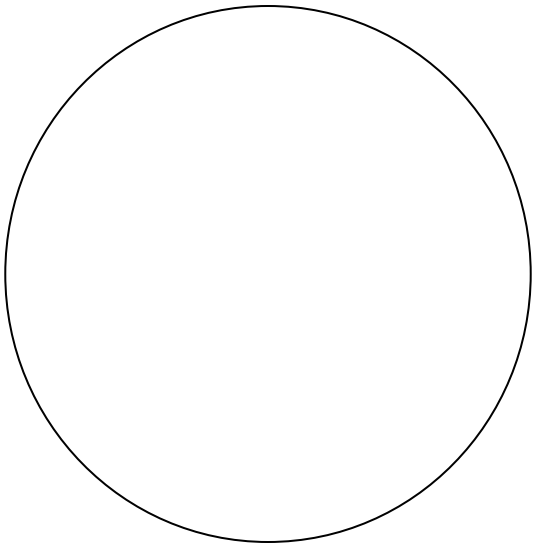






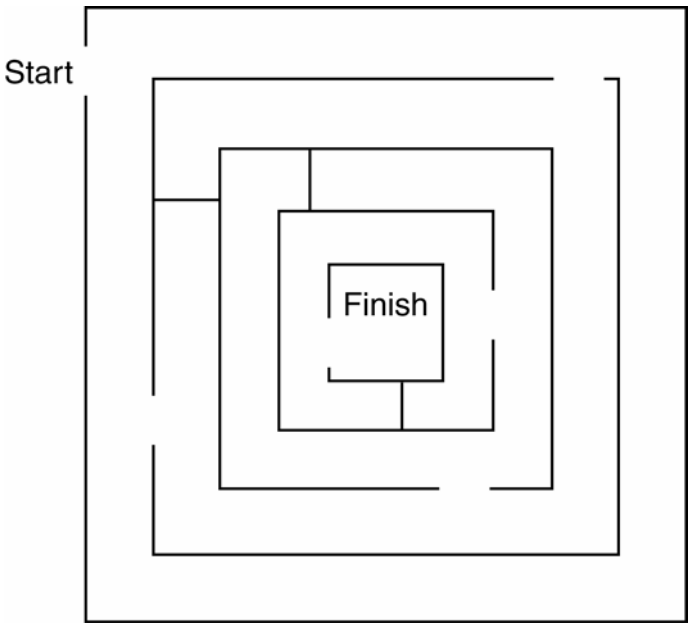




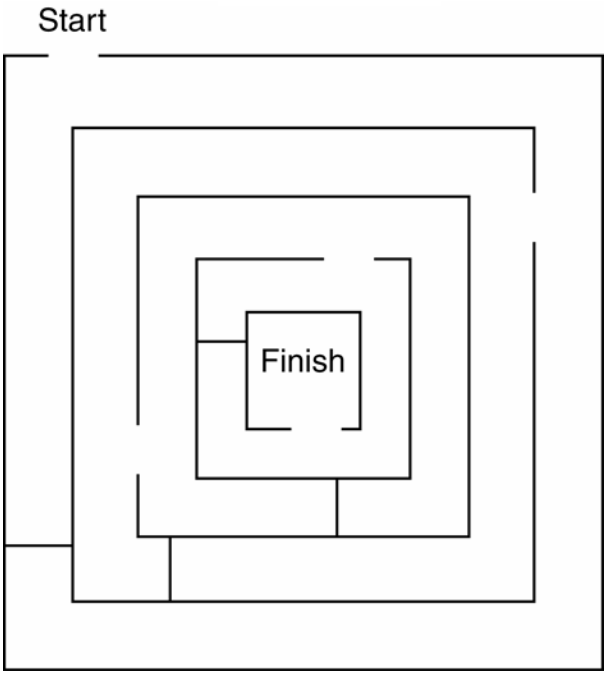


Mazes I

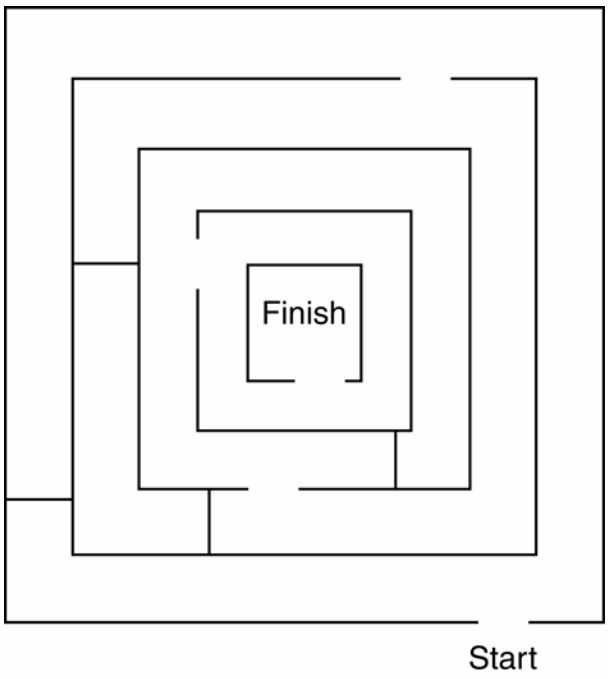
Maze #1



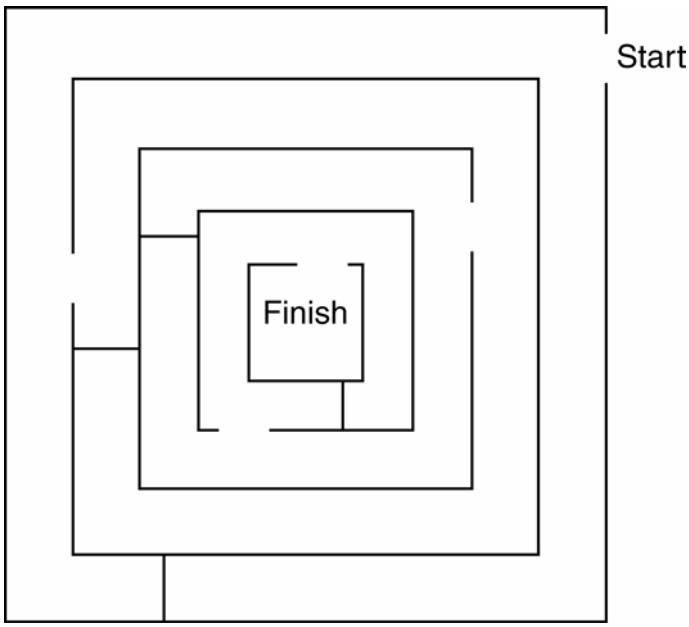
Maze #2



Maze #3

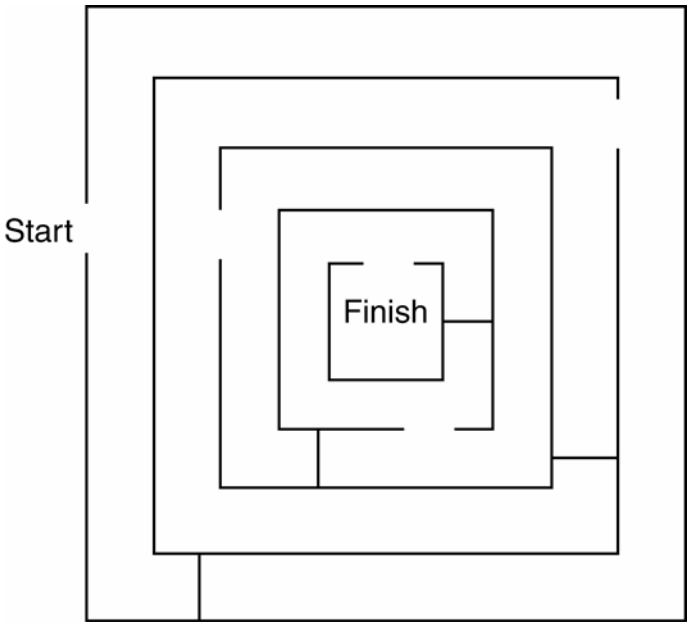


Maze #4

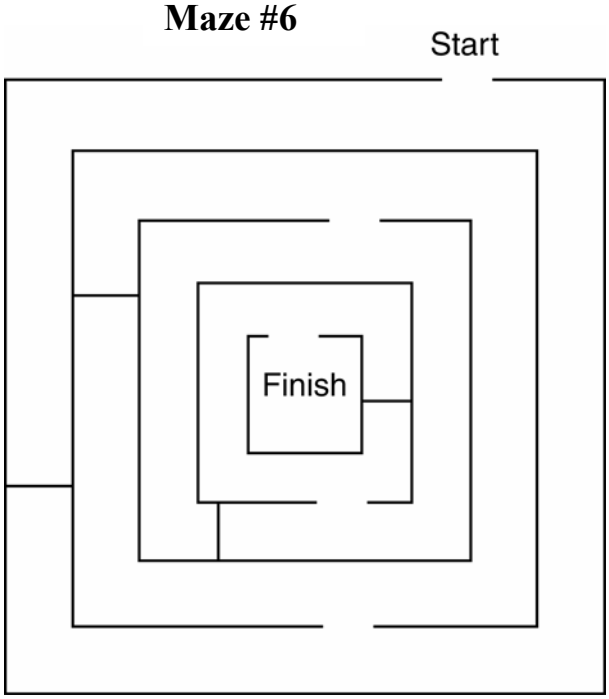


Mazes II

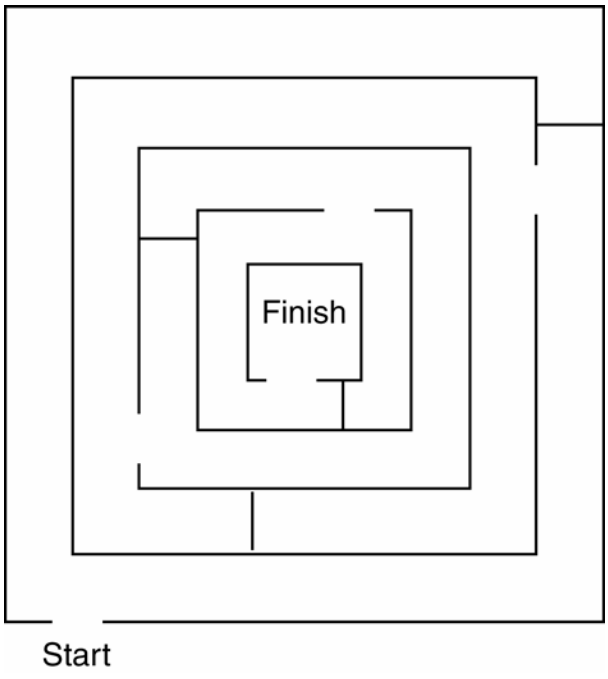
Maze #5



Maze #6



Maze #7



Maze #8