1

TEACHING MANUAL

Let's Jump!

WINTER 2019 MEETING 1

JANUARY 8 - 9

Contents

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2019 UCI MATH CEO COMMUNITY EDUCATIONAL OUTREACH.
UNIVERSITY OF CALIFORNIA AT IRVINE

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Meeting 1: Let's Jump!

- Tuesday 9:00 AM - 9:50 AM
  - Place: **UCI** NS2 1201 (Marco Forester comes)
- Tuesday 2:45 PM - 3:45 PM
  - Place: **SANTA ANA**: Carr Intermediate School
- Wednesday: 2:00 PM - 3:50 PM
  - Place 1: **UCI,** NS2 1201 (Lathrop comes)
  - Place 2: **UCI,** PSCB 140 : (Villa comes)

<table>
<tr>
<td>Tuesday Morning
(50 minutes)
January 8

• Activity 1: 45 minutes
• Weekly Youth Survey: 5 minutes</td>
<td rowspan="2">Wednesday Afternoon
January 9
(80 minutes)

• Activity 1: 30 minutes
• Stock market Game: 45 minutes
• Weekly Youth Survey: 5 minutes
Start at 3:35</td>
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<tr>
<td>Tuesday Afternoon
(50 minutes)
January 8

• Activity 1: 45 minutes
• Weekly Youth Survey: 5 minutes</td>
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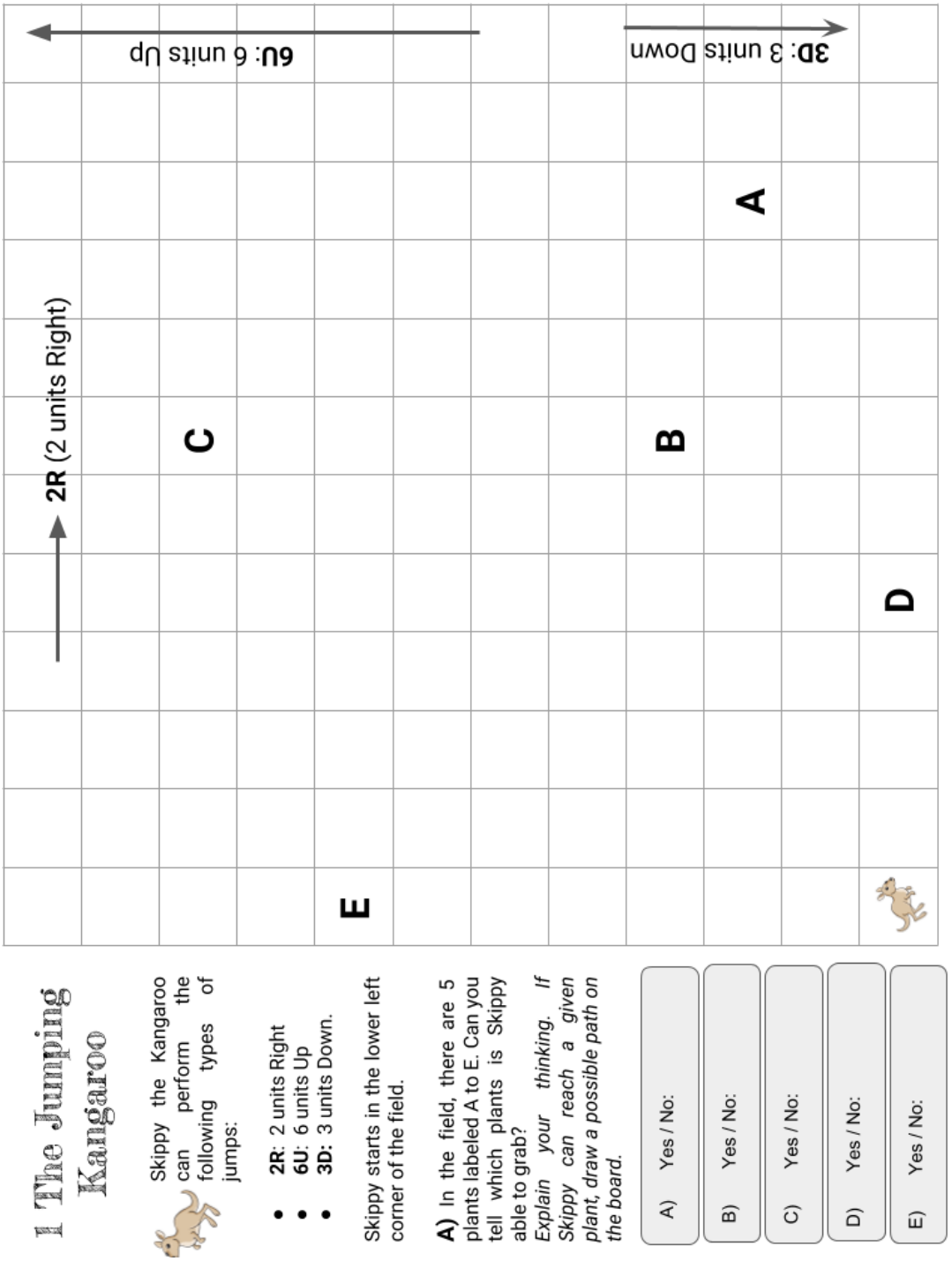
ACTIVITY 1: THE JUMPING KANGAROO

Making sense of vertical and horizontal plane motions.

Time: 40 minutes



1 The Jumping Kangaroo

Skippy the Kangaroo can perform the following types of jumps:

- **2R**: 2 units Right
- **6U**: 6 units Up
- **3D**: 3 units Down.

Skippy starts in the lower left corner of the field.

A) In the field, there are 5 plants labeled A to E. Can you tell which plants is Skippy able to grab? *Explain your thinking. If Skippy can reach a given plant, draw a possible path on the board.*

A) Yes / No:

B) Yes / No:

C) Yes / No:

D) Yes / No:

E) Yes / No:

B) Recall that Skippy can perform the following types of jumps:

- **2R**: 2 units Right
- **6U**: 6 units Up
- **3D:** 3 units Down.

1) What is the least number of jumps that will allow Skippy to eat plants C, D and B (in any order)?

Draw a possible path on the board.

2) We will count in how many different ways Skippy can reach plant B, assuming that she **cannot land more than once** in any spot during her jumps. (So for example, 6U + 3D + 3D is not allowed).

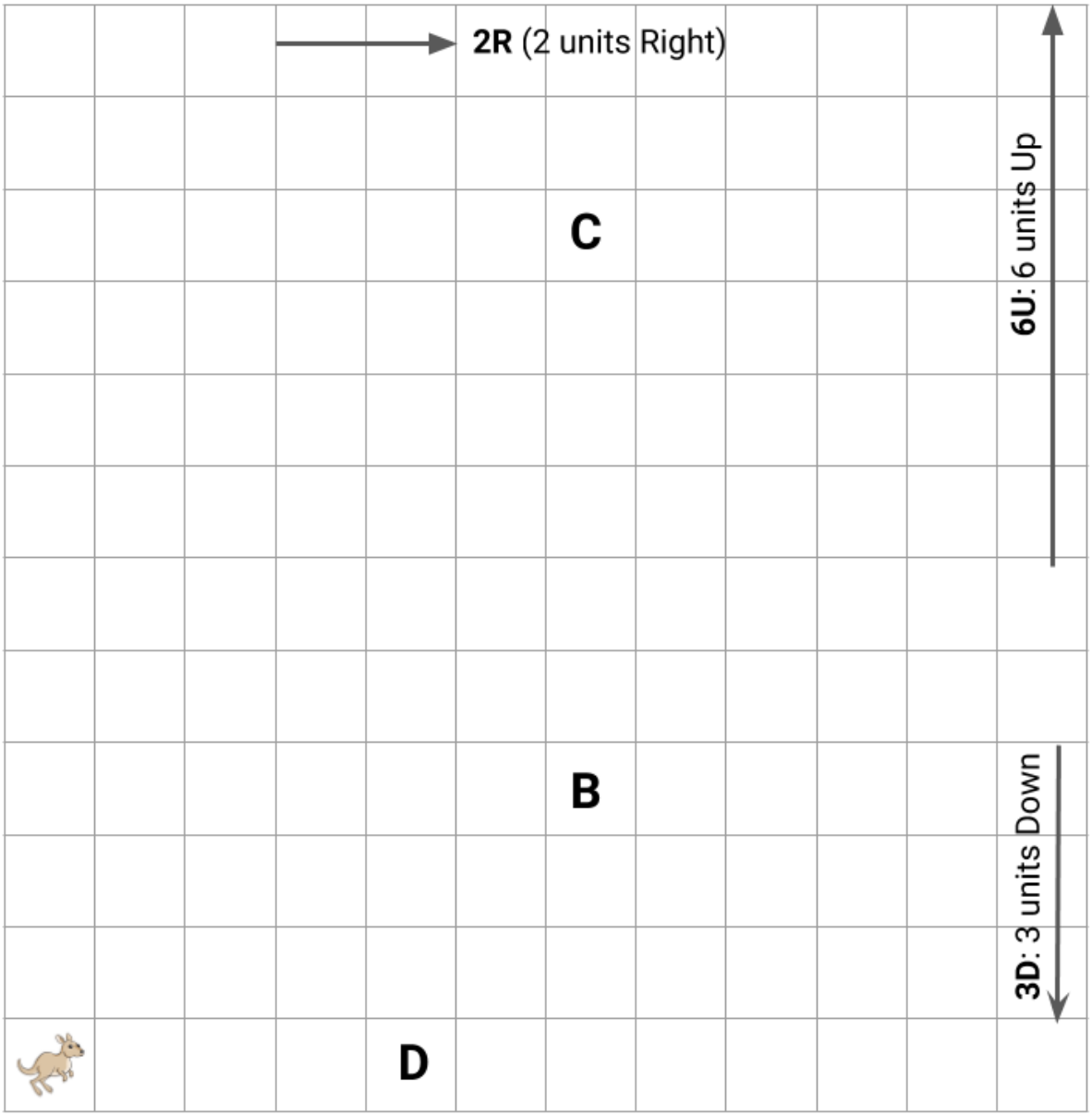
Also, she *should never step out of the board.*

Count all the ways to reach B that:

i) Use the 6U jump only once:

ii) Use the 6U jump exactly 2 times:

iii) Use the 6U jump 3 times or more:



ACTIVITY 1: JUMPING KANGAROOS	
Description	In this task, students make sense of discrete motions in a plane, by considering horizontal and vertical moves, and combinations of those. They find out whether it is possible or not to reach certain positions by restricting to certain moves and they also figure out motions that would require the least number of moves to reach certain position, from a given set of moves.
Learning Goals	● I can use horizontal and vertical moves, and combinations of these, to reach certain positions in a plane. ● I can describe in words different moves in the plane ● I can represent different moves in a plane using pictures and symbols
Materials	● Student Workbooks ● 1 Board per student (2-sided) ● 1 Pawn per student (representing the kangaroo)
Set-up	● Have students read the problem individually. ● Once this is done, ask one or more students to explain the problem **using their own words**. ○ Guide them to be precise in their explanation (but that does not mean using the same words as the statement, in fact, encourage students to use their own words). ● Encourage kids to work in groups of 2 or 3. If desired, and depending on your group, you may also do part of the activity all together, leading with questions. If that is the case, make sure to ask questions to *all* kids, and not just 1 or 2.
My solution	In this space, write your solution to the problem (working out details, not just the final answers). Use as many visual representations as possible! Also, write discussion questions: these are questions that help students, at the end, consolidate the math learning. **My solution** 

My discussion questions (some examples are included)

- Give different examples of sets of moves that would allow us to reach every possible location in our plane.
- Based on the set of moves from part A, what other locations you know that are impossible for Skippy to get to? Explain why.
- Suppose that Skippy wants to jump as many times as she can before "getting stuck" (which means not being able to move anymore). How can you think of a good strategy to solve this problem?
- ____
  ____
  ____
- ____
  ____
  ____

Productive discussion

This section gives you examples of prompts, cues and questions that you may ask students during or at the end of the problem solving process.

Before you continue, please watch:

[Communication in the Teaching and Learning of Math](www.math.uci.edu/mathceo/teachingvideos.php)
More Math 192 Series Videos:
(www.math.uci.edu/mathceo/teachingvideos.php)

- **If some groups are not able to "start" (overwhelmed)**
  - *"Can you point forward and backward in the map? Why is this? How about sideways right? left?"*
    - It is important that students understand the conventions in the problem. You can help them by giving a demonstration using your fingers, but let them also do it right after.

- **If you see two students who seem shy or are working in isolation**
  - *"Hey Alan and Bianca, I see that you are working alone, maybe you want to work together for a while? I think you can learn a lot from each other"* "Melissa, I think you can give Nora great advice in this part!"
    - Don't force them to pair up: instead, you should invite them to do so **and provide at least one reason for it**.

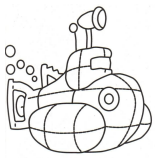
- **If you see a student working in isolation who seems quite comfortable figuring out the problem**
  - *"Linda, would you like to present (all or part) of your solution to these students and take questions from them" ; "I see that you have the answers, but it's also important that you can talk and convince others"*
    - This can be especially useful to spark communication skills in **students who do not see themselves as "good communicators"** but are confident in math.

- **Scaffolding / testing for understanding**
  - *"Suppose for simplicity that Skippy the Kangaroo can move 2 steps in any direction. Can you solve the problem?"*
    - This simplifies the cognitive load as there is just one quantity to remember (the value 2). Students could try this before if they need. Then you may make it more complicated, for example, 2 right and 3 forward.

- **If you see a wrong solution**
  - *"I'm curious why you got this location for Skippy. Guide me through it! I want to understand which steps you followed"*
  - *"Why didn't you think Skippy can get to this place? Let us verify again..."*
    - Notice the positive language, non-judgemental, but critical in a good way. It's important to inspect the process and not just say that the answer is wrong and correct it (which is tempting but will not result in meaningful learning from the student, since you will not reach the "source of the mistake").

Teaching tips	● It's always a good idea to start the activity with an informal chat with students about the situation that is presented. ○ Ask students if they have played battleship or a similar game in which they can move in 2 directions. ○ This warm-up can help students to get engaged in the math. ● This problem gives a good opportunity for students to understand and use the word "unit" in a context. Make sure that students don't just say "Skippy moves 3" or even "Skippy moves 3 forward", but that they include the word *unit* and understand what this means. (Unit here helps as the natural convention for one space in the board, and even though we don't know the actual distance, we can call it 1 unit). ● This is the first meeting, and so it is very important to set the tone. Make sure that you encourage your students to talk. Some of them will be quite shy at the beginning, but keep encouraging: you will see how little by little the open up (this is a common experience with past mentors, who have always mentioned this). Here is an excellent resource to help you be prepared: **How to Get Students to Talk in Class** https://teachingcommons.stanford.edu/resources/teaching/small-groups-and-discussions/how-get-students-talk-class *Source: teaching commons, Stanford* ● When asking questions, make eye contact with students. Listen carefully, with undivided attention. They will care more if they see that you care for their thinking (not just their answers). ● Before starting, clarify the key words involved in the problem: *move, forward, backward, sideways right, sideways left*. You can provide sentence stems such as: ○ Skippy can move _____ in the _____ direction.

Challenge (Optional)



CHALLENGE

Now Skippy can move ***wrapping the board***. For example, if she is in the right-most column and moves 1 unit to the right, she will end up in the left-most column. Similarly, if she is the top row and moves 1 unit up, she will end up in the bottom row.

Now Skippy has ***new moves*** that are not just "horizontal" or "vertical" but a combination of these.

For example, consider **the move M1**:

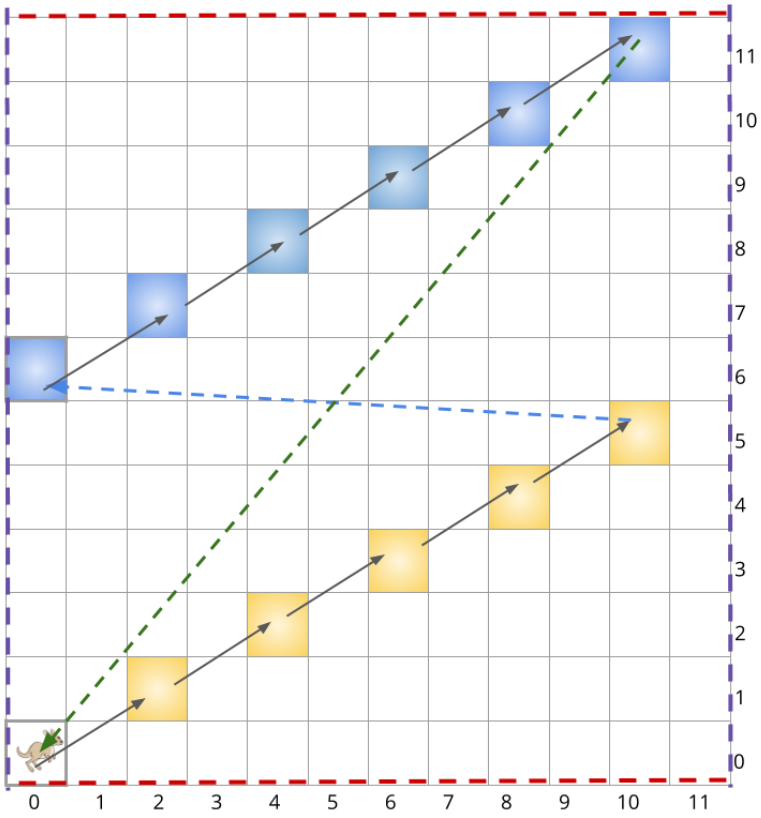
M1 = 2R + 1U (2 units right & 1 unit up)
(which is the same as 1U + 2R)

Label the rows and columns of the board from 0 to 11, as in the picture.

For example, if Skippy starts in the lower left corner (0,0) and starts moving with M1, she will get to position (2,1), then (4,2), (6,3), (8,4), and (10,5). The next step jump would bring her to (12,6), which is the same as (0,6) because of the wrapping.

As she keeps jumping, she reaches (2,7), (4,8), (6,9), (8,10), (10,11) and finally (12,12), which is the same as (0,0).

So Skippy is back to the starting point!



Here is another example:

M2 = "2R + 2U" (2 units right & 2 up)
(this is the same as "2U , 2R ")

This move will get Skippy a total of 6 different positions in the board (no more, no less):

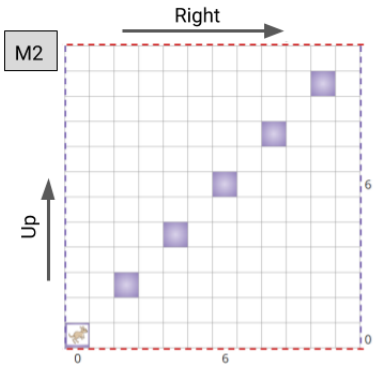
Starting from (0,0), as usual, Skippy will jump to (2,2), (4,4), (6,6), (8,8), (10, 10) and then (12,12), which is the *same* as (0,0) because of the wrapping. Back to the start!

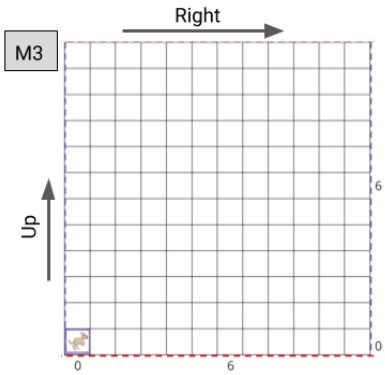
Your turn now...

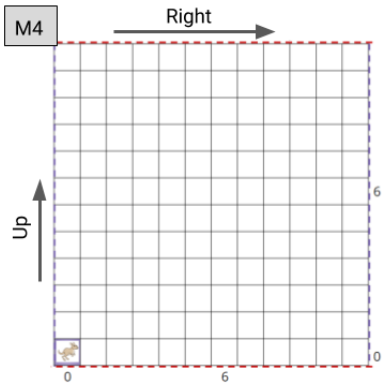
For each of the following moves M3 - M7, find out the number of *different* positions that Skippy can get to if she starts at (0,0) and uses that move.

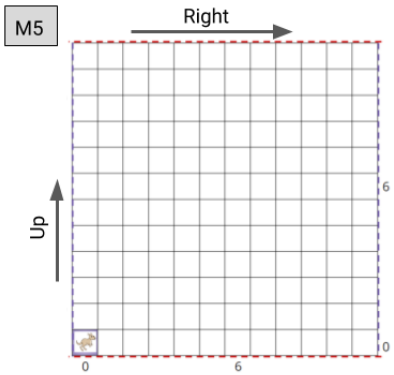
- M3 = " 3R + 3U "
- M4 = " 11R + 11U "
- M5 = " 6R + 2U "
- M6 = " 1R + 3U "
- M7 = " 11R + 5U "

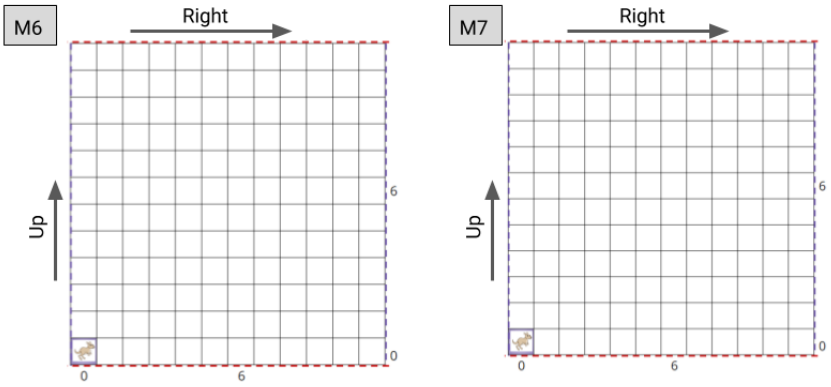
Hint: practice each move on a different board, and color all the positions that Skippy can reach with that given move.










M6
Right
Up
6
0
6
0
M7
Right
Up
6
0
6
0

Solutions (1 THE JUMPING KANGAROO)

Part A:

Skippy can reach B, C and D.

- A: Skippy cannot reach it. Plant A has an horizontal position of 9 units to the right of Skippy. 9 is an odd number and Skippy only moves right with jumps of 2.
- B : Skippy can reach it with the following jumps: 2R + 2R + 6U + 3D.
- C : Skippy can reach it with the following jumps: 2R + 2R + 2R + 6U + 3D + 6U.
- D : Skippy can reach it with the following jumps: 2R + 2R.
- E : Skippy cannot reach it. Plant E has a vertical position of 7, and 7 is not a multiple of 3. When Skippy moves up, by skipping 6 units up or 3 units down, she can only get to positions that are *multiples of 3*.

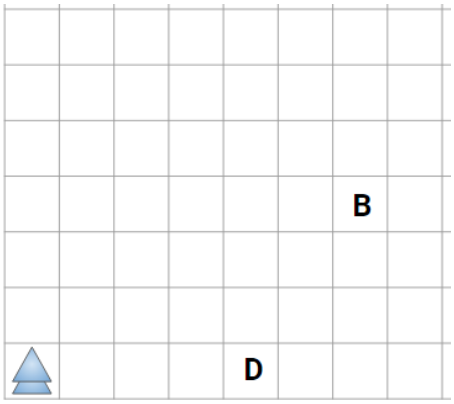
Part B:

1) What is the least number of moves that will allow Skippy to eat plants C, D and B?
Solution:

5 moves: 2R, 2R, 2R , 6U, 3D .

Another way: 2R, 2R, 6U, 2R , 3D .

2) In how many different ways can Skippy reach B, using 6U:

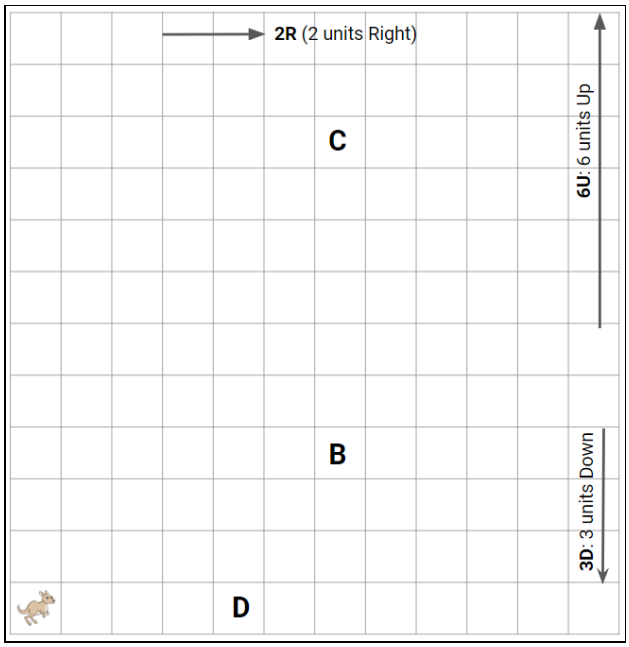


i) Exactly once:

Way 1) **2R 2R** 2R 6U 3D
Way 2) **2R 2R** 6U 2R 3D
Way 3) **2R 2R** 6U 3D 2R

Way 4) **2R 6U** 3D 2R 2R
Way 5) **2R 6U** 2R 3D 2R
Way 6) **2R 6U** 2R 2R 3D

Way 7) **6U** 3D 2R 2R 2R
Way 8) **6U** 2R 3D 2R 2R
Way 9) **6U** 2R 2R 3D 2R



Way 10) **6U** 2R 2R 2R 3D

ii) Exactly two times:

Way 1) **2R 2R 6U** 3D 6U 2R 3D 3D

Way 2) **2R 6U 3D** 2R 3D 2R 6U 3D
Way 3) **2R 6U 3D** 2R 6U 3D 2R 3D
Way 4) **2R 6U 3D** 2R 3D 6U 2R 3D

Way 5) **2R 6U 3D** 6U 2R 2R 3D 3D
Way 6) **2R 6U 3D** 6U 2R 3D 3D 2R
Way 7) **2R 6U 3D** 6U 2R 3D 2R 3D

Way 8) **2R 6U** 2R 3D 3D 2R 6U 3D

Way 9) **6U 2R 3D 6U** 2R 3D 3D 2R

Way 10) **6U 2R 3D 6U** 2R 3D 2R 3D
Way 11) **6U 2R 3D 6U** 2R 2R 3D 3D

Way 12) **6U 3D 6U 2R** 3D 3D 2R 2R
Way 13) **6U 3D 6U 2R** 3D 2R 3D 2R
Way 14) **6U 3D 6U 2R** 3D 2R 2R 3D
Way 15) **6U 3D 6U 2R** 2R 3D 3D 2R
Way 16) **6U 3D 6U 2R** 2R 3D 2R 3D
Way 17) **6U 3D 6U 2R** 2R 2R 3D 3D

iii) More than twice:

Way 1) **6U 3D 2R** 3D 6U 2R 3D 3D 2R 6U 3D
Way 2) **6U 3D 2R** 6U 3D 2R 3D 3D 2R 6U 3D

Way 3) **6U 3D 6U 2R** 2R 3D 3D 3D 2R 6U 3D

Way 4) **6U 3D 6U 2R** 3D 2R 3D 3D 2R 6U 3D
Way 5) **6U 3D 6U 2R** 3D 2R 3D 6D 2R 3D 3D

Way 6) **6U 3D 6U 2R** 3D 3D 2R 3D 2R 6U 3D
Way 7) **6U 3D 6U 2R** 3D 3D 3D 2R 2R 6U 3D
Way 8) **6U 3D 6U 2R** 3D 3D 2R 6U 3D 2R 3D
Way 9) **6U 3D 6U 2R** 3D 3D 2R 3D 6U 2R 3D

Notes:

- Note that starting with 3D is not allowed, as Skippy cannot go outside the board.
- Note that 6U 6D is not allowed, as Skippy cannot go outside the board.
- Note that 6U 3D 3D is not allowed, as Skippy cannot repeat a landing spot.
- Note that 6U 3D 6U is allowed in some cases (as long as we do not move outside the board), but 6U 3D 6U 3D is never allowed, as Skippy cannot repeat a landing spot.

Mentor reflection

Suppose that a student claims (correctly) that Skippy cannot reach E, but they say they does not know how to explain it. How can you help this student build an explanation?

_____

_____

_____

_____

Solution to Challenge (Part C)

1) 3R , 3U : will "generate" 4 locations: (0,0), (3,3), (6,6), and (9,9).

2) 11R , 11U : will generate 12 locations: (0,0), (11,11), (10, 10), (9,9), (8,8), (7,7), (6,6), (5,5), (4,4), (3,3), (2,2), and (1,1).

3) 6R , 2U : will generate 6 locations: (0,0), (6, 2), (0, 4), (6,6), (0, 8), and (6, 10).

4) 1R , 3U : will generate 12 locations: (0,0), (1,3), (2, 6), (3, 9), (4,0), (5,3), (6,6), (7,9), (8,0), (9,3), (10,6), and (11,9)

5) 11R , 5U : will generate 12 locations.
(0, 0), (11, 5), (10, 10), (9, 3), (8, 8), (7, 1), (6, 6), (5, 11), (4, 4), (3, 9), (2, 2) and (1, 7).