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!

• 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
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 high to jump
• Cat's height

• How far to jump
  • Distance to cat, width of cat, length of dog
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

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) 

Panda turns to its right

• B) 

Quiz: Which instruction?

• A) 

• B) 

The leg turns backwards!
Quiz: Which Picture after code runs?

A)  

B)  

Quiz: Trace the code

A)  

B)  

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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?

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
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

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

Selection Sort (cont.)

1 3 4 9 5 6 - end of 3rd pass
1 3 4 9 5 6 - find smallest, swap
1 3 4 5 9 6 - end of 4th pass
1 3 4 5 9 6 - find smallest, swap
1 3 4 5 6 9 - end of 5th pass, done

SORTED!
Now ...

• Increasing Computing in K-12
• Diversifying Computing

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

Teaching Alice Programming at Duke since 2005 – CompSci 4, now 94
www.cs.duke.edu/courses/fall19/compsci094

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

- 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

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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 Symposiums

• 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

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!