Announcements …

- Please fill out the "pre-course" survey if you have not yet done so

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We're underway …

Following Lightbot

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University of Washington, Seattle

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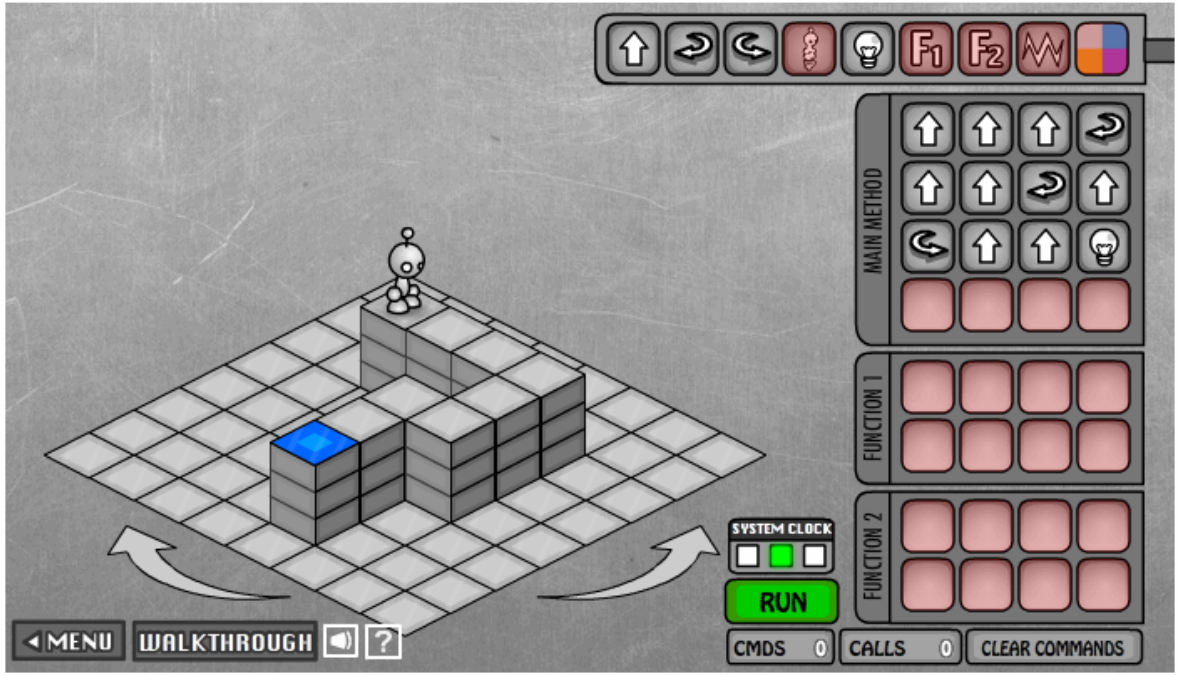
As Experienced Lightbot Hackers …

- What are you doing in Lightbot?



- Commanding a robot through a "blocks world"
- Programming is **commanding** an agent

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Agent, Instructions, Intent

- When you are commanding (programming), you direct an agent (by instructions) to a goal
  - The **agent** is usually a computer, but it can be a person, or other device (animated robot?)
  - The agent follows the commands a/k/a **instructions**, flawlessly, and mindlessly, doing only what it is asked
  - The program implements **human intent** – you are trying to get the robot to the Blue Tile goal – it's the point of your instructions

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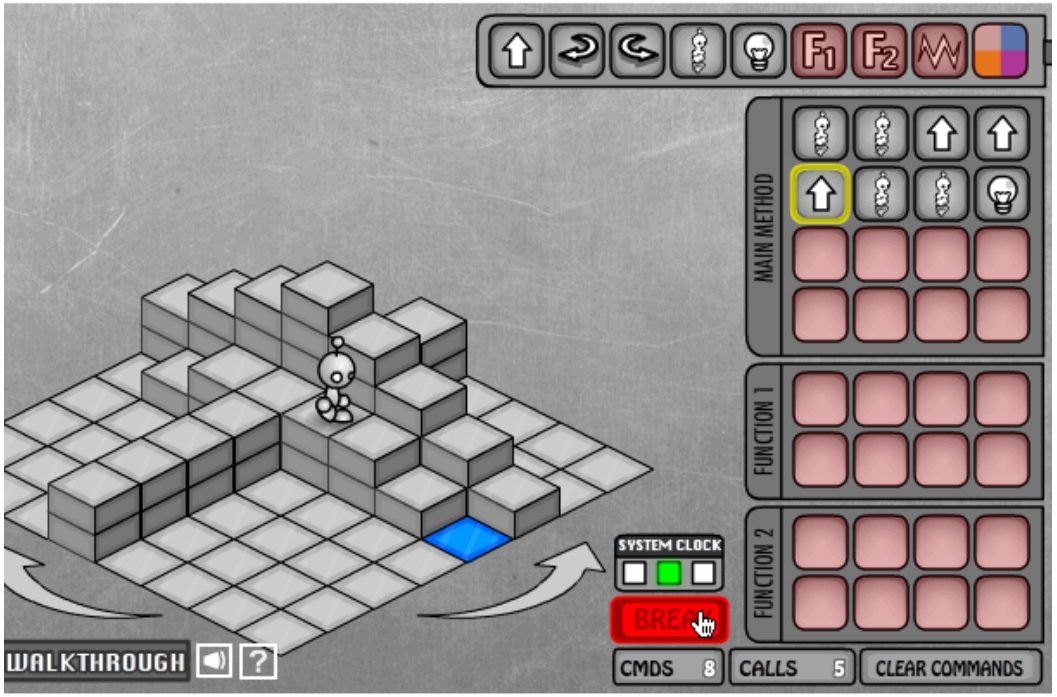
Sequencing

- Instructions are *given* in sequence, i.e. in order
- They are *followed* in sequence, i.e. in order
  - YOU give the instructions … it's called **programming**
  - The AGENT follows them … it's called **executing** or **running** the program



  - A **program counter** marks the agent's place

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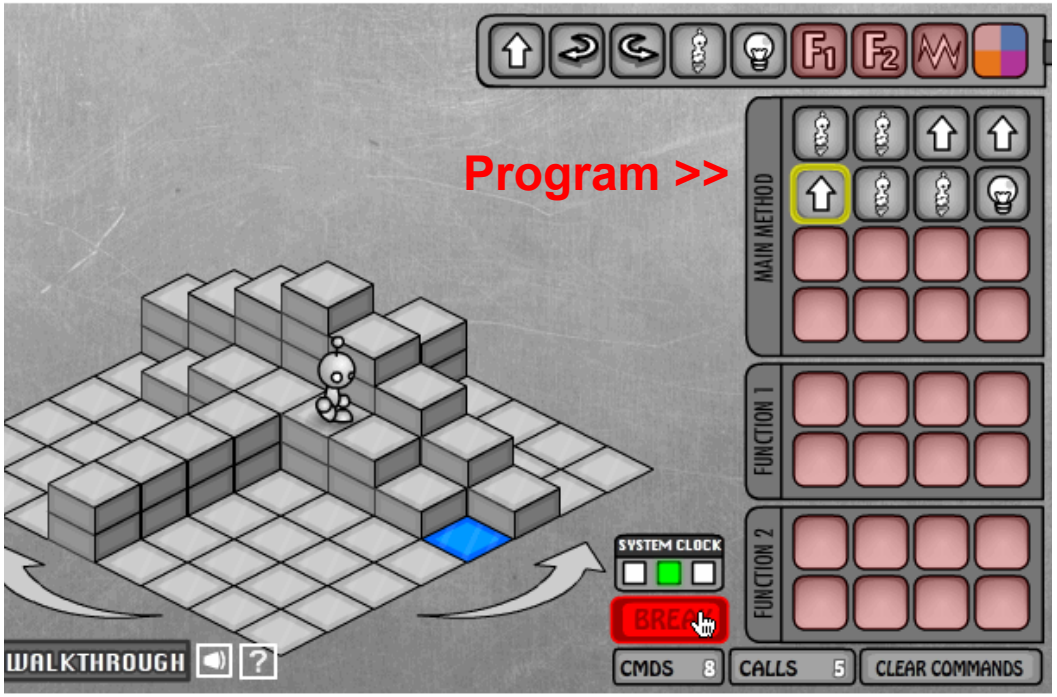
Order of Events

- The instructions are programmed *ahead of time*
- They are executed *later*, w/o programmer's intervention
  - Each instruction makes *progress* towards the goal
  - The order *must be right* to achieve the goal



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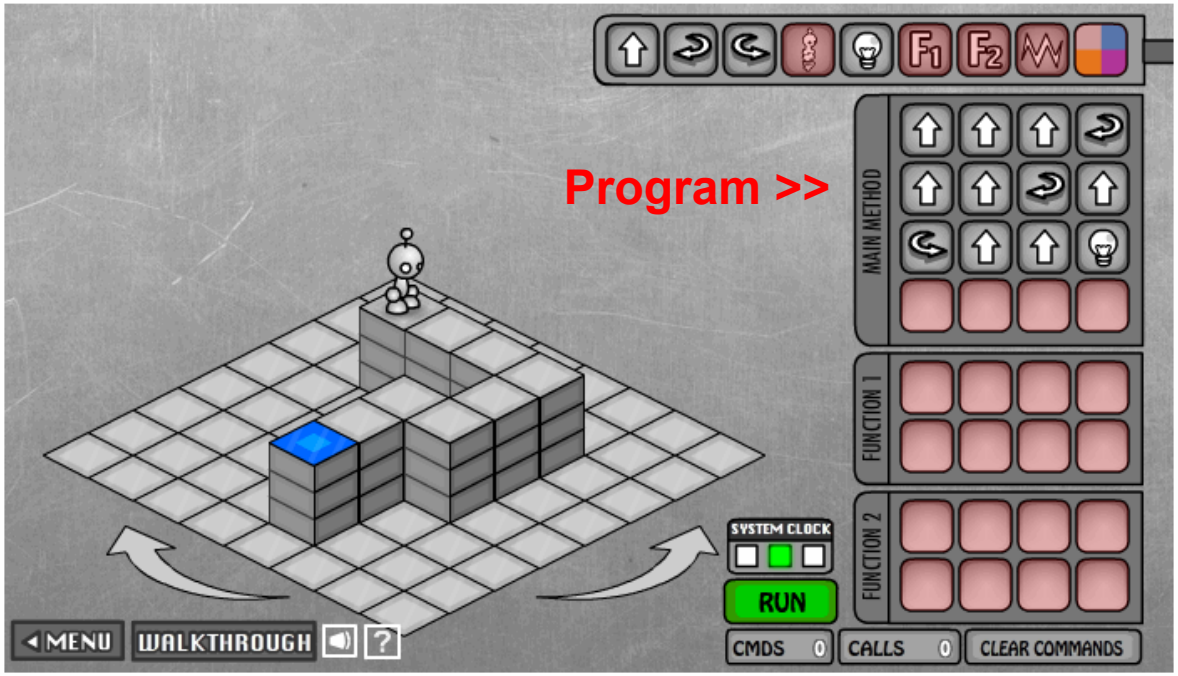
Point of View

- Programming REQUIRES you to take the *agent's point of view* … it's a essential idea



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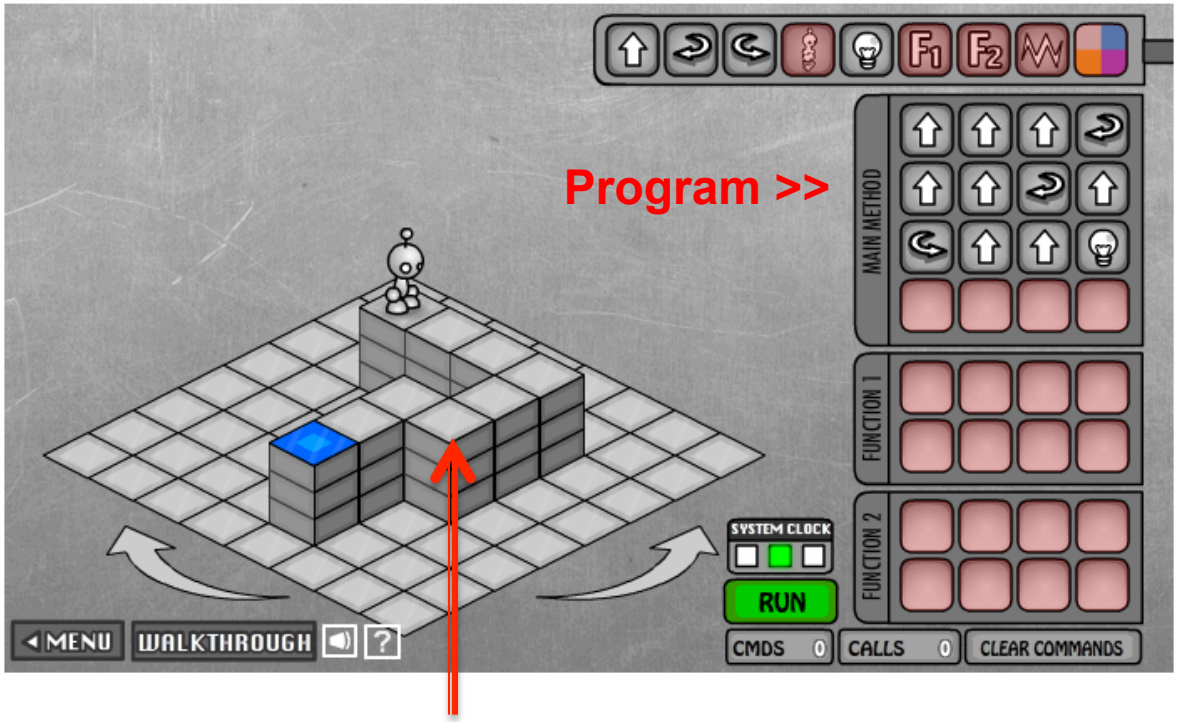

From this cell, a turn is required … R or L?

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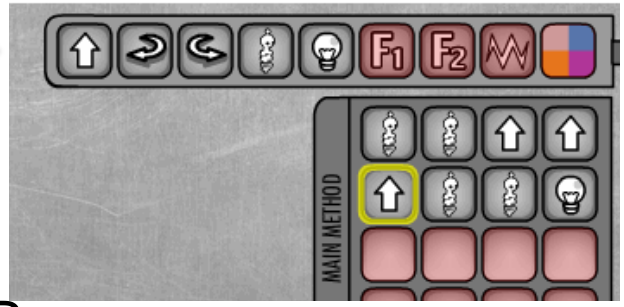
Limited Instruction 'Repertoire'

- The number and type of instructions is always limited – you need a solution using only them
  - Instructions …
    - The agent can do only certain things … nothing else
    - The Lightbot's instructions
    - There is no JUMP_3



… Lightbot's even tougher than normal programming b/c in some LB games, some instructions are unavailable … but it's a game!

    - Executed the instructions one-at-a-time

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An Amazing Fact …

- The limited repertoire is a fact of *all* computing, but how limited?
- A computer's circuitry (the hardware) has very few instructions … usually about 100, and many are just different versions of the same idea: **`add_2_bytes`**, **`add_2_words`**, **`add_2_decimal_numbers`**, etc.

In theory, a computer with only 6 instructions could compute all known computations

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If that were the end of the story

- Programming would be amazingly tedious if all programming had to use only the basic instructions – I mean REALLY REALLY tedious
  - No one would be a programmer no matter how much it paid
  - Apps as we know them would not exist
  - BTW programming was like this in the beginning
    - This is why they are called the "bad old days"
- Luckily, there are **functions**

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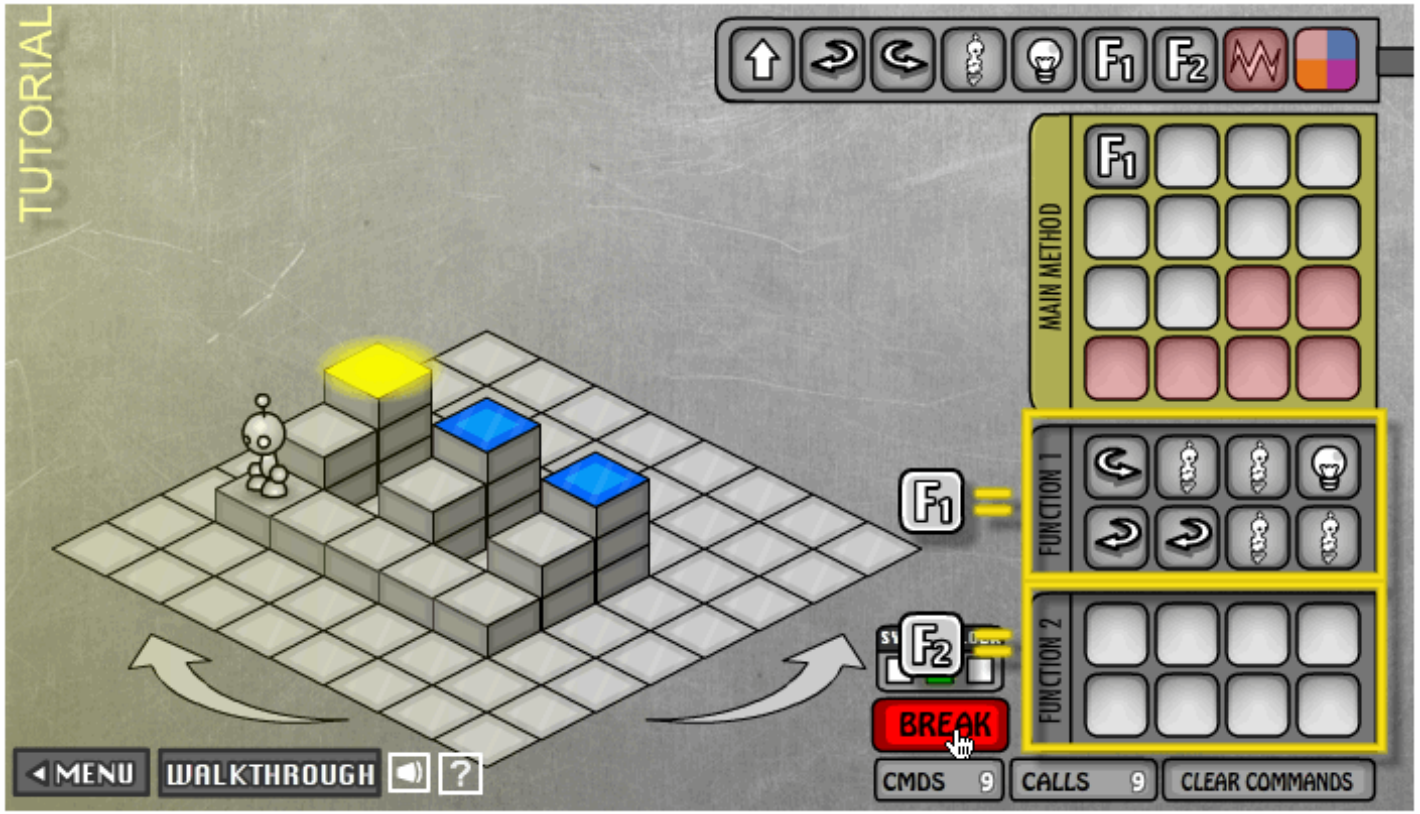
Functions Package Computation

- We make new instructions using functions!



- F1( ) packages actions: E.G. "process a riser"

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Functions Package Computation

Just Do It!

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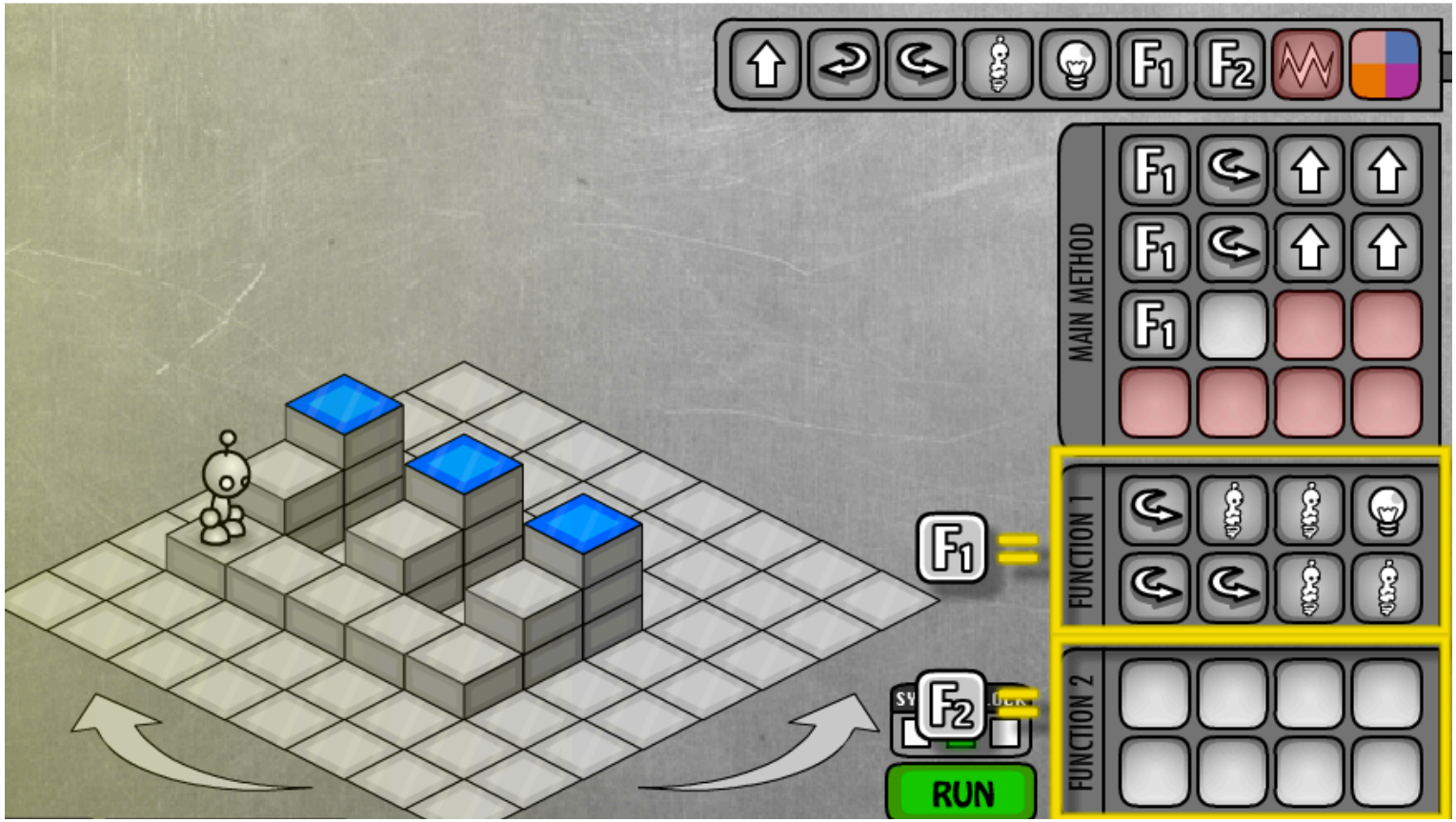
F1( ), A Process a Riser Instruction

- We have a new instruction: Process_A_Riser



- **Call** the function to use the new instruction

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It's BIG!

- Functions may seem "obvious" but they are a HUGE idea …
- They allow us to solve problems by first creating some useful instructions, and then using them to get the agent to do our work
- Sweet!

… Let's see how this works

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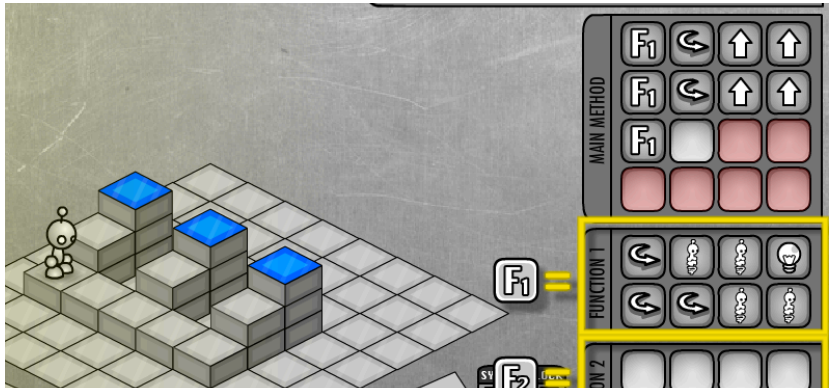
The Function Becomes A Concept

- Because F1( ) "processes a riser," we think of the programming task as

Process a riser( )	F1( )
Move to next riser	
Process a riser( )	F1( )
Move to next riser	
Process a riser( )	F1( )



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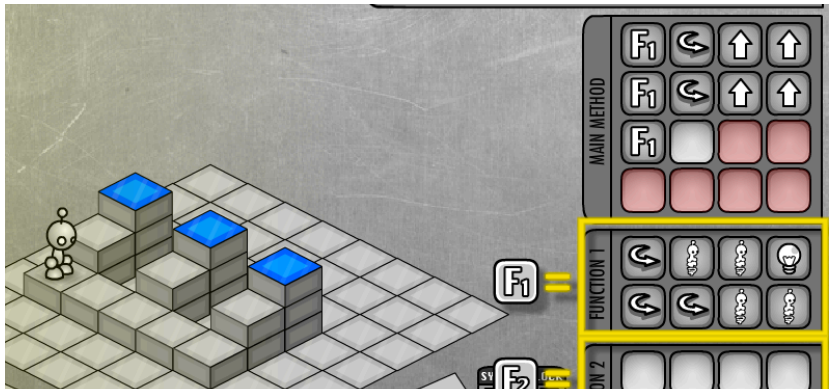

- With F1( ), we simplify the programming to just 5 conceptual steps rather than 21

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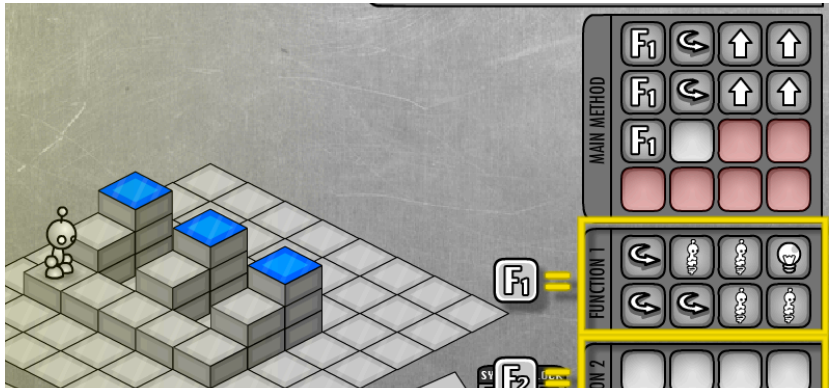

- With F1( ), we simplify the programming to just 5 conceptual steps rather than 21
- But, WAIT! What is "Move to next riser"?
  - It's a concept … make it a function!
  - Move_to_ next_ riser ( )

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The Function Becomes A Concept

- Because F1( ) "processes a riser," we think of the programming task

Process a riser( )	F1( )
Move to next riser( )	F2( )
Process a riser( )	F1( )
Move to next riser( )	F2( )
Process a riser( )	F1( )

Show that text is a function with parens

- With F1( ), we simplify the programming to just 5 conceptual steps rather than 21
- But, WAIT! What is "Move to next riser"?
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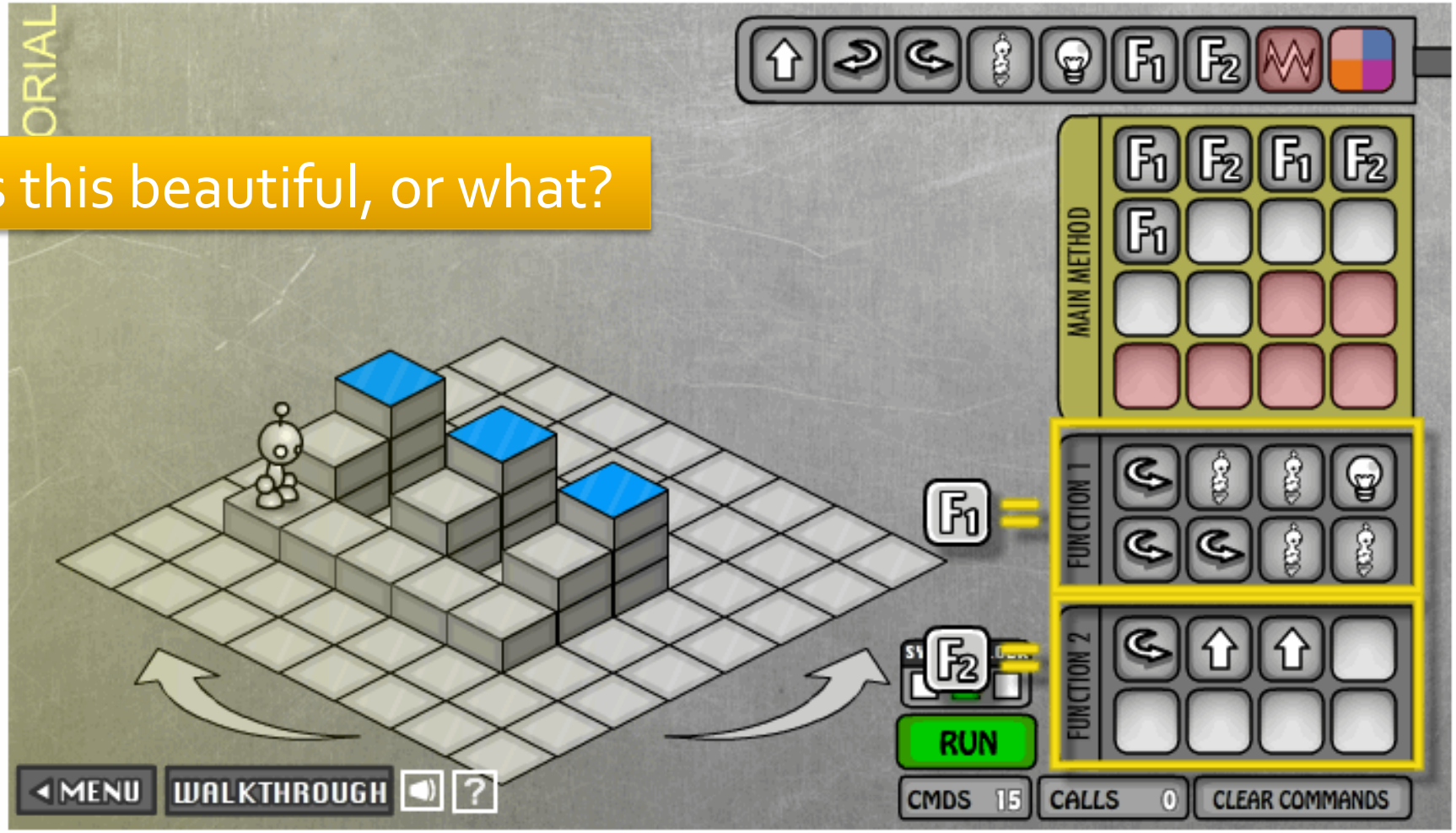
A Five Instruction Program

Is this beautiful, or what?



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Abstraction …

- Formulating blocks of computation as a "concept" is **functional abstraction** [A better definition in a moment]
- What we did just now is important …
  - We spotted a coherent (to us) part of the task
  - We solved it using a sequence of instructions
  - We put the solution into a function "package", gave it a name, "process a riser," and thus created a new thing, a concept, something we can talk about & use
  - Then we used it to solve something more complicated … and then we did it again!

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Abstracting

- Collecting operations together and giving them a name is *functional abstraction*
  - The operations perform a coherent activity or action – they become a *concept* in our thinking
  - The operations accomplish a goal that is useful – and typically – is needed over and over again
  - *Functions* implement functional abstraction: 3 parts
    - A name
    - A definition, frequently called a "body"
    - Parameters –stuff inside the parentheses, covered later

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People Abstract All The Time

- Functional abstractions in which you are the agent, but someone taught you:
  - Parallel parking
  - Backstroke in swimming
- Functional abstractions you recognized and in which you are the agent
  - Doing a load of laundry
  - Making your favorite {sandwich, pizza, cookies, …}
- Others?

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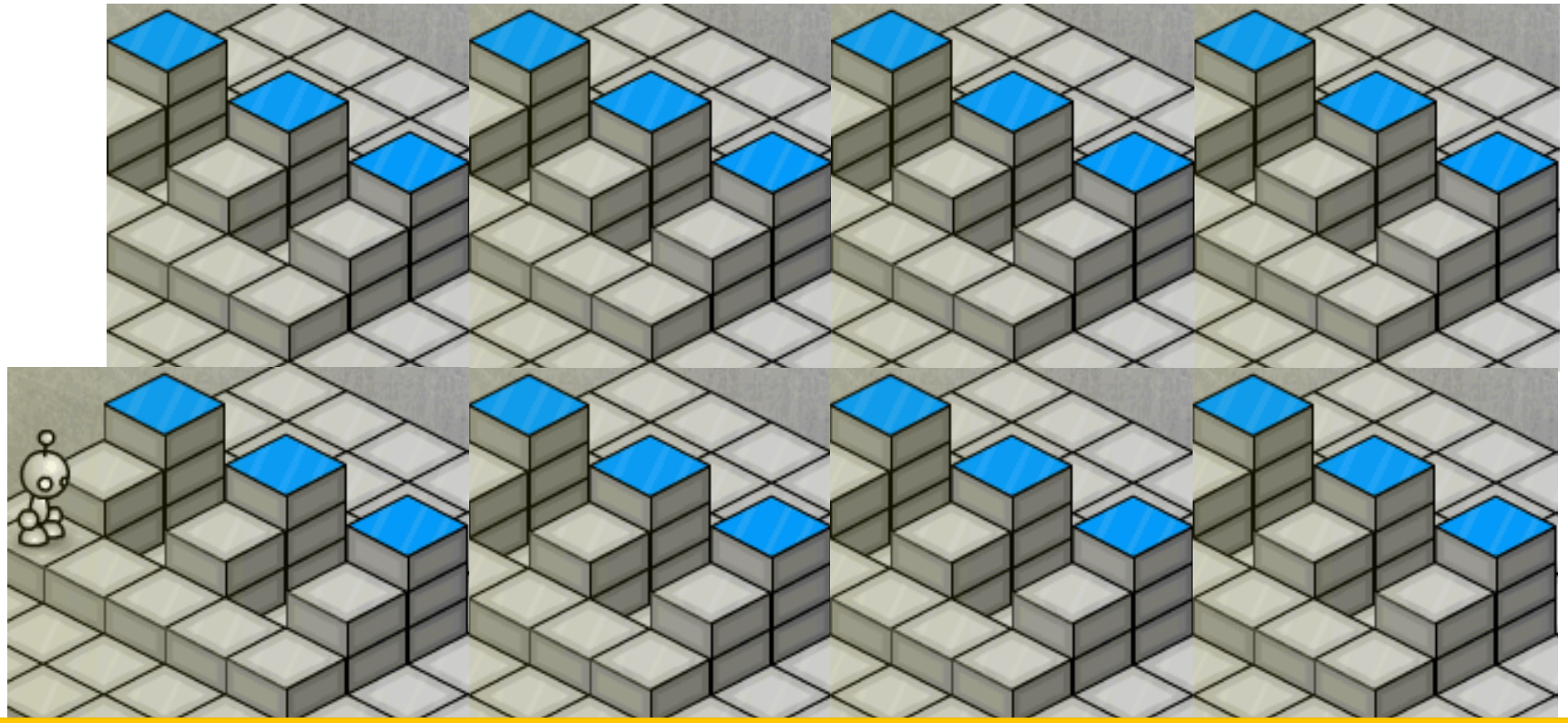
Keep Using Abstraction …

- If M.C. Escher handed us a problem … what would we do?



It only simplifies our **thinking**; the bot still does all the work

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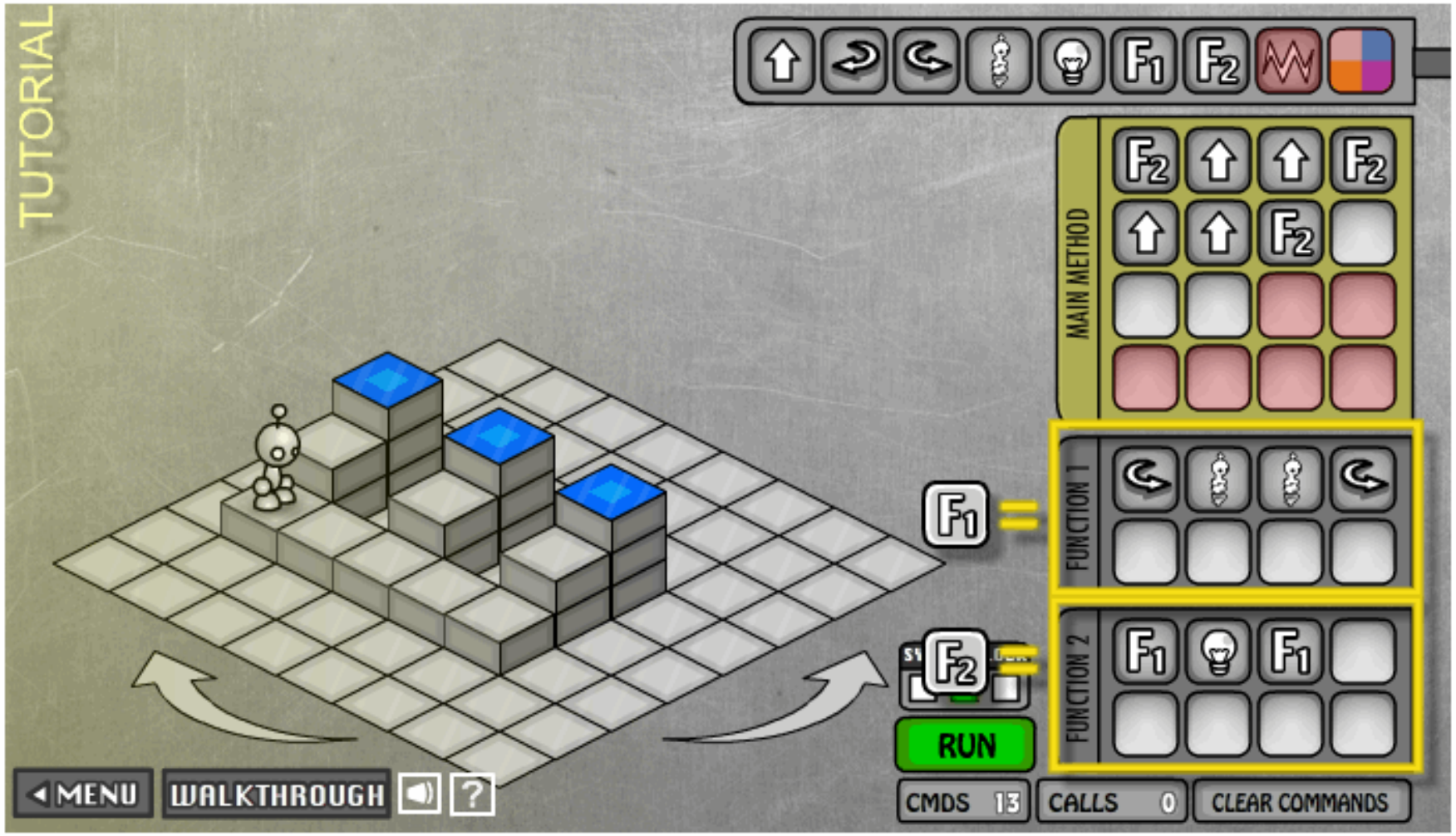
The Function Is Just The Packaging

- Another way to use a function for the risers



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Summary From Lightbot 2.0

- Programming is **commanding** an agent
  - **Agent:** usually a computer, person, or other device
  - Agent follows **instructions**, flawlessly & mindlessly
  - The program implements human intent
- Instructions are *given* in sequence
- … and *executed* in sequence
  - Limited repertoire, within ability, one-at-a-time
  - "Program counter" keeps track current instruction
- Formulating computation as a "concept" is **functional abstraction**

We'll See It Again &Again

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