

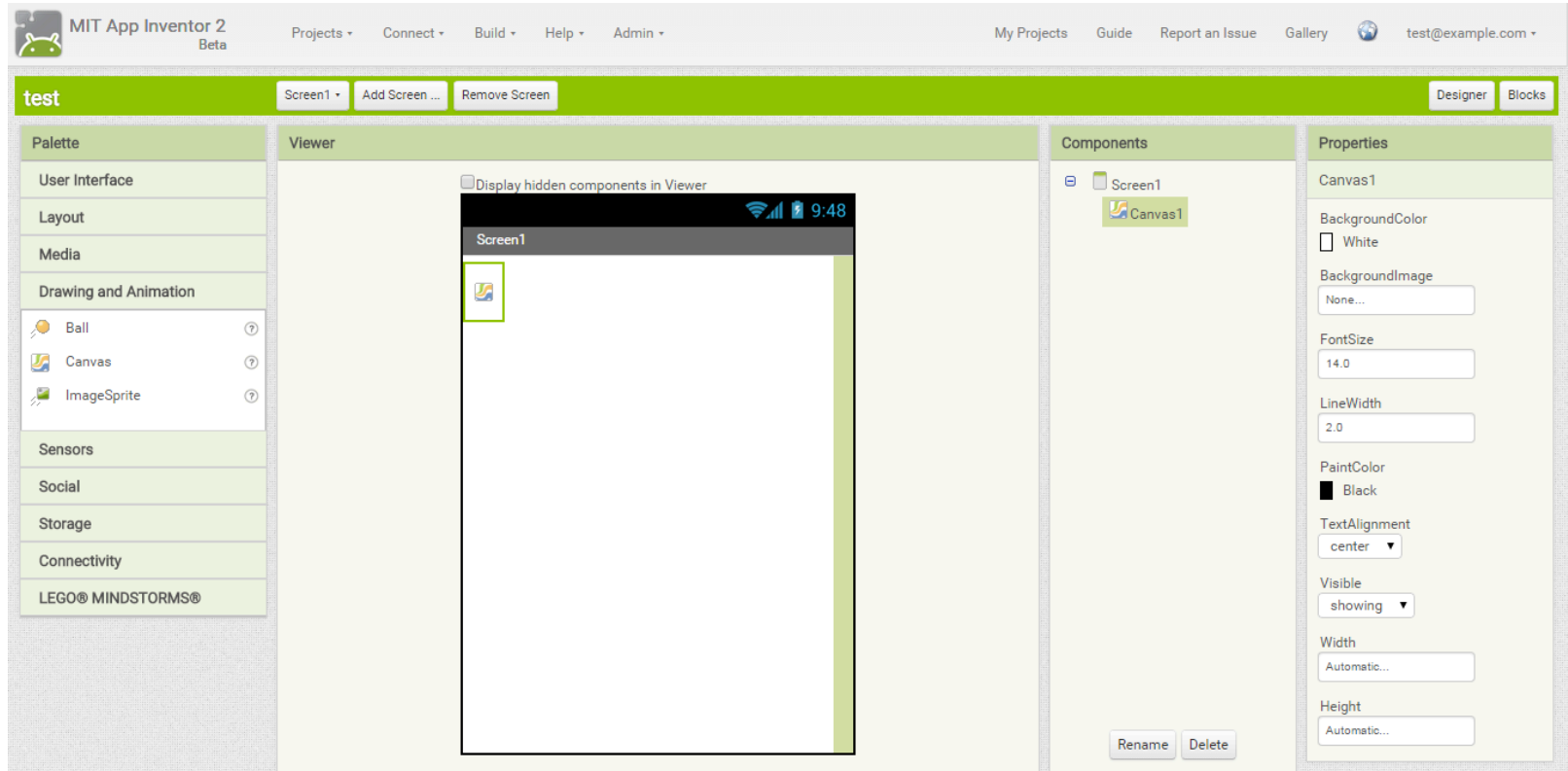
Adapting higher-order list operators for blocks programming

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Designer



Blocks Editor

The screenshot displays the MIT App Inventor 2 web interface. At the top, the header includes the MIT App Inventor 2 logo and navigation links: Projects, Connect, Build, Help, Admin, My Projects, Guide, Report an Issue, Gallery, and a user profile icon with the email test@example.com. Below the header, a green bar contains the project name 'test' and buttons for 'Screen1', 'Add Screen ...', and 'Remove Screen'. On the right of this bar are 'Designer' and 'Blocks' tabs, with 'Blocks' being the active tab.

The interface is divided into two main sections: 'Blocks' on the left and 'Viewer' on the right.

The 'Blocks' section features a sidebar with a 'Built-in' category containing various block types: Control, Logic, Math, Text, Lists (highlighted in green), Colors, Variables, and Procedures. Below this, a 'Screen1' category lists components: Canvas1, Button1, and Label1. At the bottom of the sidebar is an 'Any component' option.

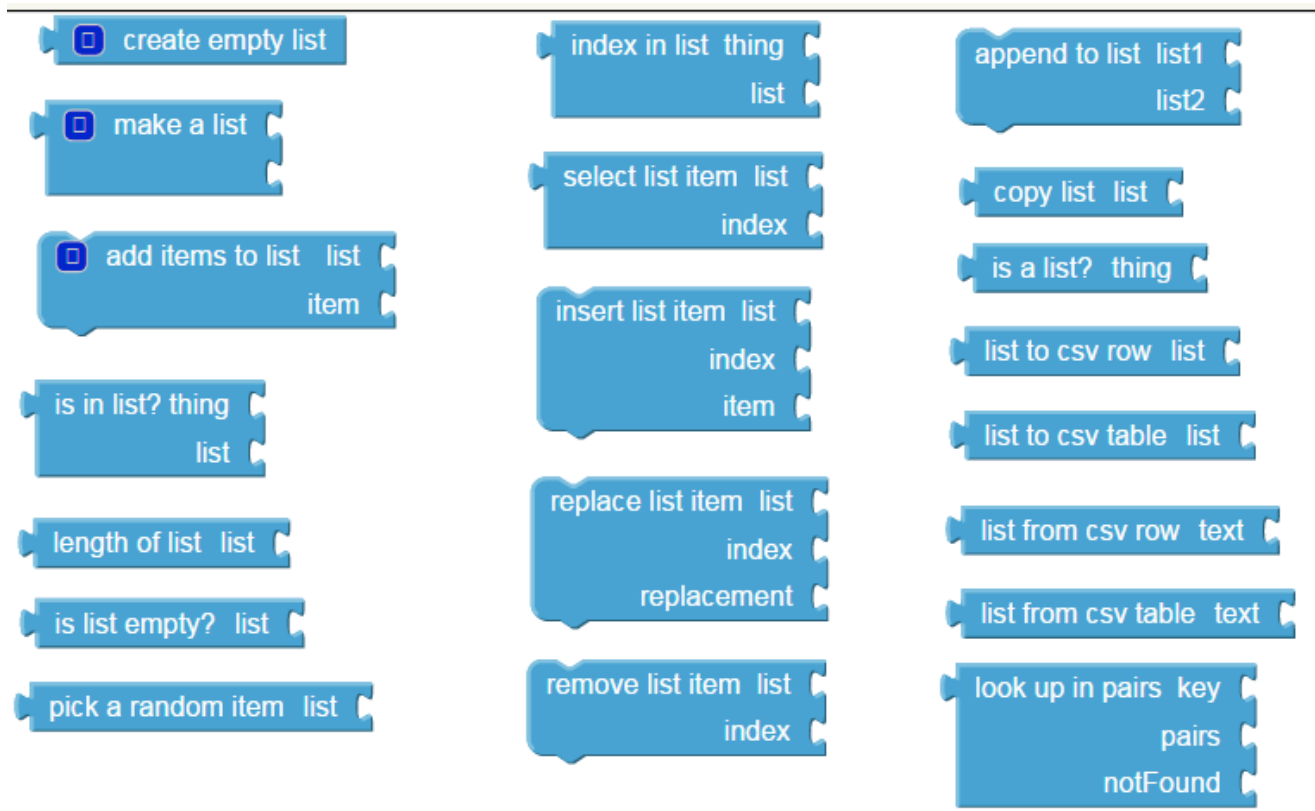
The 'Viewer' section shows a visual representation of the code blocks. The code includes:

- Two global initialization blocks: 'initialize global randomInteger to 0' and 'initialize global listofRandomIntegers to create empty list'.
- A 'when Button1 Click' event block containing a 'do' loop with the following actions:
 - 'set global randomInteger to random integer from 1 to 100'
 - 'set Label1 Text to get global randomInteger'
 - 'add items to list list' with 'list' as the list and 'get global listofRandomIntegers' as the item.
 - 'add items to list list' with 'list' as the list and 'get global randomInteger' as the item.

At the bottom left of the Viewer, there are warning indicators (a yellow triangle with '0' and a red triangle with '0') and a 'Show Warnings' button. A trash can icon is located at the bottom right of the Viewer area.

Problems with Current List Operators

Current List Operators



Berry's Lemonade

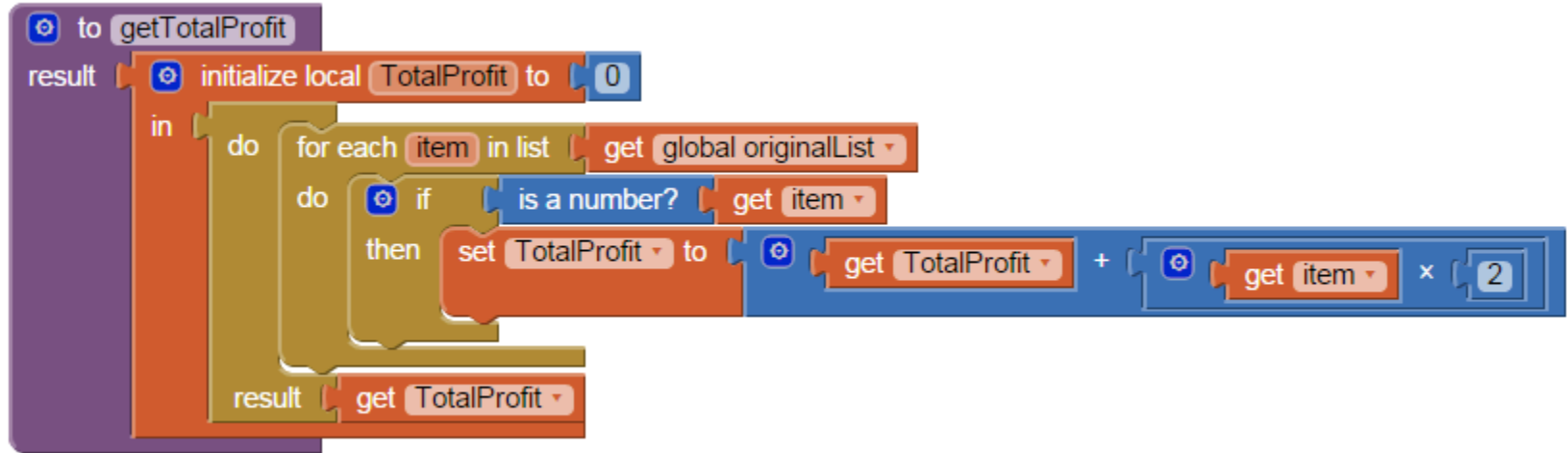


Date	# of Lemonades Sold	Daily Profit (\$)
6/1/15	13	26
6/2/15	20	40
6/3/15	N/A	
6/4/15	18	36
6/5/15	N/A	
6/6/15	10	20
6/7/15	16	32
	Total Profit	154

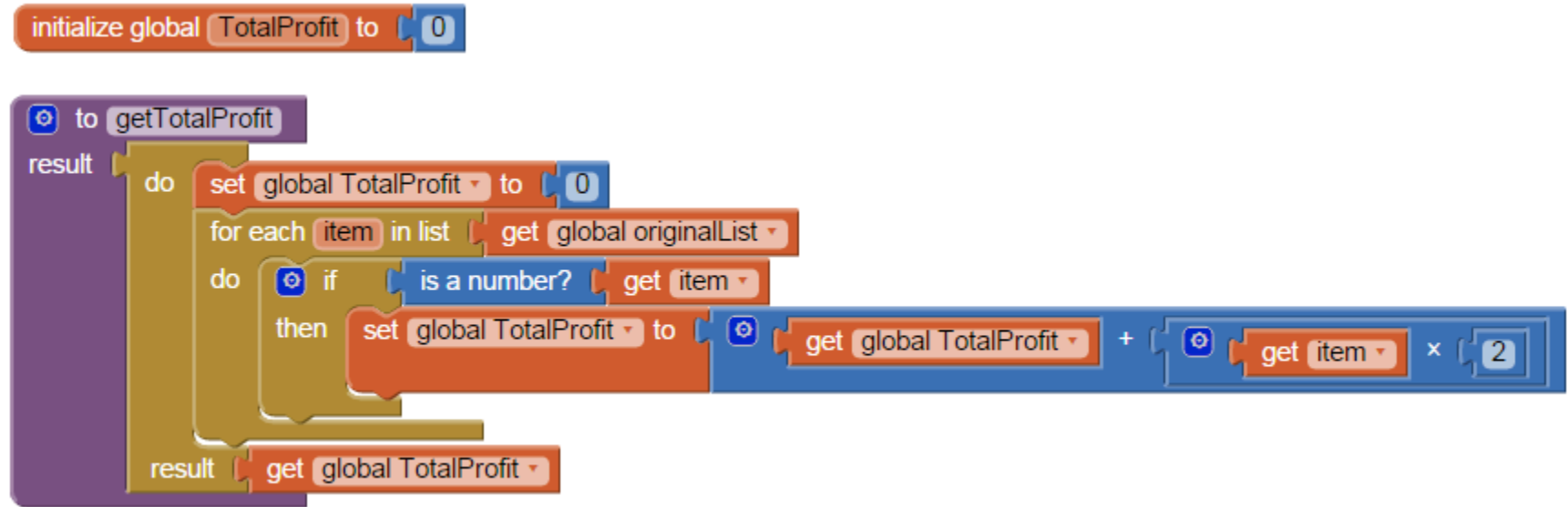
Berry's Lemonade List Data in App Inventor



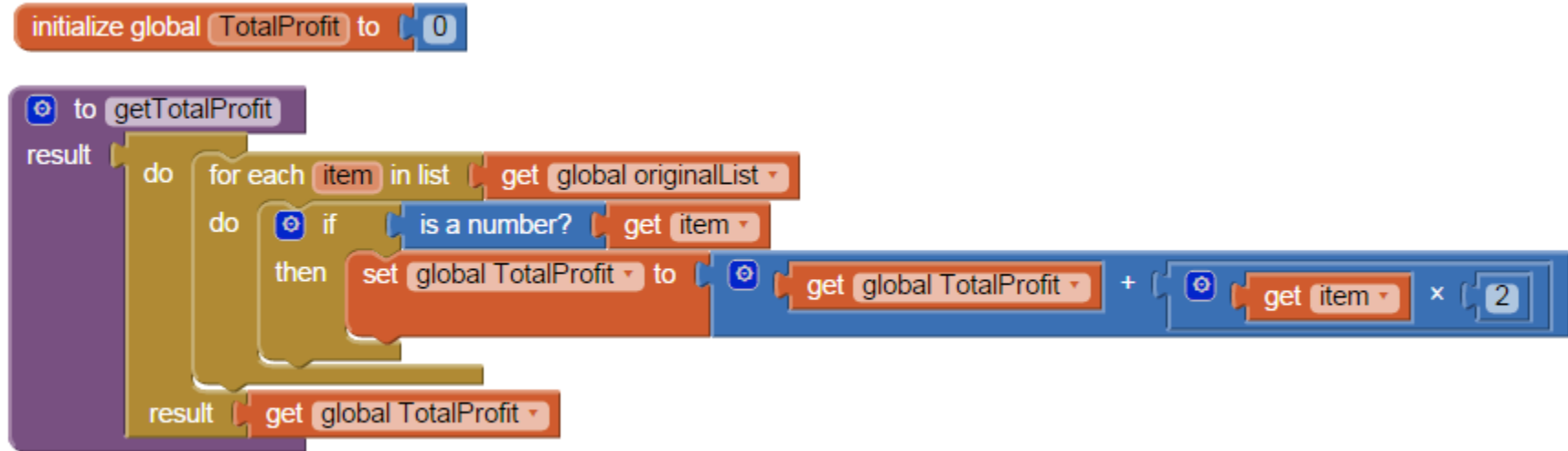
Solution Using a Loop and Local Variable



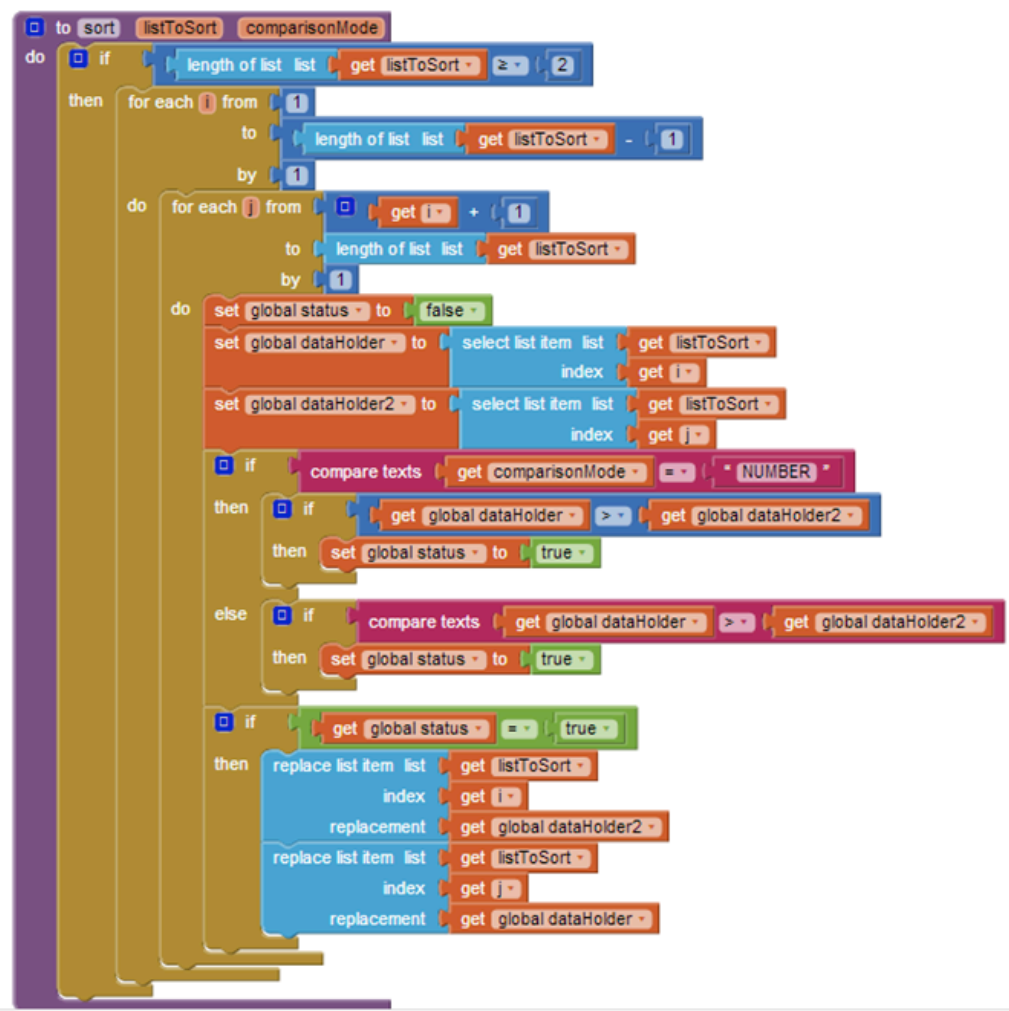
Solution Using a Loop and Global Variable



Common Bug: Failure to Reinitialize Global Loop Variable



Sort: Old Design



Solution: Addition of
Pseudo-Higher-Order Operators
(PHOLOs)

Map, Filter, and Reduce in Python

```
>>>(map (lambda x: x + 1) [5,3,8,10,2])  
[6,4,9,11,3]
```

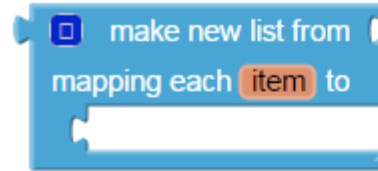
```
>>>(filter (lambda x: x < 6) [5,3,8,10,2])  
[5,3,2]
```

```
>>>(reduce (lambda x, y: x + y) [5,3,8,10,2])  
28
```

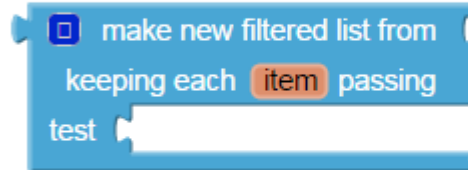
Higher-Order List Operators (HOLos)

Map, Filter, and Reduce in App Inventor

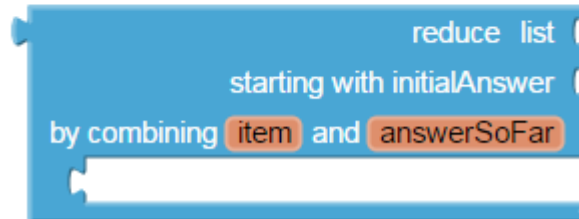
Map



Filter

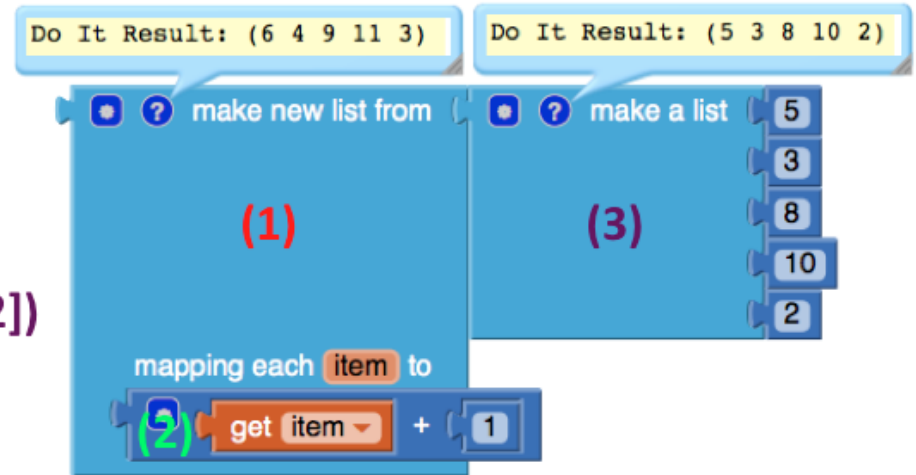


Reduce



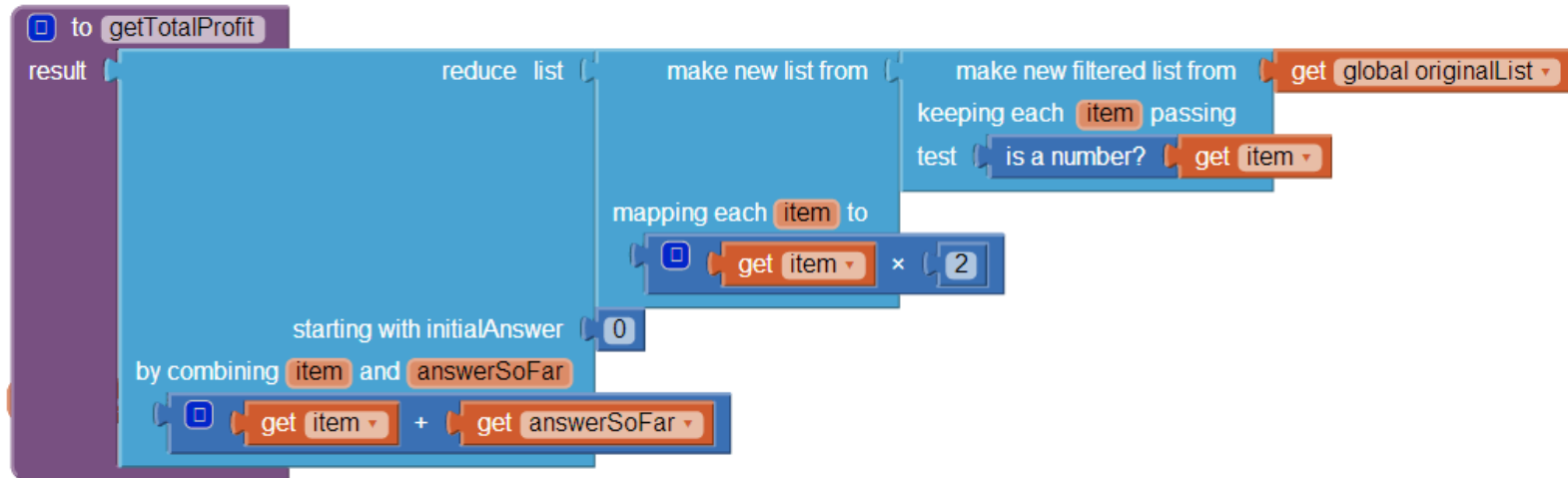
Map Block

(1) (2) (3)
`map (lambda item: item + 1, [5,3,8,10,2])`



Pseudo-Higher-Order Operators (PHOLOs)

Solution Using Filter, Map, and Reduce

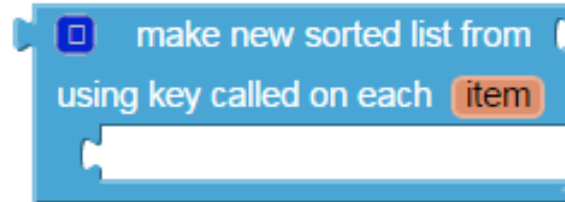


Three Sort Blocks

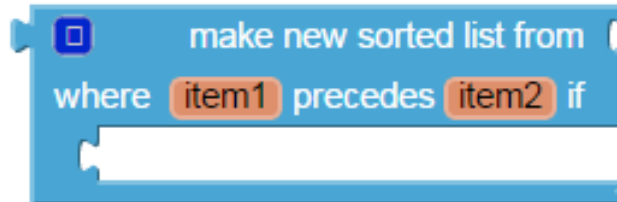
Basic sort



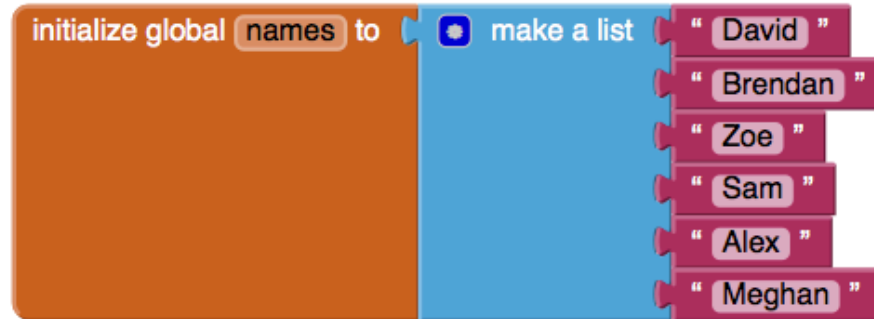
Sort with key



Sort with comparator



Basic Sort

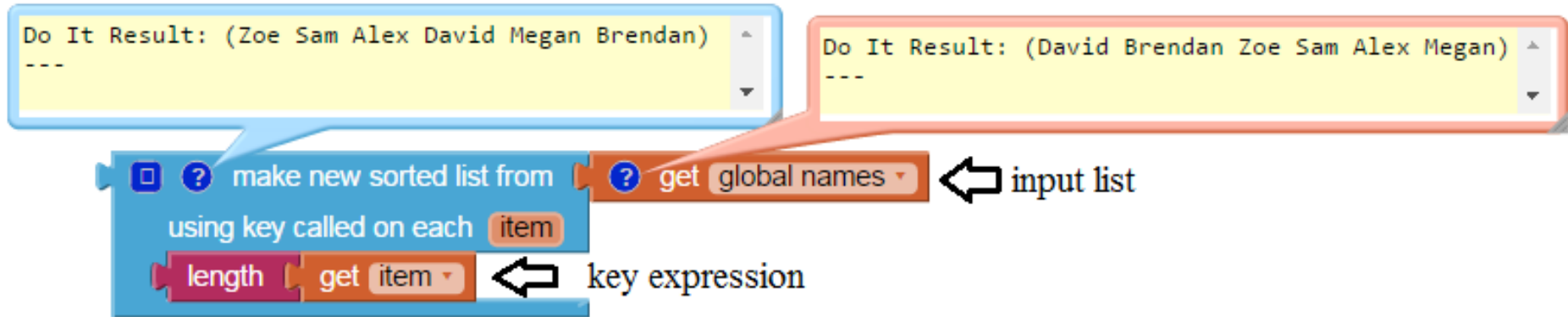


Do It Result: (Alex Brendan David Meghan Sam Zoe)

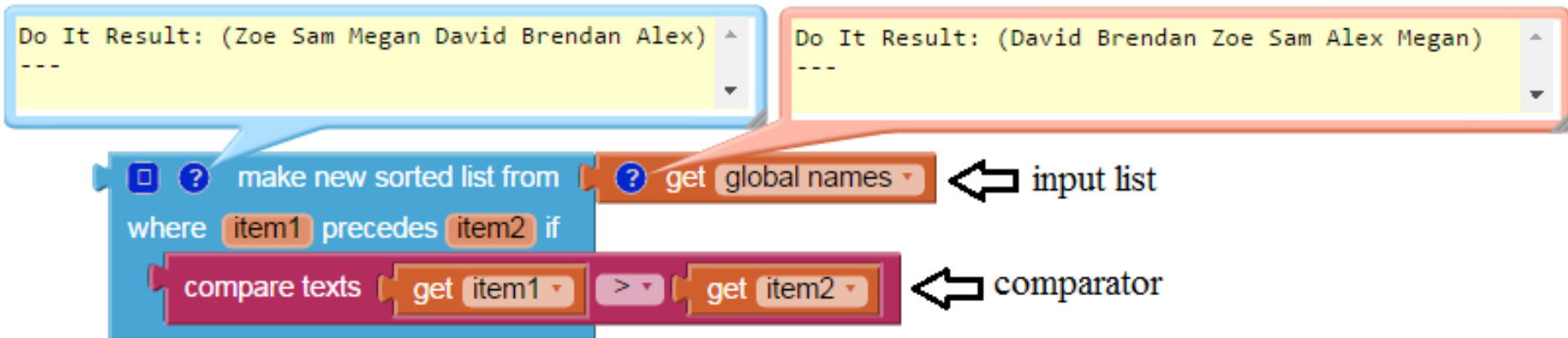
Do It Result: (David Brendan Zoe Sam Alex Meghan)



Sort with Key



Sort with Comparator



Design and Results of User Study

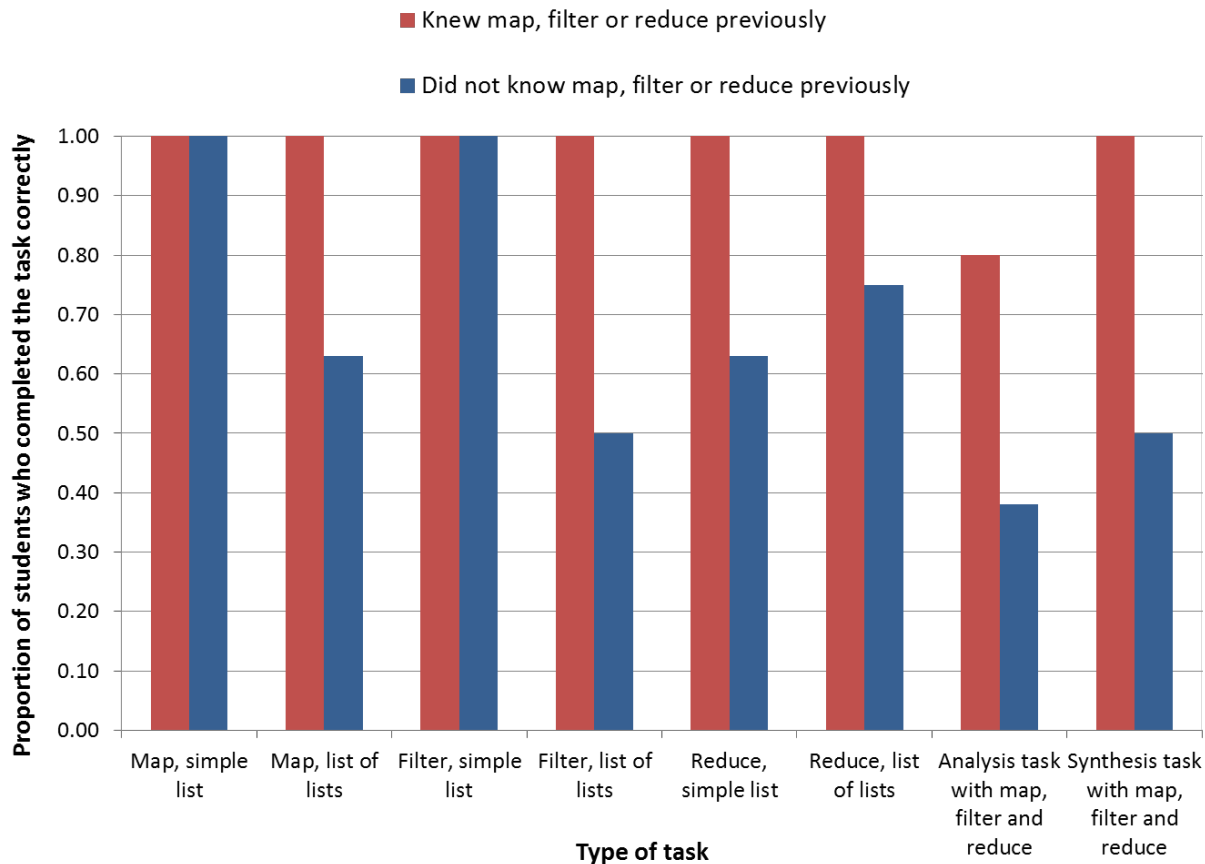
Design of User Study

- 60 to 90 minutes
- Short tutorial on each list operator
- Part 1: 8 tasks involving mapping, filtering, and/or reducing
- Part 2: 6 tasks involving sorting

User Study Participants

- 18 Wellesley students who had previous experience working with App Inventor
- 10 users (56%) knew map, filter or reduce previously and the remaining 8 users (44%) did not

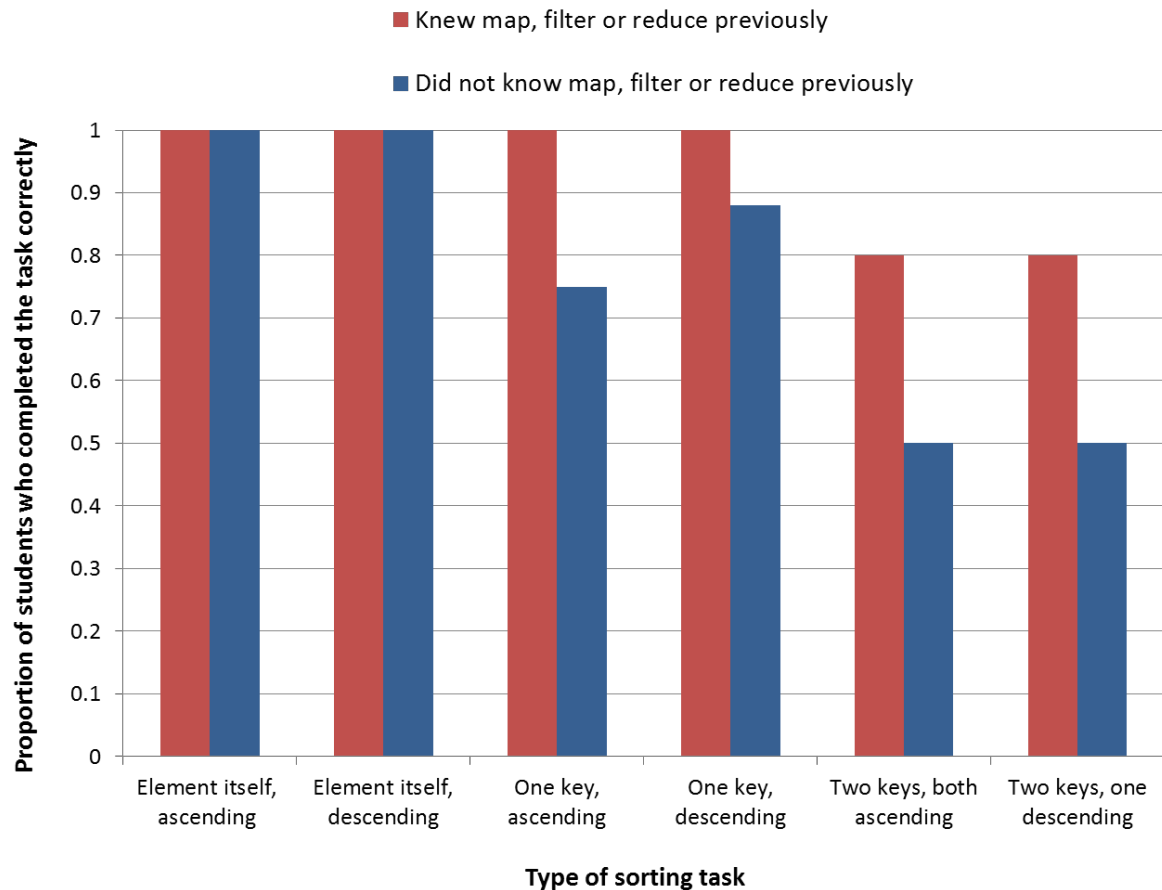
User Study Results Part 1



Feedback

- “I have worked with map, filter, and reduce a lot in different languages, so the concepts were familiar and I was able to interpret pretty quickly what parts the blocks should have. ”
- “These blocks were fairly simple to use, but I sometimes became frustrated because I would forget which block was useful in what kind of scenario. Reading the english on the blocks also helped with this though when I would get stuck.”

User Study Results Part 2



Feedback

- “I didn't like that there were three different blocks for three different kinds of sorting...I almost think it would be easier if you had to explicitly decide how you want a list to be sorted every time you want to sort a list.”
- “I liked that there were three options, so I could use the one I felt most comfortable with.”
- “There are multiple ways you can perform a single task, especially with these three specific sort blocks. That made it both easier (can use any) and more difficult (many options for how to execute) to use.”

Related Work


Map in Snap! vs. App Inventor



Canvas App Example in Code.org App Lab

Code Design View Data

clear




Show Toolbox Workspace:

```
1 button("clearButton", "clear");
2 createCanvas("myCanvas", 200, 300);
3 setActiveCanvas(▼ "myCanvas");
4 onEvent(▼ "myCanvas", ▼ "mousedown", function(event) {
5   setFillColor(▼ "blue");
6   circle(event.clientX, event.clientY, 10);
7 });
8 onEvent(▼ "clearButton", ▼ "click", function(event) {
9   clearCanvas();
10 });
```

Properties of Events in Code.org App Lab vs. App Inventor

```
onEvent (▼ "myCanvas", ▼ "mousedown", function(event) {  
  setFillColor (▼ "blue");  
  circle (event.clientX, event.clientY, 10);  
});  
  
onEvent (▼ "clearButton", ▼ "click", function(event) {  
  clearCanvas ();  
});
```

```
when Canvas1 .TouchDown  
do  
  set Canvas1 . PaintColor to   
  call Canvas1 .DrawCircle  
    centerX get x  
    centerY get y  
    radius 10  
    fill true  
  
when Button1 .Click  
do  
  call Canvas1 .Clear
```

Conclusions and Future Work

Conclusions

- Addition of PHOLO blocks
 - Understandable to some extent
 - Bypasses problem of not having first class functions
- Sort with key not necessary

Future Work

- Finalize the labels on the blocks
- Conduct additional user studies
 - Compare loops vs. PHOLOs
 - Study wider demographic base
- In the process of adding to official App Inventor release

Questions?