We can build (or at least imagine!) lots of circuits.

We can even think about state machines that use circuits to do various things over time.

We’re headed towards using these ideas to create a programmable computer.

Hillis has us take a detour to talk about programming first.
Programming

- Many different languages have been devised for programming.
- Each provides a way of writing a kind of script along with rules for the computer to interpret the script as instructions.
- They can all do pretty much the same things, but make it easier to say some things than others.
- How many languages can you name?

Scratch

- Developed by the “Lifelong Kindergarten” group at MIT.
- Allows users to make media-rich programs by clicking together blocks.
- Share your creations a la YouTube.
- My miniNim program is an example.
Things

- Performance area
  - stage (background)
  - sprites (objects)
    - scripts (behavior)
    - costumes (appearance)
    - sounds (available sounds)
More Things

- Run/Stop
- Script inventory
  - Motion
  - Looks
  - Sound
  - Pen
  - Control
- Sensing
- Numbers
- Variables

Shapes

- Trigger
- Statement
- Ending statement
- Boolean value
- Numeric value
Motion Inventory

- move 10 steps
- turn 15 degrees
- turn 15 degrees
- point in direction 90°
- point towards
- go to x: 0 y: 0
- go to
- glide 1 secs to x: 0 y: 0
- change x by 10
- set x to 0
- change y by 10
- set y to 0
- if on edge, bounce

Looks Inventory

- switch to costume costume1
- next costume
- say Hello! for 2 secs
- say Hello!
- think Hmm... for 2 secs
- think Hmm...
- change color effect by 25
- set color effect to 0
- clear graphic effects
- change size by 10
- set size to 100%
Sound Inventory

- Play sound "pop" and wait
- Stop all sounds
- Play drum 48 for 0.25 secs
- Play note 60 for 0.5 secs
- Set instrument to 1

Pen Inventory

- Clear
- Pen down
- Pen up
- Set pen color to 0
- Change pen color by 10
- Set pen color to 0
- Change pen shade by 10
- Set pen shade to 50
- Change pen size by 1
- Set pen size to 1
- Stamp
Logo in Scratch

- Logo is a language invented to help people (kids?) learn to program.
- Scratch is the language we’ve been using for examples and demos in this class. It’s a descendent of Logo, in many ways.
- Hillis uses Logo for his examples in this chapter.
- I’ll translate them into Scratch so it fits better with our other examples.
Drawing Commands

New Command
Command With Variable

Afterwards, I renamed it “squareSize”

Conditionals

- Based on the random number, two possible outcomes.
- Executes only one block of code, depending on the Boolean condition.

If.  If is good.
**Kinds of Loops**

- **Infinite loop**
- “For” loop: Repeat a set number of times.
  - Flexible.
- “While” loop: Until a condition holds.
  - More Flexible.
- Recursion: Repeat substructure.
  - Most Flexible.
Just Four, Thanks

- Sets a repeat count
- Stops after that number of repetitions

Unroll The Loop

- It’s as if the statements inside the loop are repeated four times.
More Power

- “For” (repeat) loops are great if you know how many times you will be repeating.
- Sometimes need something more powerful.
- “While” (repeat-until) loops keep going until a condition becomes true.
- Can behave like for loops...

Four Square Countdown
• “While” (repeat-until) loops are great if repetitions are sequential.

• Sometimes need something more powerful.

• “Recursion” can allow control to proceed in multiple directions at once!

• But, can also behave like for loops...
**Infinite Recursion**

- Each “pattern” message spawns another.
- Ad infinitum

**Proper Recursion**

- “Base case” says what to do when the counter runs down.
- In this case, it stops when the counter reaches zero.
Not A Simple Loop

• Loop proceeds in two directions at once.
• Can’t do that with for or while.
(In fact, can’t do it at all in Scratch, but other it is commonplace in other programming languages.)

I Think That I Shall Never See...

• Each tree is made up of a trunk and two smaller trees.
• Base case keeps the structure from growing infinitely.
• Makes shapes known as “fractals”.
• Other examples?