LATHROP ⚙L⚙ ENGINEERING

Name:

UNIT 3: LEGO ROBOTICS

Introduction to Engineering & Robotics   Unit Due Date: **October 18, 2019**

Welcome to the third unit of *Introduction to Engineering & Robotics*! In this unit we'll learn the basics of computer programming. We'll also put together a simple robot using the LEGO Mindstorms components, and then program the robot to complete various tasks. In the end, the expectation is that you learn the following:

- How to create simple programs using a computer simulation called Jeroo
- How to create more complex programs that can make decisions
- How to build basic robots following specific instructions
- How to program a robot to complete various tasks

As we move through this unit, you are responsible for making adequate progress through the assignments, and for being done by the Unit Due Date (**October 18, 2019**). You are also responsible for completing each part before moving on to the next. Our unit is broken up into three main parts:

Part 1: **Jeroo Programming** (30 pts) Approx. 3 days	
The unit starts with an introduction to programming. To do this, we'll use a computer programming simulation called "Jeroo". Jeroo will allow you to learn how to write simple programs and give you visual feedback as your Jeroo hops around the world. You'll start with some very basic Jeroo challenges, and then be tasked with solving a super difficult challenge. Each of your successful Jeroo challenges needs to be checked off by Benshoof!	▯ Jeroo Programming Notes
	⊕ Complete First Jeroo Challenge
	⊕ Complete 5 Jeroo Challenges
	⊕ Complete 1 Super Challenge
	📄 Complete the Jeroo Assignment
	☆ Check-off from Mr. Benshoof
☆*Achievement:* Complete an additional Jeroo Super Challenge	

Part 2: **Build Your Robot** (40 pts) Approx. 3 days	
Next, you and a partner will build a LEGO robot. We'll start by building the LEGO robot described in some standard instructions, and write a short program in RobotC just to make sure everything works. Once you've got your LEGO robot working properly, you and your partner will complete all 4 of the First LEGO Robot Challenges. Make sure Mr. Benshoof confirms your successful Robot Challenges.	⊕ Build Simple LEGO Robot
	▯ RobotC Programming Notes
	⊕ Complete all 4 First Challenges
	☑ Take the Unit 3 Quiz!
	☆ Check-off from Mr. Benshoof

Part 3: **Robot Challenges** (30 pts) Approx. 3 days	
To wrap up the unit, you and your partner need to complete one of the LEGO Super Challenges. You'll need to think about redesigning your LEGO robot. You and your partner will need to do some serious planning and brainstorming. Then, create the robot and program that can accomplish the LEGO Super Challenge you chose. Finally, write a full page summary of your LEGO Robot building experience.	⊕ Select a LEGO Super Challenge
	▯ Plan and Brainstorm Solutions
	⊕ Build & Program Your Robot
	☆ Check-off from Mr. Benshoof
	📄 Write a 1-Page Summary

(30 pts) Approx. 3 days

The first part of this unit is all about learning how to program. Programming requires planning out and writing a series of very precise instructions that the program will follow. You'll start by watching a few videos about Jeroo and how to make programs work. Once you've taken some good notes about how to program in Jeroo, you'll complete the very first Jeroo challenge. From there you get to choose from a series of Jeroo challenges to complete. As you work, it's a good idea to keep taking notes and even printing/saving your successful programs!

1. Start by watching *Getting Started in Jeroo,* as well as *Sample Jeroo Programs 1 & 2.* Be sure to take a full page of good notes on how to program in Jeroo.
2. Complete the first Jeroo Challenge listed on the Jeroo Challenge Sheet (next page)
3. Have Mr. Benshoof confirm your completed first challenge!
4. Read through the rest of the Basic Jeroo Challenge options. Choose and complete 5 of these Basic Jeroo Challenges.
5. Have Mr. Benshoof confirm each of your successful Basic Jeroo Challenge programs.
6. Read through the Jeroo Super Challenges. Choose and complete 1 of the Jeroo Super Challenges.
7. Have Mr. Benshoof confirm your successful super challenge.
8. **Achievement:** If you want to earn an achievement here, complete a second Jeroo Super Challenge and have Mr. Benshoof confirm your successful program!

Part 1: Tasks	5 points	4-3 points	2-1-0 points
🔲 Jeroo Programming Notes	+ Watch *Getting Started in Jeroo* + Watch the sample Jeroo programs + Take 1 page of good notes in your engineering notebook	- Less than a full page of Jeroo notes	- Very brief or no notes in your engineering notebook
⊕ Complete Jeroo Challenge 1	+ Complete the first Jeroo Challenge + Have Mr. Benshoof confirm that your program works	- Your program does not fully accomplish the task	- You do not complete the first challenge - Mr. Benshoof does not see the program work
⊕ Complete 5 More Basic Jeroo Challenges	+ You choose and complete 5 more tasks from the Basic Jeroo Challenges list + Have Mr. Benshoof confirm that your programs work	- You only complete 4 or 3 of the Basic Jeroo Challenges	- You complete fewer than 3 Basic Jeroo Challenges
⊕ Complete 1 Jeroo Super Challenge	+ You choose and complete 1 Jeroo Super Challenge	- You sort of solve the super challenge, but not completely	- You do not try to solve a super challenge
	10 points	*9-4*	*3-0 points*
📄 Complete the Jeroo Assignment	+ You completed the Jeroo Assignment	- You completed some of the assignment	- You did not complete the Jeroo assignment
☆ Achievement	+ Complete an additional Jeroo Super Challenge		

(20 pts) Approx. 3 days

First Jeroo Challenge:

First Jeroo Challenge: Develop a program that creates a new Jeroo named after you! The Jeroo should start at location (2,3), and should start holding 50 flowers.   The Jeroo should then hop around on the island planting flowers that create your first initial.   In the example below, Jeroo "Jeremy" has hopped around and planted flowers in a "J":
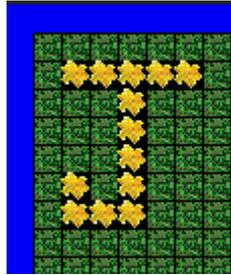
Figure 1 – The Island After Jeremy Plants The Letter "J"

Basic Jeroo Challenges (Choose 5 of the 6)

NOW DOWNLOAD THE MAPS FOLDER FROM MRBENSHOOF.COM AND PUT THE FOLDER ON THE DESKTOP. YOU CAN OPEN PRE-MADE MAPS BY CLICKING ON THE "OPEN" ICON ON THE RIGHT SIDE OF THE PROGRAM WINDOW!

Basic Challenge 1: Develop a program that has two methods in the "Jeroo Methods" tab. One method should tell your Jeroo how to hop and plant your first initial (like in Challenge 1), and the second method should tell your Jeroo how to hop and plant your second initial.   Then use the "main method" to create a Jeroo and have it hop out both of your initials. In the example below, a Jeroo has hopped out it's initials "ME":
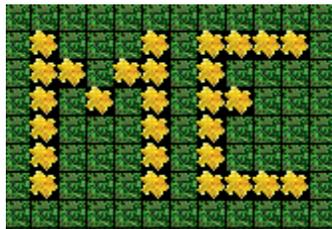
Figure 2 – The Island After Planting The Initials "ME"

Basic Challenge 2: (USE THE PRE-MADE MAP) Develop a program that uses the included island file (in the map folder) to create a new Jeroo at the location (0,0).   The Jeroo should pick the flower then use it to disable the net so it can get home. (Home is the square of nets).

Basic Challenge 3: (USE THE PRE-MADE MAP) Develop a program that makes 4 Jeroos on the included relay island. One Jeroo should start in the top left of the island, one in the bottom left, one in the bottom right, and one in the top right. The Jeroos are running a relay; the first Jeroo picks up the flower. It should then run clockwise and disable the net so it can meet the Jeroo in the top-right corner. That Jeroo should then pick the nearby flower, and use it to get to the bottom-right corner. That Jeroo then uses the flower to reach the bottom-left corner. That Jeroo then picks the flower and runs up to end at spot (0,0).

SUPER **HELPFUL HINTS:**

- If you type "if(*name*.hasFlower())" then whatever you put in the brackets after that will only happen if the Jeroo named "*name*" has a flower.
- Other logical questions you can ask are
    - isWater(DIRECTION)
    - isNet(DIRECTION)
    - isClear(DIRECTION)
- In all these cases, DIRECTION can be AHEAD, LEFT, or RIGHT
- You can ask multiple questions in an if statement by going
        if(*name*.isClear(AHEAD) && *name*.isWater(RIGHT))
- You can have many if statements, or many questions in a single if statement

Basic Challenge 4: (USE THE PRE-MADE MAPS) The Jeroos are running hurdles. Develop a program that creates a Jeroo along the very bottom of the island (for example 23,0).   They should run left to right and each time they encounter a vertical row of nets they should run up and over them. For example, a Jeroo on the island below would follow the arrow to get around the nets. **This program should work for *any* configuration of net "hurdles".** *(test islands available for in the map folder)*
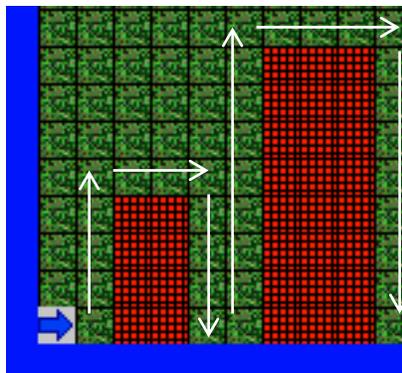
Figure 3 – The path over the hurdles. **This program needs to work for any configuration of "hurdles".**

(test islands available for in the map folder)

Basic Challenge 5: (NO PRE-MADE MAP) One Saturday morning, two friends, Bugs and Daffy, decide to meet and plant flowers to beautify Santong island. Daffy starts in the Northwest corner facing East with 90 flowers in his pouch. Bugs starts in the Northeast corner facing West with 90 flowers in his pouch. Bugs and Daffy begin hopping toward one another. As they hop, each plants exactly one flower at every location it enters, including its starting location. They meet, facing each other, roughly in the middle of row 0. After a handshake and a little small talk, Bugs and Daffy both turn toward the south and continue planting flowers all the way to the southern edge of the island. When both reach the South Sea, the say goodbye and part. Daffy turns west and plants flowers all the way to the Western Ocean. Bugs turns east and plants flowers all the way to the Eastern Ocean. This is where our story ends. Your task is to write a Jeroo program that will illustrate this story.
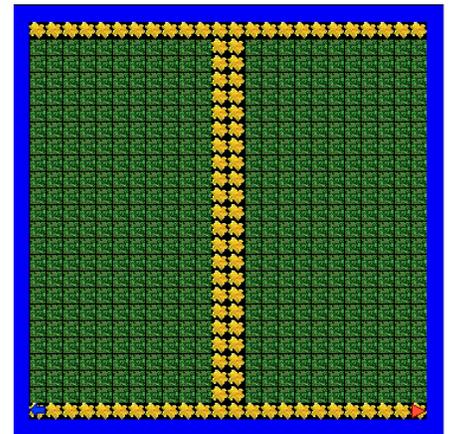

Figure 4 – The resulting pattern of flowers when the program is complete

Basic Challenge 6: (USE THE PRE-MADE MAPS) The Jeroos are practicing planting flowers in special patterns. Develop a program that makes a Jeroo that walks along the top edge of the island shown. As your Jeroo hops along it should plant a flower right above any flower it hops next to.

Figure 5 – The starting orientation of one of the test islands
(test islands available in the map folder)

Figure 6 – The final orientation of the test islands when the program is complete
(test islands available in the map folder)

Jeroo Super Challenges

Super Challenge 1 ("Tom & Tammy") : Tom and Tammy are in love, and today's the day that Tom is going to propose. According to custom, Tom must present Tammy with a flower as an official sign of his intentions. Tom lives in the extreme northwest corner of the island, and Tammy lives in the extreme northeast corner. The dividing river runs north and south, dividing the island roughly in the middle; the river is at least 5 cells away from the western and eastern edges of the island. The river, itself, is exactly two cells wide. Fortunately, for the lovers, there is a bridge somewhere to the south of their homes. Tom has asked Tammy to meet him at the middle of the bridge. While she suspects his motives, she doesn't want to appear too anxious.

The purpose of this program is to have Tom and Tammy find the bridge and meet in the middle where Tom will give an engagement flower to Tammy. After he has given her the flower, each returns to its home and faces the home of its betrothed. Each Jeroo starts at its home, Tom at (0,0) and Tammy at (0,23). Each can start facing any direction. Tom starts with one special flower in his pouch.
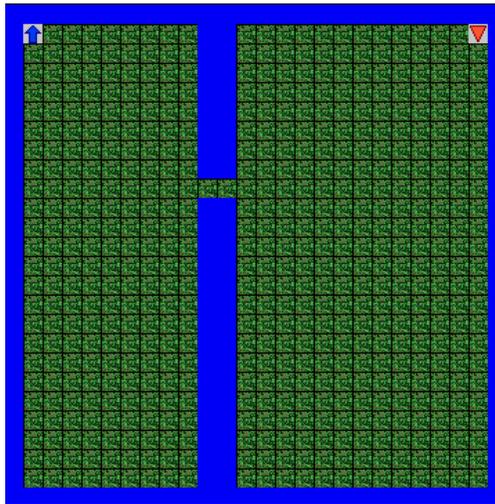

Figure 2 – One possible island; the program needs to handle vertical streams at any location.

(test islands available in the map folder)

Super Challenge 2 ("Netsweeper"): Develop a program that creates a Jeroo at (23,23) and has the Jeroo run around and pick up all the flowers on the island, then use them to disable all the nets on the island.
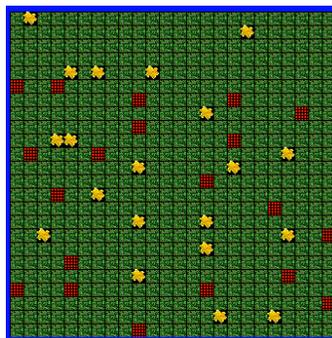

Figure 2 – One possible island; the program needs to work for any configuration of flowers & nets.

(test islands available in the map folder)

Super Challenge 3 ("Photocopier"): Develop a program that creates a Jeroo with a pouch full of flowers (like 50 or so). The Jeroo should then hop around to create a copy of the pattern of flowers that already exist on the island.
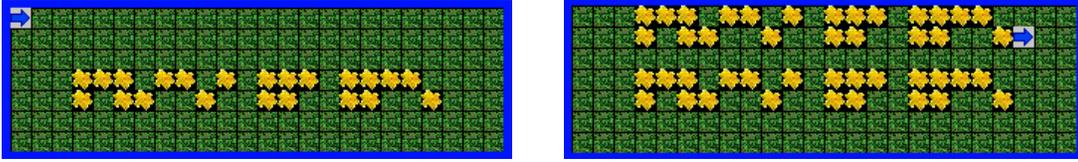

Figure 3 – The starting and finishing orientation of one of the test islands
(test islands available in the map folder)

Super Challenge 4 ("Maze Solver"): Your Jeroo is now like Theseus (from Minotaur battling fame). Theseus had to successfully enter a labrynth (maze), complete a task, and then get himself back out safely. Create a Jeroo that can navigate a maze made of nets. The Jeroo should start at (0,0), enter the maze, pick a flower somewhere in the maze, then get back out.
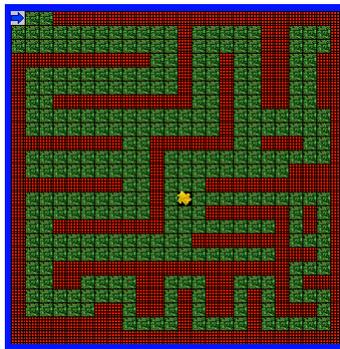

Figure 1 – One sample maze. Your program needs to work for any maez.

(test islands available in the map folder)

(40 pts) Approx. 3 days

The second part of our unit has you work with a partner to build and program a functioning robot. To do this, you'll start with a booklet of basic LEGO instructions, and you'll build a robot that matches the instructions as closely as possible. This beginning robot will be used to accomplish the 4 "First Challenges" for your LEGO robot.

1. Work with your partner to build a basic LEGO robot. Be sure to follow the LEGO Mindstorms instructions as closely as possible. If you need to occasionally substitute different parts, that's okay… but your final robot should look very much like the one the instructions were asking you to build.
2. Watch the video resources on our website including *Building Your LEGO Robot* and *Programming in RobotC*. Take a full page of notes on the programming information.
3. Work with your partner to plan and program your robot to complete EACH of the following "First Challenges":
    a. **First Challenge #1:** Program your robot to drive *forward* for 3 seconds. Stop. Then drive *backward* for 3 seconds.
    b. **First Challenge #2:** Program your robot to drive from one edge of a white lab table to the other, turn around, and then drive back to it's starting point. The robot should be able to do this without ever falling off the table.
    c. **First Challenge #3:** Program your robot to drive in a large figure-8 on the floor.
    d. **First Challenge #4:** Program your robot to drive from our main classroom, through the robotics room, around the corner in the computer lab, and back through the office space into the main classroom.
4. Have Mr. Benshoof confirm your completed challenges as each one is accomplished!

Part 2: Tasks	5 points	4-3 points	2-1-0 points
⊕ Build Simple LEGO Robot	+ Work with your partner to build your LEGO Robot + Follow the instructions as closely as possible	- You deviated significantly from the instructions	- You did not work with your partner - Your robot is not complete
⊡ Notes on RobotC Programming	+ Watch *Building Your LEGO Robot* + Watch *Programming in RobotC* + Take 1 page of good notes in your engineering notebook	- Less than a full page of RobotC programming notes	- Very brief or no notes in your engineering notebook
⊕ Complete First Challenge #1	+ Program your robot to successfully drive forward and backward on the floor.	- Your robot does not fully accomplish the designated task	- Your robot does not come close to accomplishing the task
⊕ Complete First Challenge #2	+ Program your robot to successfully drive around your table	- Your robot does not fully accomplish the designated task	- Your robot does not come close to accomplishing the task
⊕ Complete First Challenge #3	+ Program your robot to drive in a figure-8 on the floor.	- Your robot does not fully accomplish the designated task	- Your robot does not come close to accomplishing the task
⊕ Complete First Challenge #4	+ Program your robot to drive a loop through the engineering room and computer lab	- Your robot does not fully accomplish the designated task	- Your robot does not come close to accomplishing the task
	Up to 10 points		
☑ Take the Unit 3 Quiz!	+ You took the Unit 3 Quiz. + Your grade is based on the number you got correct	N/A	- You did not take the Unit 3 Quiz

(30 pts) Approx. 3 days

The final part of our unit has you adapt your LEGO robot and its program to accomplish one of the three LEGO Super Challenges. As you and your partner work through the proesss of solving the problem you'll need to actually barinstorm some possible solutions, make a plan for what you want to do, draw out a picture, and then make it happen! The Engineering Design Process returns!

1.   Read through the following LEGO Super Challenges with your partner and choose one (1) to work on!
     a.   **Wooden Maze:** Build and program a robot that can complete the large wooden maze. Your robot will need to be able to start at the end that is labeled "start" and finish at the point labeled "finish".

     b.   **Line Follower:** Build and program a robot that can follow the wiggly taped line on the floor of our classroom. The robot needs to be able to make a complete loop without any physical help from you!

     c.   **Whiffle Ball Pickup:** Build and program a robot that can drive from one end of a white lab table to the other, pick up a whiffle ball from it's stand, and then bring it back to the starting point and put it back down on a new stand.
2.   Once you and your partner have chosen a single Super Challenge, brainstorm at least 10 ways to accomplish the task. Record your brainstorming in your notebook.
3.   Start building and programming your robot! Work together to make sure things go well.
4.   Test, Evaluate, Redesign, Rebuild, and Retest as much as it takes to get it working!
5.   Evaluate your final solution. When you think your robot is as good as it's going to get, run the program 5 times in a row. Let Mr. Benshoof watch! Record how many times you are successful out of the 5 total trials.
6.   Write a 1-page summary in your engineering notebook about your LEGO Robotics experience. What was easy and fun? What was frustrating or annoying? What would you do differently if you were building a new robot?

Part 3: Tasks	5 points	4-3 points	2-1-0 points
⊕ Select a LEGO Super Challenge	+ Talk with your team about the LEGO Super Challenge options. + Agree on which challenge your team wants to tackle.	N/A	**0 points only if:** - No agreement between partners
🔲 Plan and Brainstorm Solutions	+ You and your partner brainstorm possible solutions and possible robot designs. + Draw a picture of what you want your robot to look like.	- Your plan is not recorded - Your brainstorming is not recorded	- Nothing is recorded - No plan for accomplishing the super challenge is present
	10 points	*9-4 points*	*3-0 points*
⊕ Build & Program Your Robot	+ Build your robot. + Program your robot to complete the Super Challenge + Make sure your robot can complete the challenge at least 4 out of 5 tries. + Have Mr. Benshoof confirm your success.	- Your robot is successful between 1 and 3 times out of 5.	- Your robot is never successful at the super challenge.
📄 Write a 1-page Summary	+ Write a full page in your engineering notebook reflecting on the LEGO Robotics building	- Your summary is less than a full page - Your summary is not about the LEGO Robots	- Your summary is missing