Why did my dog’s head fall off?
Teaching Computing with Visualization, Animation and Interaction

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Duke Family Weekend
Duke University
Welcome to a Computer Science course!
Welcome to a Computer Science course!

• Punch Cards
Welcome to a Computer Science course!

• Email – early 1980’s
Now let’s move to the present!

• Teaching computing with visualization, animation and interaction.
• Increasing Computing in K-12
• Diversifying Computing
Beginning Programming

• How many of you …
  • Have never done any programming?
  • Have done a little programming?
  • Have taken a programming course?
  • Have done a LOT of programming?
Let’s Learn Programming with Animation!

• Learn some topics that is taught in CompSci 94
• Non-majors course at Duke
Alice Programming Language

• Create interactive stories or games
• Learn programming in an easy way, drag-and-drop your code
• Problem solving with visual feedback
  • Logical thinking, Computational thinking
• Along the way, learn computer science concepts:
  • Loops, classes, procedures, arrays
• Developed by Randy Pausch, CMU
  • alice.org

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An example with Alice
What concepts were in that animation?

- Placing a 3D object in a virtual world
- Program an object with instructions
  - Move, turn, say
What concepts were in that animation?

• Writing a new instruction
  • Walk
  • Jump

• Repetition
  • Walk repeatedly
How do you calculate the jump?
How do you calculate the jump?

• How high to jump
  • Cat’s height
How do you calculate the jump?

• How high to jump
  • Cat’s height

• How far to jump
  • Distance to cat
How do you calculate the jump?

• How high to jump
  • Cat’s height

• How far to jump
  • Distance to cat + width of cat
How do you calculate the jump?

• How high to jump
  • Cat’s height
• How far to jump
  • Distance to cat + width of cat + length of dog
What concepts were in that animation?

• Parts of objects
  • Turn parts – stay attached

• Move parts – No! stretch
What concepts were in that animation?

- Camera movement – close up view
What concepts were in that animation?

• Camera movement – top view
How does one add an object?
How does one add an object?
How does one add code?
How would you learn concepts?

• Watch Videos
• Duke Learning Innovation helped me make videos
• Part of an online Alice Coursera course
  • Launch in January 2020
  • With Steve Cooper at University of Nebraska
Moving and Turning Video
Quiz: Which instruction?

• A) 

• B)
Quiz: Which instruction?

Panda turns to its right

• B)

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Quiz: Which instruction?

- A) `this.sarah getRightHip` `turn FORWARD`, $0.25$

- B) `this.sarah getRightHip` `turn BACKWARD`, $0.25$
Quiz: Which instruction?

The leg turns backwards!

B)
Quiz: Which Picture after code runs?

START

A)  

B)
Quiz: Which Picture after code runs?

START

A)  

B)  

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Quiz: Trace the code

START

```text
this.panda roll RIGHT, 0.25
this.panda move LEFT, 1.0
```
Quiz: Trace the code

START

![Image of a panda moving and rolling]

```
this.panda roll RIGHT, 0.25
this.panda move LEFT, 1.0
```
Let’s look at an example of what you could do with Alice

• Things to look for
  • Grouping objects together – penguins
    • All penguins execute the same instruction
  • Color the penguins in an ordered fashion
  • Color the penguins random colors
  • Calculations based on the colors
    • How many penguins are red?
    • Which penguin is the first penguin in the line that is red?
What my class did yesterday
Let’s look at another example of what you could do with Alice

• Things to look for
  • Game – click on bunnies
    • Group of bunnies
  • Click on bunnies for points
    • White bunny – 1 point
    • Yellow bunny – 3 points
  • Score
  • Timer
  • Win if you get 10 points
Game my class will build next week
More complicated concepts taught with Alice

• Search for a data item
  • Organize the data
  • Sort the data to make it easier to search

• Let’s look at an example in Alice
Let’s look at sorting in Alice
First mix up the people – shuffle them
Then put in sorted order by height
Example Sorting

Sort by height
Let’s learn that Sorting Algorithm
Selection Sort

• Need some volunteers!
Selection Sort
Sort a list of numbers

• List is in two parts
  • Part sorted
  • Part not sorted yet.

• Idea:
  • Repeat until list is sorted
    • Find smallest element in part of list not sorted
    • Put it where it belongs in sorted order.
      • Swap it with the element where it should be
Example: Selection Sort

• Sort the list of numbers using Selection Sort.
• 9, 5, 4, 1, 3, 6
Selection Sort – red area sorted

9 5 4 1 3 6 - find smallest, swap
1 5 4 9 3 6 - end of 1\textsuperscript{st} pass
1 5 4 9 3 6 - find smallest, swap
1 3 4 9 5 6 - end of 2\textsuperscript{nd} pass
1 3 4 9 5 6 - find smallest, swap

compsci 101 fall 2017
Selection Sort (cont.)

1 3 4 9 5 6 - end of 3\textsuperscript{rd} pass

1 3 4 9 5 6 - find smallest, swap

1 3 4 5 9 6 - end of 4\textsuperscript{th} pass

1 3 4 5 9 6 - find smallest, swap

1 3 4 5 6 9 - end of 5\textsuperscript{th} pass, done

SORTED!
Now ...

• Increasing Computing in K-12
• Diversifying Computing
Teaching Alice Programming at Duke since 2005 – CompSci 4, now 94
www.cs.duke.edu/courses/fall19/compsci094

CompSci 94, Fall 2019
Home

Course Announcements

- August 27, 2019 is the first day of class.
- You will need to bring a laptop to class and download a particular version of Alice 3 before coming to the first class if possible. More info on Alice 3 and downloading it is on the Resources page.

CompSci 94
Introduction to Programming Via Animation and 3D Virtual Worlds

CompSci 94 is an introductory programming course that teaches fundamental computer science concepts. This version of CompSci 94 uses the tool Alice 3 to create 3-D virtual worlds. You will learn programming constructs such as repetition (calculating how many steps a person needs to walk to their car), selection
Computer Science - K-12 schools around 2005

• Computer Science not in schools
  • Few High schools taught AP CS
  • Few middle schools teaching computing
  • CS not required at college level

• Students don’t know what CS is
  • Keyboarding? Powerpoint?

• Women and minorities in CS low
Success - Alice attracts diverse group

• At Duke
  • CompSci 4 Spring 2005
    • 22 preregister, 30 enroll (12 female + 3 African Amer.)
  • CompSci 4 Fall 2005
    • 20 preregister, 31 enroll (17 female – 1 African Amer.)
  • CompSci 4 Fall 2006 – 2 sections
    • 64 students, 33 female, 7 African Amer.
  • CompSci 4 Fall 2007 – 2 sections
    • 84 students - > 50% female
  • CompSci 4 Fall 2008 – 2 sections
    • 100 students - > 50% female
  • Same for Spring 2009, Fall 2009...
  • Advertised in school paper
    • picture of ice skater
    • Web site of animations
  • This course is now CompSci 94
Success - Alice Excites 4th-6th Grade Girls

- Duke Femmes Event, April 07
- 60 girls – 4 groups of 15
- Taught them Alice for an hour
- Handout to take home
Adventures in Alice Programming and Other Workshops
Duke University, Durham, NC

Adventures in Alice Programming is a project for integrating the programming language Alice into middle schools and high schools in the state of NC, based in the Durham, NC region. Originally, the target schools were the schools in Durham county, Vance county, Person county and Chatham county. We have now expanded to schools throughout NC. We have also taken a few teachers from other states.

Note that this is the page for the NC site. See information about other sites and more history with this project here.
Adventures in Alice Programming

• 2-week Teacher workshops
  • Over 400 teachers, middle school, high school, some elementary
  • First week Teach Alice, Practice
  • Second week - Develop Lesson Plans
  • Follow-up workshop the following summer
  • Summers 2008-2017, funding for lodging

• Main Sites:
  • Duke University, Durham, NC, USA
  • Charleston/Columbia, SC, USA
  • San Jose, CA, USA
  • Lincoln, Nebraska, USA
Curriculum materials

• Over 200 Tutorials on animation and computing topics

• Over 200 Teacher lesson plans

Science
4th Grade

• Rock Cycle by Debra Ludde (2012)
  ○ Alice World (Finished)
  ○ QuickTime Movie
  ○ Rock Cycle Rubric
  ○ Lesson Plan (.docx)

• Magnet Lab Sort by Dawn Delk (2013)
Impact

• Number of teachers
  • Over 400 teachers learned programming with Alice since 2008

• Number of students
  • Our teachers have taught Alice to over 10,000 students

• Google Analytics on our curriculum website
  • Since Sept. 2012 – over 50,000 users
Run 4 Alice Symposia

- Around 100 people each
Online Alice Coursera Course coming

• Summer 2019
  • 100 teachers as Beta testers

• Fall 2019
  • Five teachers – each private site for their students

• January 2020
  • Course launches
  • Anyone can take

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Special Video – How to make Alice Cookies
Take Aways

• Learning programming with animation
  • Programming objects in 3D space
  • Learn concepts visually
    • Mistakes visual
  • Problem solving - calculations
  • Algorithms - Sorting

• Making progress with Computing in K-12
  • More work to be done!