Functions and the Step Counter Model
(Project 11)
Goals

• In this tutorial you will:
  – Learn to use a step counter in your program
  – Practice creating functions

• Important note: There will be several slides at the beginning of this tutorial to read and understand before you begin to create your next program.
Review of previous tutorial

• The sketch and flow diagram on the right describe the program you wrote in a previous tutorial (Applied Conditionals)

• What would happen if the location of Position B were changed? Would this program always move the SPHERES satellite to Position B?

• On the next slide you will be given an example of a location where the program would not work and the reason why.
Example that doesn’t work

• Look at the new position called Position C.
  – Q: How does the x-coordinate of the satellite change as it moves from position A (1,0,0) to position C (0,1,0) in the picture?
  – A: The satellite starts with x-coordinate = 1 and moves towards x coordinate = 0

• The program sets target x = 0.97 then states:
  If myZRState[0] < target [0],
  (which means If SPHERES x-coordinate < 0.97)
  Then go to position A
  Else go to position C

• As the satellite moves from position A toward position C, its x-coordinate becomes < 0.97 and it will be sent back to position A.
  – The program will not allow the satellite to move to position C (which has x-coordinate < 0.97)
Picking a target value for Position C

• So what is the target value that you would choose to move the satellite from position A to position C?
  – Since the satellite starts with \(x\)-coordinate=1 and moves towards \(x\)-coordinate=0:
  – Pick a target close to zero.
  – Pick target[0]=0.03 to include margin for error

• In this case the satellite’s \(x\)-coordinate is **greater than** 0.03 until it reaches the target

• So the conditional statement for this example would be:

  “If myZRState[0] > target[0]  
  Then continue to position C”
Solution to problem

• We need to write a program that allows us to pick different target values depending on where we want the satellite to move

• We can solve this problem using a step counter (as described on the following slides)
Using a step counter

• A step counter is one way you can organize a program. It is particularly useful in a game like ZR.

• To use a step counter:
  – Break up the program into steps (for example, moving to a point is one step)
  – Use a variable to keep track of how many steps have been performed
  – Use conditionals to make sure you execute only the next step in the process
  – This process ensures that all steps happen in the right order

• An example of this process is provided on the next several slides
Look more closely at the example: Let’s say the first step in the program (step 0) is for the satellite to go to position A

- The flow diagram to the right includes a step counter. Note that:
  - A conditional statement is added to the program to check if the program is in the first step (Step=0?)
  - The step is increased by 1 (Step=step+1) after the satellite completes the first step by reaching position A
  - Another conditional statement is added to check whether or not the program has moved to the next step (Step=1?).
Using a step counter (cont.)

- Next we want the satellite to leave position A and go to position C (as shown in the sketch).
- By using a step counter we don’t have the same problem that we had before because the variable target x can be given a new value inside each step.
- For Step=0: target x was set to a value appropriate for position A (see previous slide).
- For Step=1? target x is set to a new value appropriate for position C (shown here).
- Next, Step=0 resets the step counter.
Using a step counter (cont.)

- This slide shows the complete flow chart
Functions

- We can make this program simpler to read by breaking it down into smaller pieces.
- This is done by creating procedural functions.
- For example, we can create two functions:
  - One that includes the parts of the program that sends the satellite to position A
  - One that includes the parts of the program that send the satellite to position C

Create function called “Go to position A”
Create function called “Go to position C”
• This is what the example program’s flow diagram and graphical editor program would look like if written using two functions: one called “Go to position A” and one called “Go to position C”

• You don’t see Step=step+1 here because it is included inside each function.
Create a New Project Using “Save As”

• To create this program with a step counter and functions, you will start from the program you created in the previous tutorial
  – Open the ZR IDE
  – Open Project 10
  – On the menu bar select “File” and then “Save As” from the drop down menu.
  – Type in **Project 11** and select **Graphical Editor, Free Mode**
Declare Variables and Arrays

- You will need to create two new variables
  - float positionC[3]
    - Create array
    - Set initial value to 0,1,0
  - Int step
    - Create variable
      - Leave initial value blank

- Verify the remaining variables as follows:
  - float positionA[3]
    - Verify initial value is set to 1,0,0
  - float myZRstate[12]
    - Leave initial value blank
  - float target[3]
    - Leave initial value blank

- Check that your program has the variables shown in the box to the right
Create “GoToPositionA” Function

• Your program already has a function to send the SPHERES to position A that is very similar to the one shown in the flow diagram.

• Click on the page “GoToPositionA”.

• Can you see the difference between the part of the flow diagram that we want to make into a function called “GoToPositionA” and your program?

• (Hint: compare your program’s else statement with the flow diagram)
  – your old program continues to set the SPHERES position to positionA
  – the new program increments the step counter (step=step+1)
Create “GoToPositionA” Function (cont.)

- To modify your program: Open your page “GoToPositionA” and delete the setPositionTarget block from the else statement (drag to trash)
- Add a step counter into the “else” slot
  - Drag a “step = 0” block from the variables accordion into the “else” slot
  - Drag a “__+__” block from the Math accordion into 0 block
  - Drag a “—Select—” block from the variables accordion into the first blank and toggle to “step”
  - Drag a number block (1) from the math accordion into the second blank
- Your function “GoToPositionA” is complete!
Create “GoToPositionC” Function

• Now let’s create the second function in the flow diagram “GoToPositionC”
• First create a new page called “GoToPositionC”
• Click on the “+” button on the “pages” window
• For Page Name type: GoToPositionC. This will be the name of your function
  – Leave Return Value blank
  – Click the “Create Page” button
Create “GoToPositionC” Function (cont.)

- Your new page will open to a loop called “GoToPositionC”
  - Do not add anything to the loop yet
- Your new page will show up in the list of pages
- Click on the “main” page to return to your main loop.
- On the “main” page, open the Functions accordion (as shown)
  - You will see both functions: “GoToPositionA”
  - “GoToPositionC”
The two functions are similar so to save time you will copy and paste the code from the “GoToPositionA” page into the “GoToPositionC” page and then edit:

- In the GoToPositionA” loop click on the `target[0]=.97` block and select “Edit” then “Copy” from the top menu.
- On the Pages menu, open the page: “GoToPositionC”
- Select “Paste”
- Repeat for the If-Then-Else block
- Drag and Drop the pasted code into the “GoToPositionC” loop

This code now needs to be edited to send the satellite to positionC (instead of positionA) as described on the next slide.
Create “GoToPositionC” Function (cont.)

- The portion of the flow diagram that sends the satellite to position C is shown to the right as a reference.
- Change “target [0]=.97” to: “target [0]= 0.03”
- Change the conditional statement from `myZRState[0]<target[0]` to `myZRState[0]>target[0]`:
  - Use the drop down menu to change the “<” to “>”
- Change the toggle on the `setPositionTarget` block to “positionC”
- `Step=step+1` should already be in your program
- Your function “GoToPositionC” is complete!
Using the Step Counter Model

- The next step is to go back to the main loop and create the program shown below.
- This program uses a step counter and “calls” the functions.
Using the Step Counter Model (cont.)

- Click on “main” on the pages menu to go back to the main loop
- Drag the “GoToPositionA” function (left over from program you started with) to trash
- Drag an “If-Then” block from the Logic accordion into the loop after the “GetMyZRState” block
- Change the “if” statement to:
  
  ```
  If step == 0 then “GoToPositionA”
  ```

  as follows:
  - Drag a “==” Block from the logic accordion
  - Drag a pink “—Select—” variable block from the variables accordion into the first “__”
  - Drag number block (0) from the math accordion into the 2nd “__”
  - Drag “GoToPositionA” block from the Functions accordion into the “then” slot
Using the Step Counter Model (cont.)

- Click on the white star on the if statement and add “else-if” and “else” statements

- Change the “else-if” statement to:
  “else-if step == 1 then goToPositionC”
  - Copy “step==0” from the if statement above, paste it into the else-if statement and then change the “0” to “1”
  - Drag “GoToPositionC” block from the Functions accordion into the “then” slot

- Change the “else” statement to:
  “else step=0”
  - Drag “--Select-- = 0” block from the Variables accordion into the “else” slot and toggle to “step”
  - Leave the number=0.
• Your code is complete!
• Compile, Simulate
  – Maximum Time: 180 seconds
  – View simulation

• The C Code for the separate pages “loop”, GoToPositionA”, and “GoToPositionC” is shown below:

```c
1: void loop() {
  api.getMyZRState(myZRstate);
  if (step == 0) {
    GoToPositionA();
  } else if (step == 1) {
    GoToPositionC();
  } else {
    step = 0;
  }
}
```

```c
1: void GoToPositionA() {
  target[0] = 0.97;
  if (myZRstate[0] < target[0]) {
    api.setPositionTarget(positionA);
  } else {
    step = step + 1;
  }
}
```

```c
1: void GoToPositionC() {
  target[0] = 0.03;
  if (myZRstate[0] > target[0]) {
    api.setPositionTarget(positionC);
  } else {
    step = step + 1;
  }
}
```
The program you just created resets the step counter to zero in the last “else” statement.

If you wanted to program the satellite to go to another position after going to position C, can you see how this would be done?

- You would:
  - Create a new function
  - Add another “else-if” statement
  - Call the new function

When you program your SPHERES for the game you will probably use a series of Else-If statements with multiple steps

Using functions will also make it easier for you to figure out which part of your program needs debugging
Review

- Congratulations!
  - You have learned how to:
    - Use a Step Counter
    - Create multiple functions
  - You are just about ready to start programming your game!

```
Call function: “Go to position A”
```

```
Call function: “Go to position C”
```