Scratch: programming for children and other not-yet-programmers

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What is Scratch?

- A multimedia authoring tool
- A graphically-edited programming language
- Designed for children aged 8-16
- Used by students, scholars, teachers & parents
- Used for animations, games, interactive art, simulations, visualizations
- Event-driven, with “sprite” objects
- Designed for collaboration & remixing
- Available in over 40 languages
Who am I?

- Bill Kendrick
- Co-founder of LUGOD
- Creator of Tux Paint
- CTO of Smashwords, Inc.
- Father of a 7 year old Scratch addict
- A newcomer to scratch & its community
  (this talk will only 'scratch' the surface)
  (aka: thanks, Wikipedia!)
Who made Scratch?

- Massachusetts Institute of Technology
  - Media Lab
    - Lifelong Kindergarten group
      - Mitchel Resnick
- Supported/funded by:
  - National Science Foundation
  - Intel Foundation
  - Microsoft
  - MacAuthor Foundation
  - LEGO Foundation
  - Google
  - Dell
  - ...etc.
History of Scratch & Friends

- Named for turntablism (mixing music)
- Scratch 1.x
  - Development began 2003
  - Website launched 2006, download in 2007
  - Share/remix added to website in 2007
  - GPLv2 & Scratch Source Code License
  - Implemented in Squeak
  - You can `apt-get install` it in Ubuntu

Turntable and Mixer, CC BY 3.0, Baskoner @ Wikipedia.org
History of Scratch & Friends

- What's Squeak?
  - Dialect of Smalltalk
  - Created at Apple Computer in 1996
  - Dev. Continued at Walt Disney Imagineering
  - Core designers included
    - Alan Kay – Xerox PARC, Atari, Apple, Disney, a father of object-oriented programming, Dynabook concept, etc.!
    - Dan Ingalls – Xerox PARC, designer/implementer of 5 generations of Smalltalk, inventor of Bit blit, pop-up menus, etc.!
    - Adele Goldberg – Xerox PARC, Smalltalk
History of Scratch & Friends

• What's Smalltalk?
  – Object-oriented, dynamically-typed, reflective programming language
  – Created to underpin the “new world” of computing exemplified by “human-computer symbiosis”
  – Development began 1969, first released 1972
  – First true object-oriented language
  – Influenced C++, C#, Java, Python, Ruby, etc.
History of Scratch & Friends

- **Scratch 2**
  - Released, together with updated website, late 2012
  - Implemented in ActionScript
  - Offline Editor available for Linux, Mac OS X and Windows (requires Adobe Air be installed)

- **What's ActionScript?**
  - Developed by Macromedia in 1998
  - A dialect of ECMAScript (aka JavaScript)
  - Used for websites & software that uses Adobe Flash Player
History of Scratch & Friends

• Mitchel Resnick
  – Heads Media Arts and Sciences academic program at MIT Media Lab
  – Research group created “programmable bricks”, the basis of LEGO Mindstorms and StarLogo

• See also:
  – Logo
  – Etoys
  – Lisp
  – BASIC
Show me Scratch, already!
First, back to Scratch's home page

- Get started learning
- See examples
- Join the community
- View projects & studios
  - Featured
  - Curated
  - Top picks
The Stage

• Where the action happens!
• Where you interact with a running program
• Different backdrops can be shown during a program
  – Select from an online library
  – Draw something within Scratch
  – Upload a picture
  – Take a photo with your webcam
• Can have its own scripts
The Stage
Coordinates & Dimensions

- 480 x 360
- (0,0) is at the center
- X is horizontal (left/right)
  - Negative is to the left of center, positive to the right
- Y is vertical (up/down)
  - Negative is below the center, positive is above
- Example:
  - coordinates (240,180) is the top right corner
  - coordinates (-240,180) is the top left corner
Sprites

- Objects that can move around the stage
- Can interact with each other and the backdrop
- Can have numerous “costumes” (images)
- As with backdrops, multiple sources (library, draw, upload, webcam)
- Where most of your program's code (“scripts”) goes!
Sounds

• Import sounds
  – From a library
  – Record a sound
  – Upload a sound file

• A few editing & effects options are available
Scripts – where it all happens!

- Programs aren't typed
  - 10 PRINT "HELLO, WORLD"
  - 20 GOTO 10
- Color-coded command blocks that “fit” together
Command Types

- **Motion**
  - Move, turn, point in a direction, etc. (like turtle graphics)
  - Go to a specific spot ((x,y) location)
  - Set or change x or y individually
  - Etc.
Command Types

• Looks
  – Say/think some text (speech/though bubbles)
  – Show/hide the sprite
  – Change costumes or backdrop
  – Special effects (color, brightness, ghost, etc.)
  – Change size
  – Change position in layers (go in front of / behind other sprites)
Command Types

- **Sound**
  - Play recorded sounds
  - Play instruments
    - Drum beats
    - Other instruments – play notes
  - Change volume & tempo
Command Types

- **Pen**
  - Set or change color, shade, and thickness (size)
  - "Pen up" (stop drawing), and "pen down" (draw!)
    - You need to move the sprite to draw
    - It's just like turtle graphics from Logo!
  - "Stamp" the sprite's current costume onto the stage
  - Clear the stage
Command Types

- **Events**
  - Start running a script (part of your program) when:
    - the green 'start' flag is clicked (above the stage)
    - a particular keyboard key is pressed
    - a particular sprite is clicked with the mouse
    - the timer reaches a certain number
      - The timer starts counting from 0 when the 'start' flag is clicked, and can be reset to 0 by your scripts
    - when a message is received *(see below)*
  - Broadcast a message
    - All other sprites & the backdrop can intercept it!
Command Types

- **Control**
  - Repeat parts of your script:
    - Forever
    - Based on a counter (e.g., “repeat this 10 times...”)
    - Based on a test (e.g., “repeat this until...”)
  - “If” and “If/Else” tests
  - Pause this script's code
    - For a certain amount of time
    - Until some test succeeds
  - Sprite cloning! *(advanced topic)*
Command Types

- Sensing
  - Tell when things are touching
  - Calculate distance between things
  - Ask for user input
    - Like C “printf() / scanf()” and BASIC “PRINT / INPUT”
  - Detect mouse & keyboard input
  - Control the timer
  - Get current date/time
  - Etc.
Command Types

- Data: Variables
  - Hold data, like numbers or text
  - For all sprites (“global”), or for the current sprite (“local”)
  - Values can be set or changed
  - Variables can be shown on the stage, or hidden
  - Variable values can be used elsewhere
    - Say [ Join “Hello “, {name} ]
    - Move {steps} steps
Command Types

- **Data: Lists** *(advanced topic!)*
  - Values can be appended to the list, or inserted at a specific spot
  - Values at spots can be replaced, or removed
  - Values can be read
  - The length of the list can be detected
  - Test whether a list contains an item
  - Lists can be shown/hidden on stage
Command Types

• Operators
  - Do math on things (numbers, variables, list items, sensed values, etc.!)  
    • Add, subtract, multiply, divide, round, modulus, and many other functions  
    • Join strings of text, detect a string's length, and fetch individual letters  
    • Compare things – less than, equal to, greater than  
    • “Boolean” operators – “and”, “or”, “not”  
    • Get a random number
Simple Example

```
when clicked
forever
if mouse x > x position then
  say "Mouse is on my right"
else
  say ""
```
A simple game

- Cat sprite
  - Program begins
  - Say something
  - Reset timer
  - Start game
  - For 10 seconds
    - Point at pointer
    - Move towards it
  - Then show score
A simple game

- **Mouse sprite**
  - Program begins
    - Hide!
  - Game starts:
    - Glide to random spots around the screen
  - Game starts:
    - If game is still going (10 seconds aren't up):
      - If touching the cat:
        - Disappear
        - Add to the score
A simple game

You caught 5 mice!
Things I've Played With
(when my son isn't hogging my laptop)

- Bubble sort
  - Ask user for a list of names (use "done" to stop)
  - Sort the list alphabetically
- Fireworks
  - Ask user to enter a sequence of fireworks (A, B, C for different kinds/colors, comma to pause)
  - Iterate over sequence, use sprite cloning to launch
  - Use sprite cloning again to explode into pieces
- Lunar lander
  - Use 'pen' to draw mountainous terrain, with flat, colored landing pads
  - Keyboard controls rotation & applying thrust
  - Variables for ship's speed & direction ($x_\Delta$ & $y_\Delta$)
    - Both change (using sine & cosine of ship's direction) when thrust applied
    - $y_\Delta$ changes all the time (gravity!)
Enter some names and I'll alphabetize them! Type "done" when you're done.
Scratchnapped

• *Super Mario Bros.* style game!
  - As an example of what Scratch can do: blew me away!
  - Scrolling, enemies, secrets, multiple levels, etc.
  - 206 scripts, 15 sprites
Links

• Scratch - http://scratch.mit.edu/
• Scratch Wiki - http://wiki.scratch.mit.edu/
• Scratch 2 Offline Editor download - http://scratch.mit.edu/scratch2download/
• ScratchEd, online community for educators - http://scratched.media.mit.edu/
Books

• **Super Scratch Programming Adventure**
  - http://www.nostarch.com/scratch

• **Scratch Programming for Teens**
  - http://www.cengagebrain.com/shop/isbn/9781598635362

• **Sams Teach Yourself Scratch 2.0 in 24 hours**

• Probably others...!?