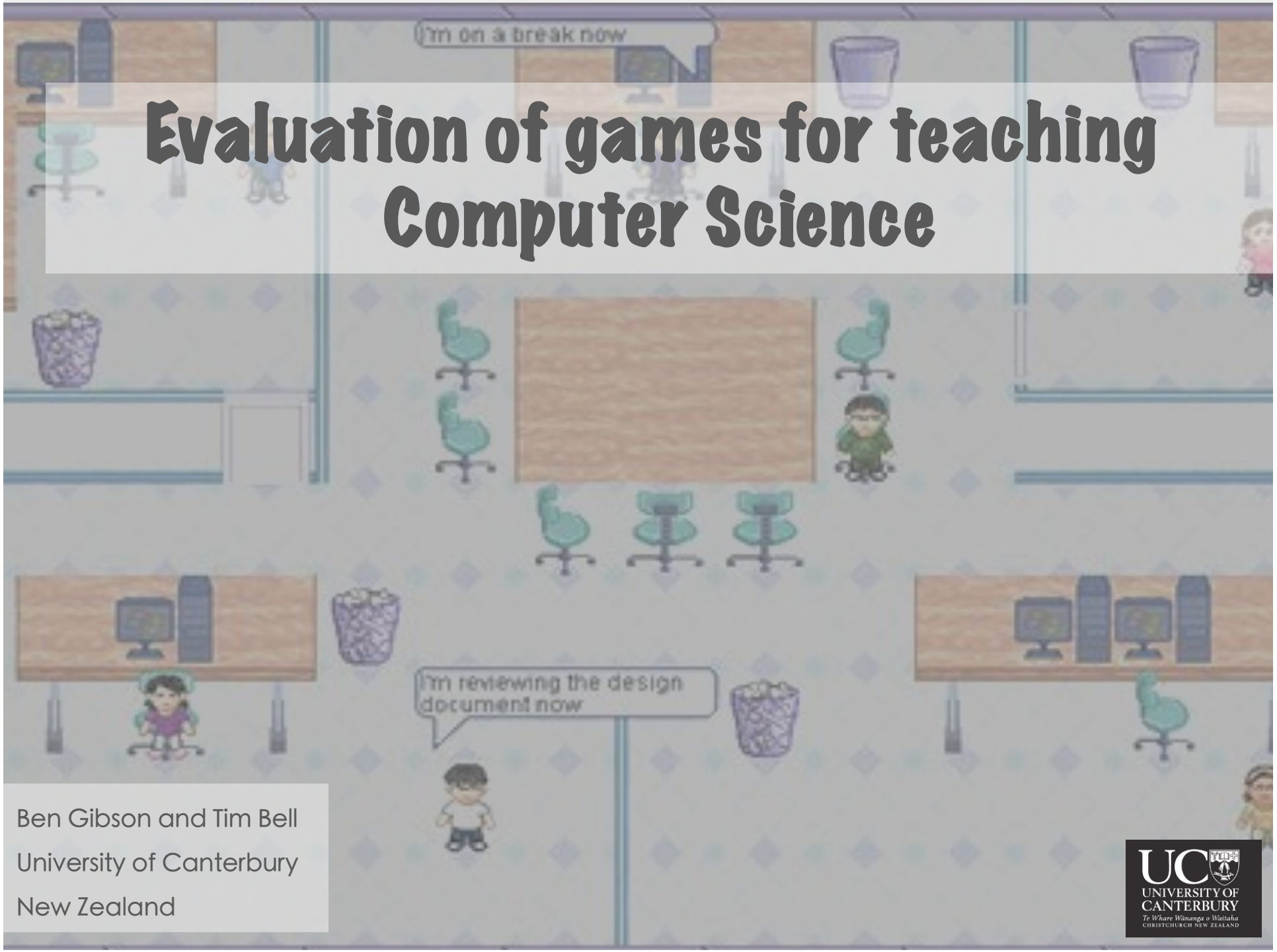
Evaluation of games for teaching Computer Science



Ben Gibson and Tim Bell
University of Canterbury
New Zealand

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Why games?

- Engagment
- Motivating
- Introductory for grade school
- Time on task
- CS Field Guide

More effective than:

- lectures
- reading
- videos
- assignments
- discussion
- combination of computerized tutorials and assignments
- the combination of lecture and instructional methods

Sitzmann: meta-analysis of 60 papers

Less effective than:

- hands-on practice
- computerized tutorials
- the combination of group activities and discussion

- Better retention
- Better factual knowledge
- Better skill based knowledge
- Higher self-efficacy

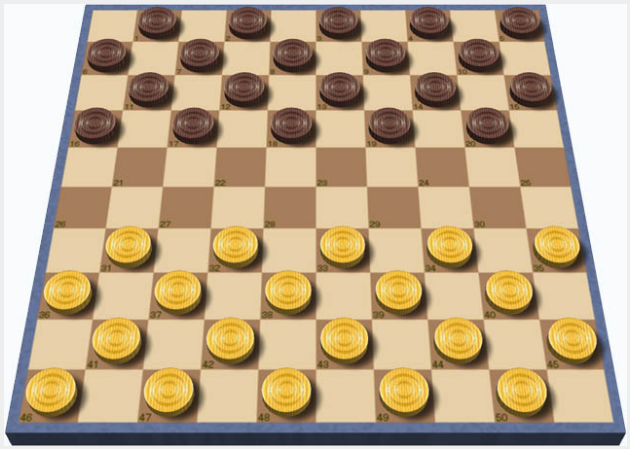
BUT!!

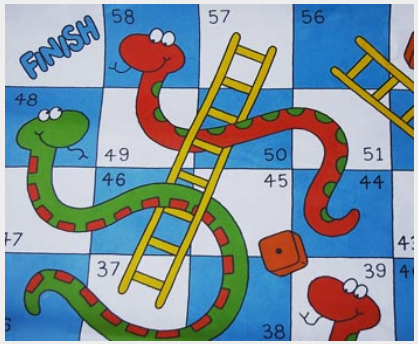
- Must be used with other instruction, especially debriefing

What is a game?

- Fun/free:
  - Light hearted, not obligatory, joyous
- Separate:
  - Circumscribed in time and space
- Uncertain:
  - Not pre-determined, player innovation

Roger Caillois (1913-1978)





http://dratarrant.wordpress.com/

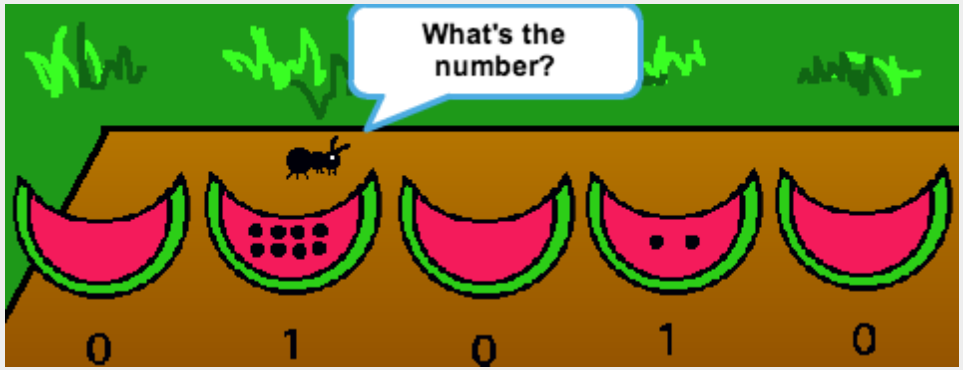
What is a game?

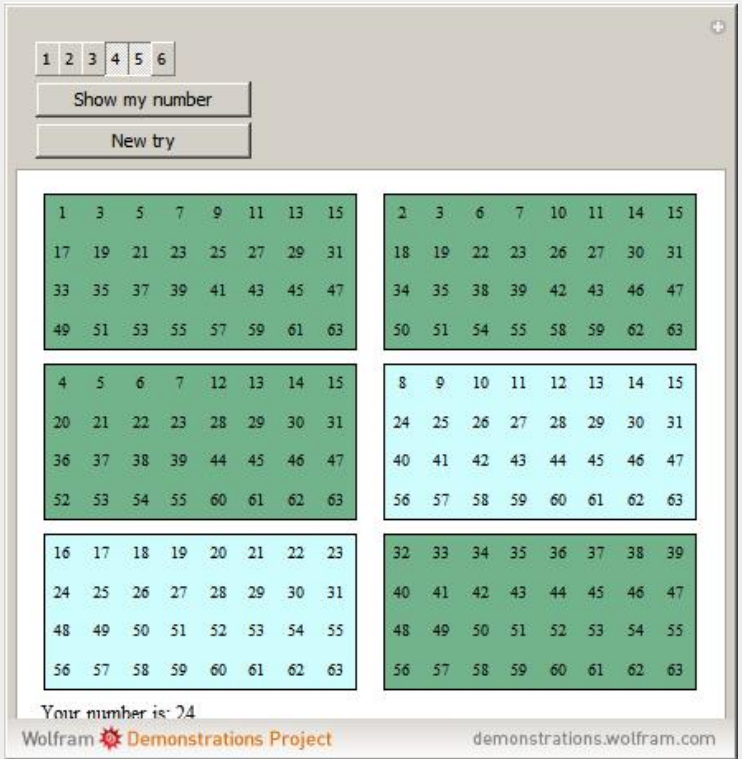
Roger Caillois (1913-1978)

- Rules:
  New legislation which alone counts
- Make-believe:
  Second reality or free unreality
- ~~Non-productive~~
  Educational:
  Teaches a CS topic: better understanding or skill

Continuum

- Obligatory play?
- Is binary make-believe?
- Replayability?





CS games

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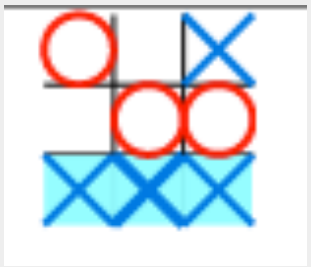
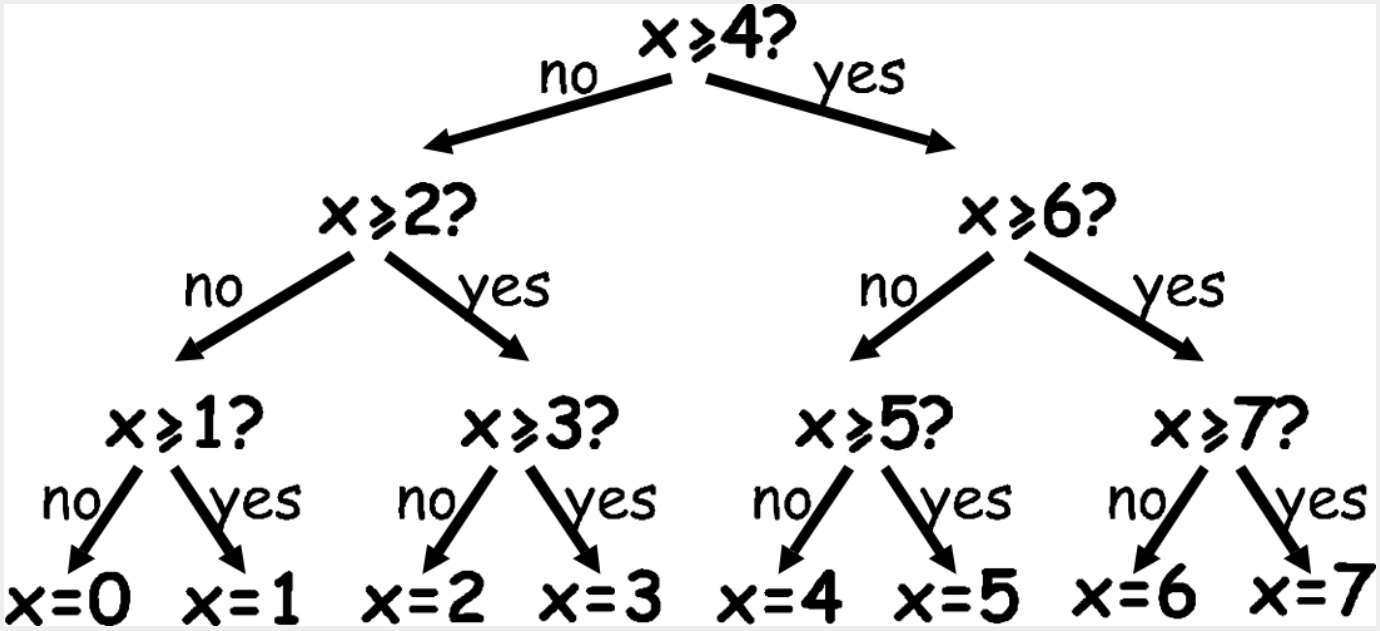
Finding games

- CS ed papers
- CS teaching resource repositories
- Search
- Post list on SIGCSE mailing list
- 81 potential games
  - 13 not CS
  - 18 not games
  - 9 unavailable
  - 41 in final list

Useful, but concept not in game

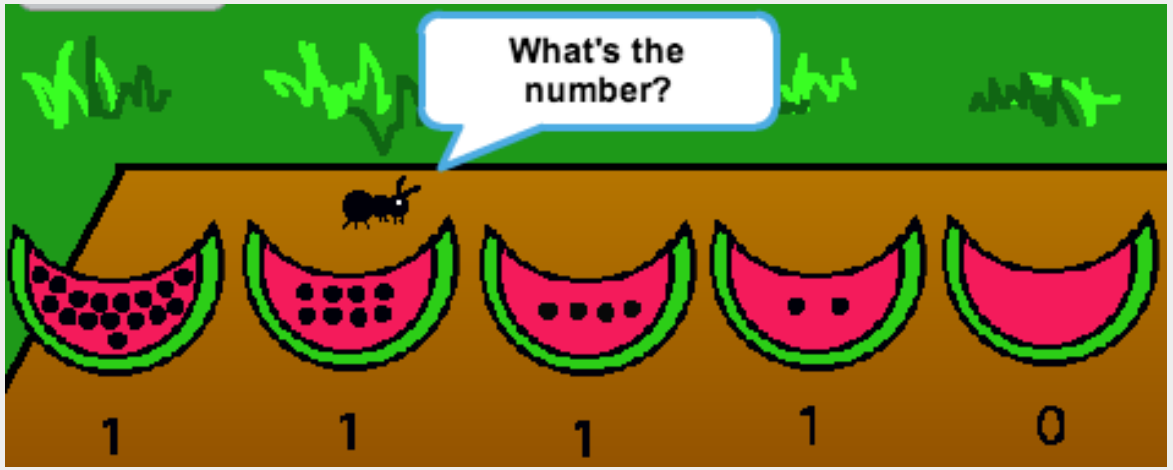
- Noughts and crosses (AI)
- Twenty questions (Information theory)



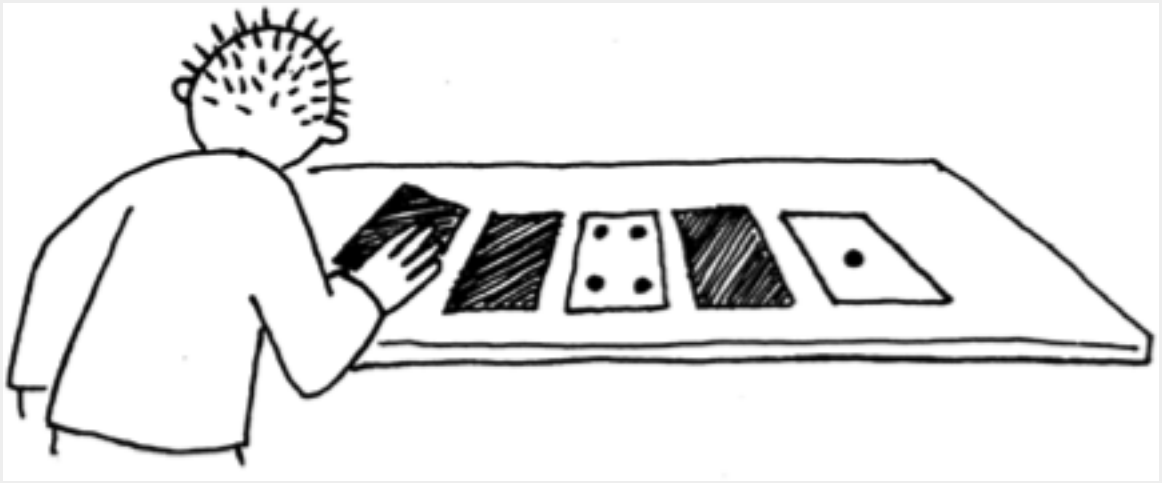


Sitzmann and Callois

- Game



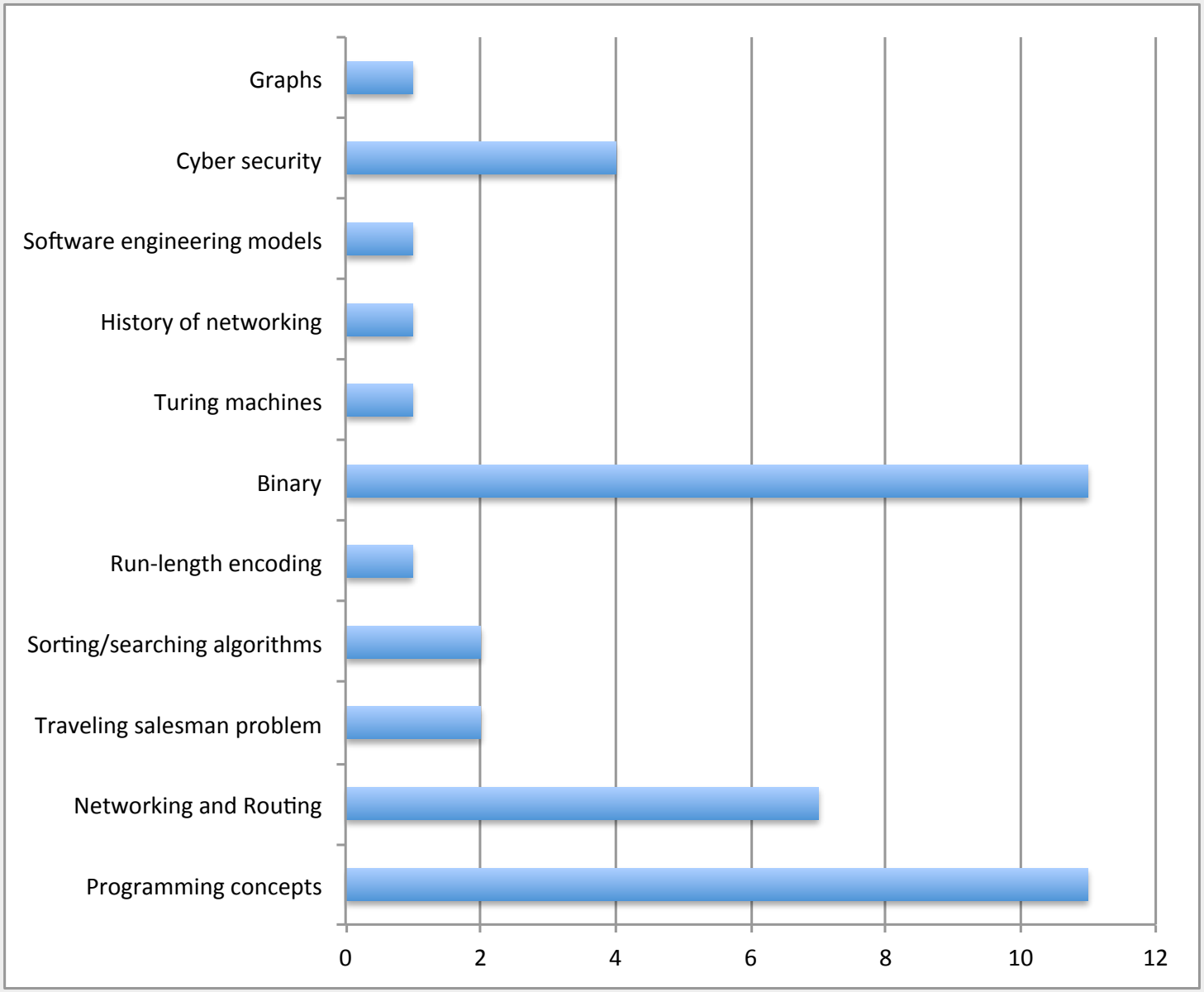
- Not a game



Types of games found

	Cost			Hours required		
	Free	Low	High	$< \frac{1}{2}$	$\frac{1}{2}$ to 2	> 2
Desktop	4	0	1	0	0	5
Mobile	1	3	0	4	0	0
Browser	21	0	0	21	0	0
Unplugged	9	0	2	6	5	0

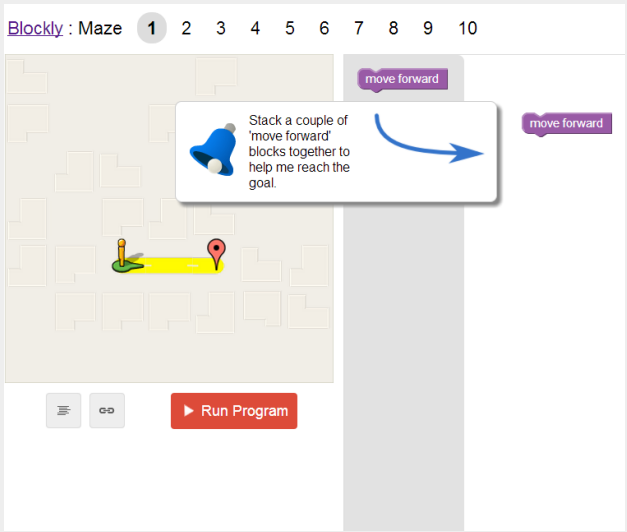
Topics covered



Programming concepts

CS games

- ToonTalk 3
- Cargo bot
- The Bead Loom game
- Blockly
- Brando the Egg Hunter
- Lightbot
- Lightbot 2.0
- RoboZZle
- Treasure Hunter
- Swap puzzle



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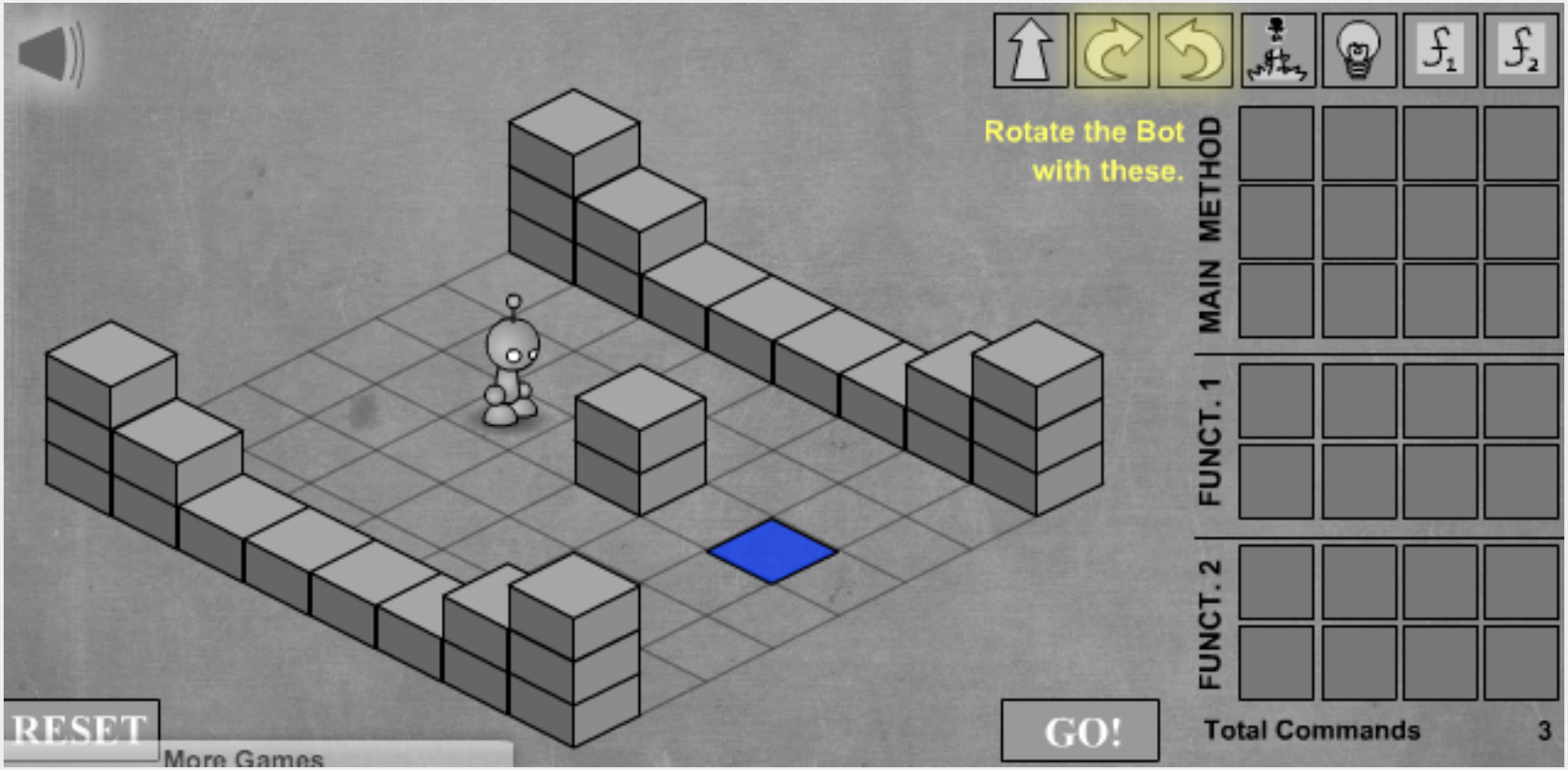
RoboRally

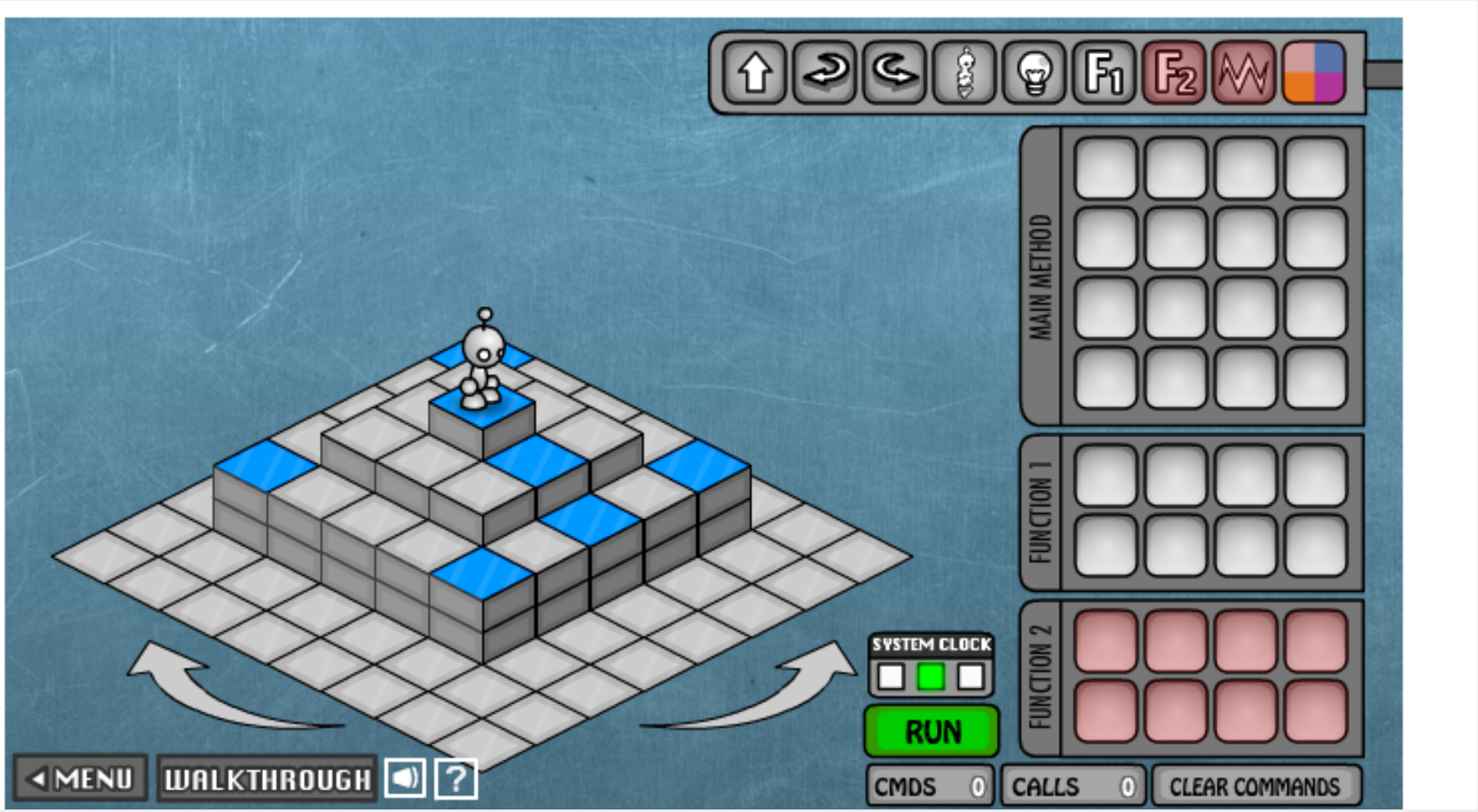
Programming concepts

- Instruction sequence
- Functions
- Design/planning
- Conditionals
- Loops

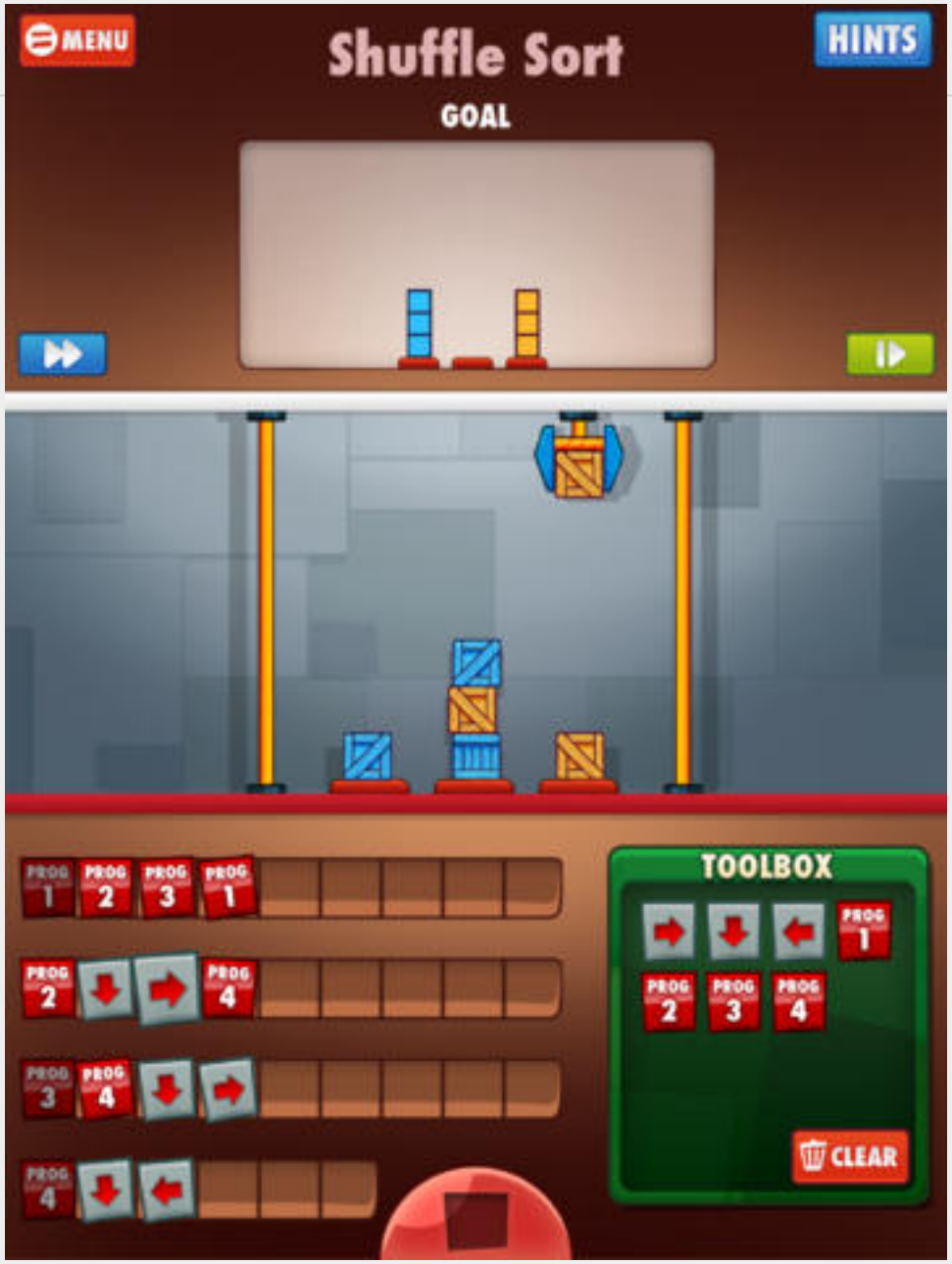
Light bot


Rotate the Bot
with these.
MAIN METHOD
FUNCT. 1
FUNCT. 2
Total Commands
3
GO!
RESET
More Games

Lightbot 2 (recursion)

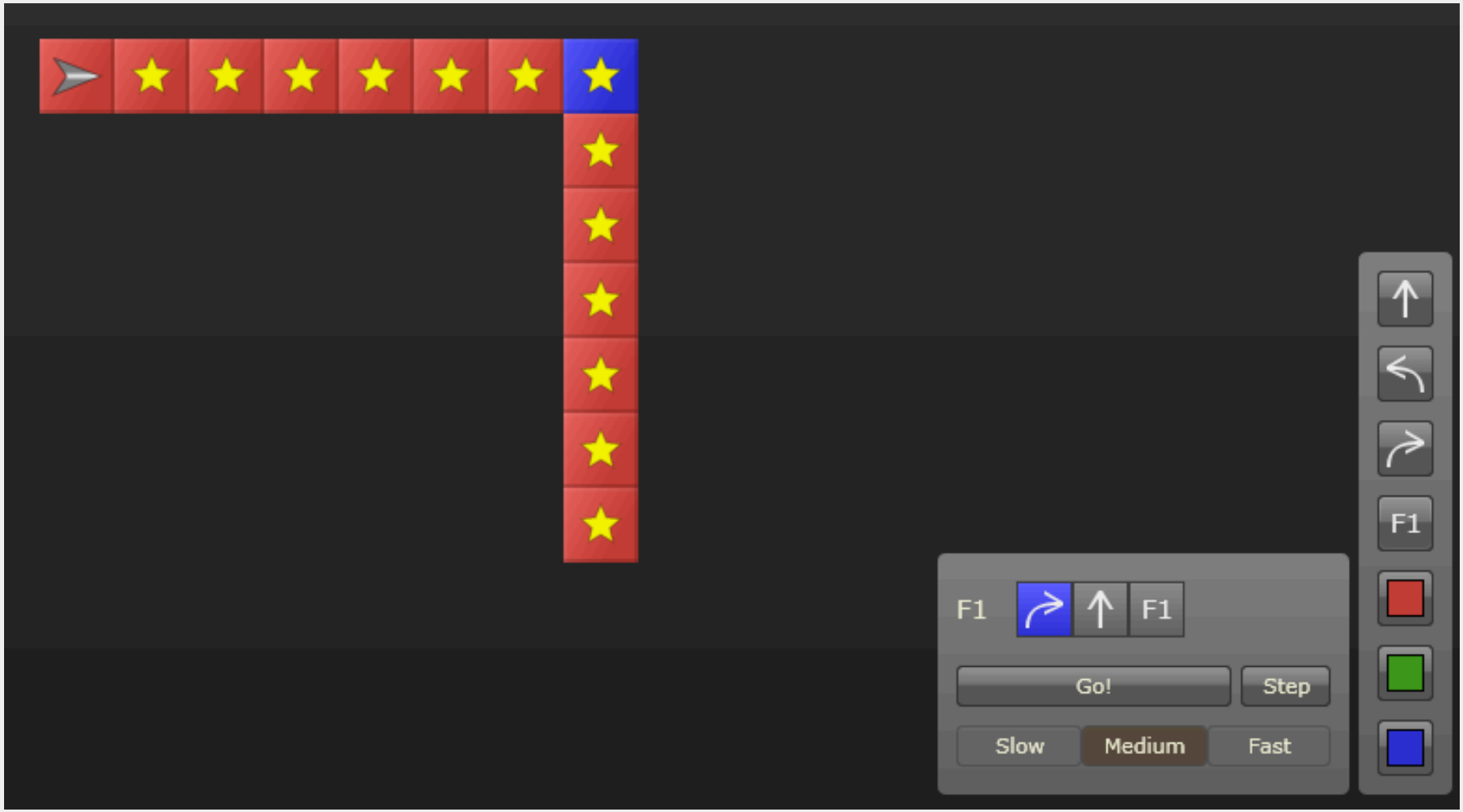


Cargobot

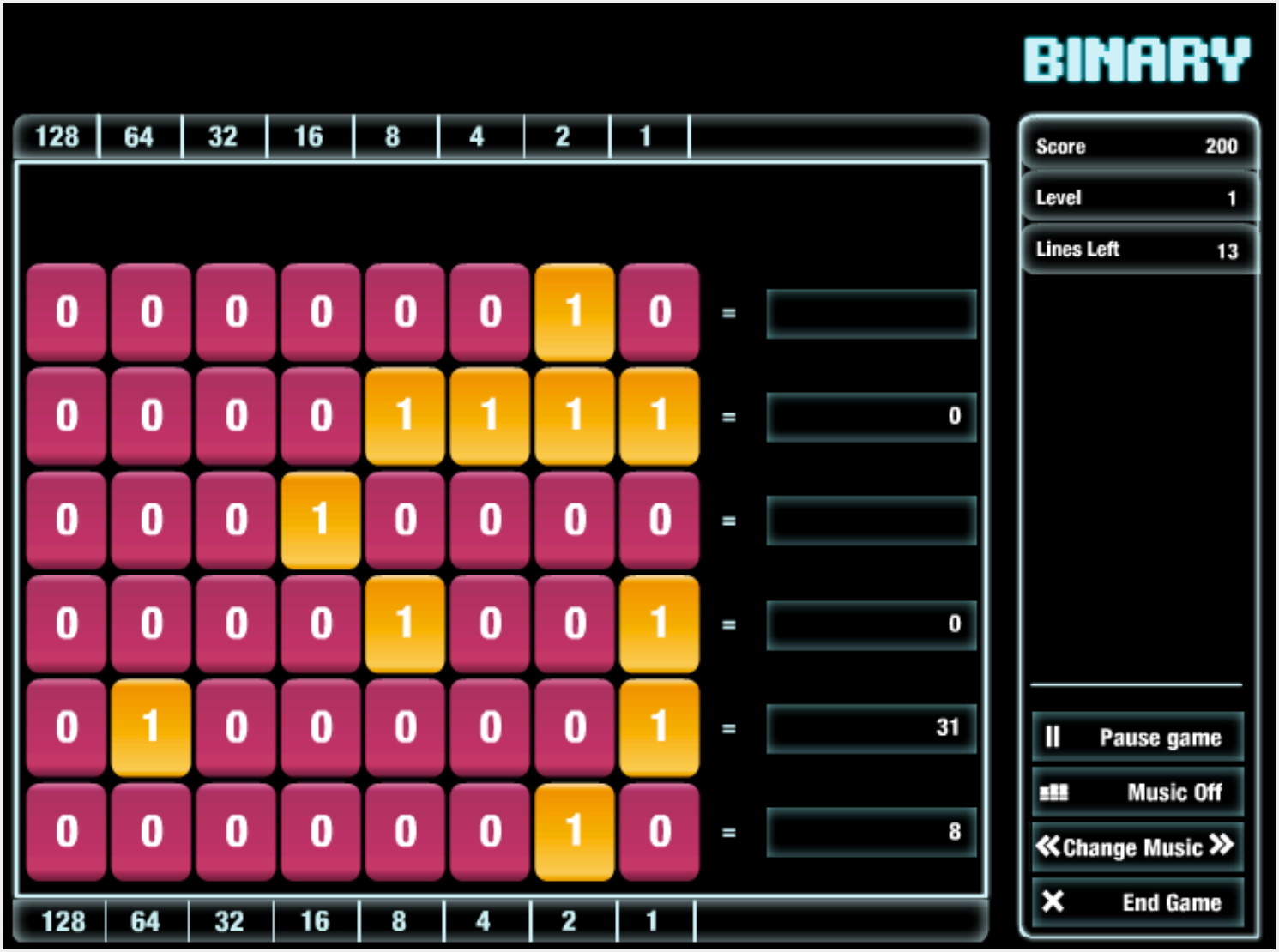


CS games

RoboZZle (recursion)

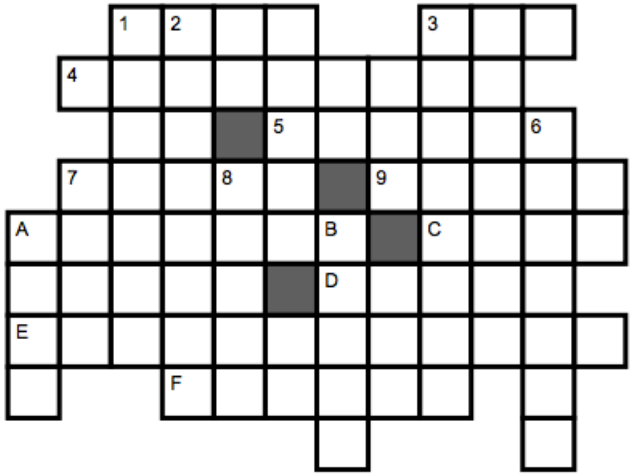


Cisco Binary



Crossbin

Crossbin #1



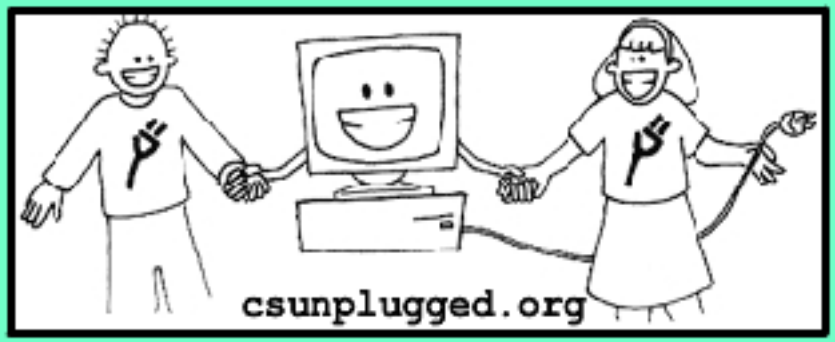
Across

[1]: **8**
[3]: **4**
[4]: **44**
[5]: **3C**
[7]: **1B**
[9]: **C**
[A]: **7F**
[C]: **E**
[D]: **1D**
[E]: **A0A**
[F]: **36**

Down

[1]: **5F**
[2]: **6D**
[3]: **BE**
[6]: **1C**
[7]: **C**
[8]: **1D**
[A]: **E**
[B]: **1A**

Binary Flash



Convert to decimal

Convert the binary number "0 0 1 1 1 1" to decimal, you may use the columns to help you.

32	16	8	4	2	1
0	0	1	1	1	1

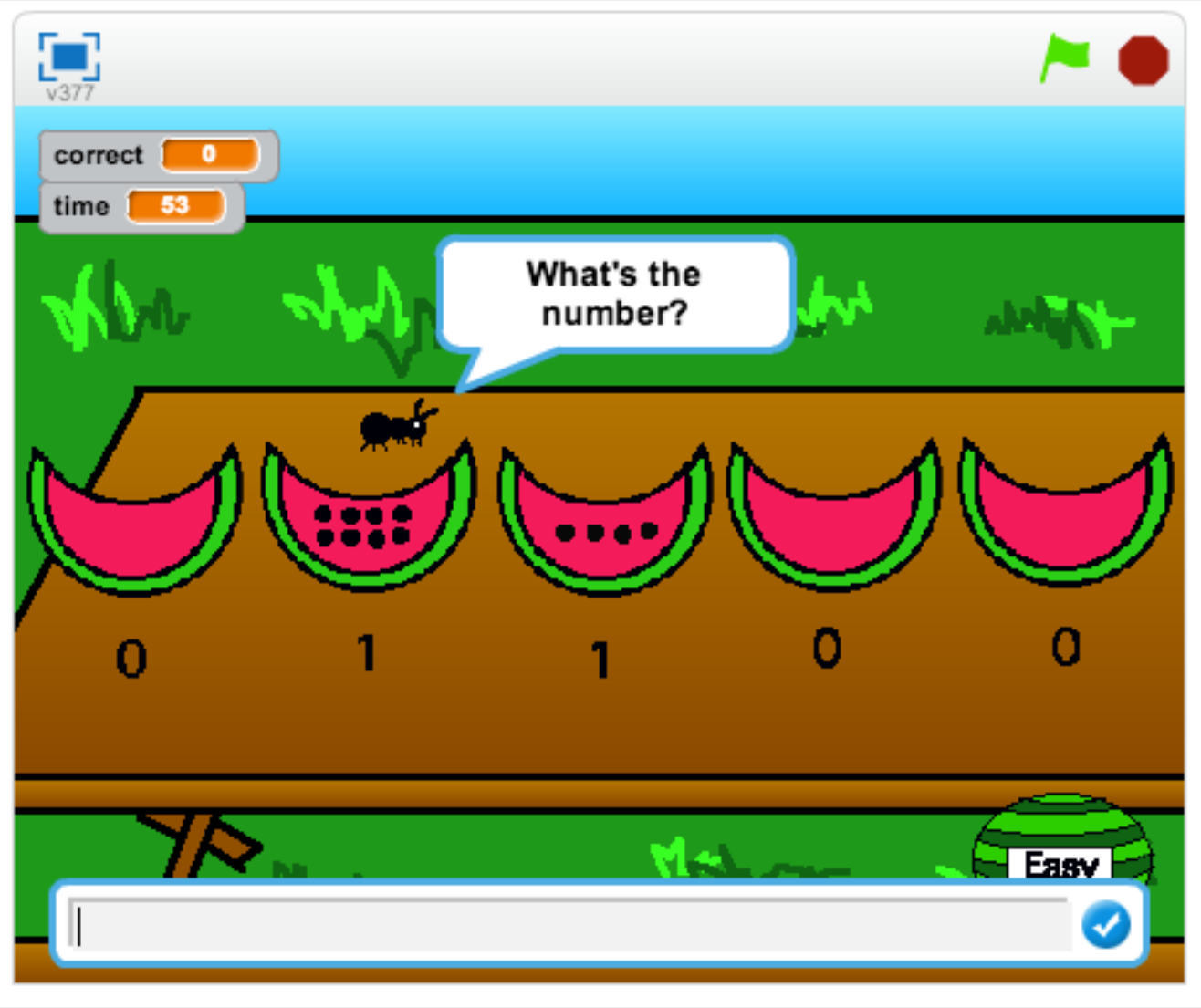
Answer: ?

(10 left to go)

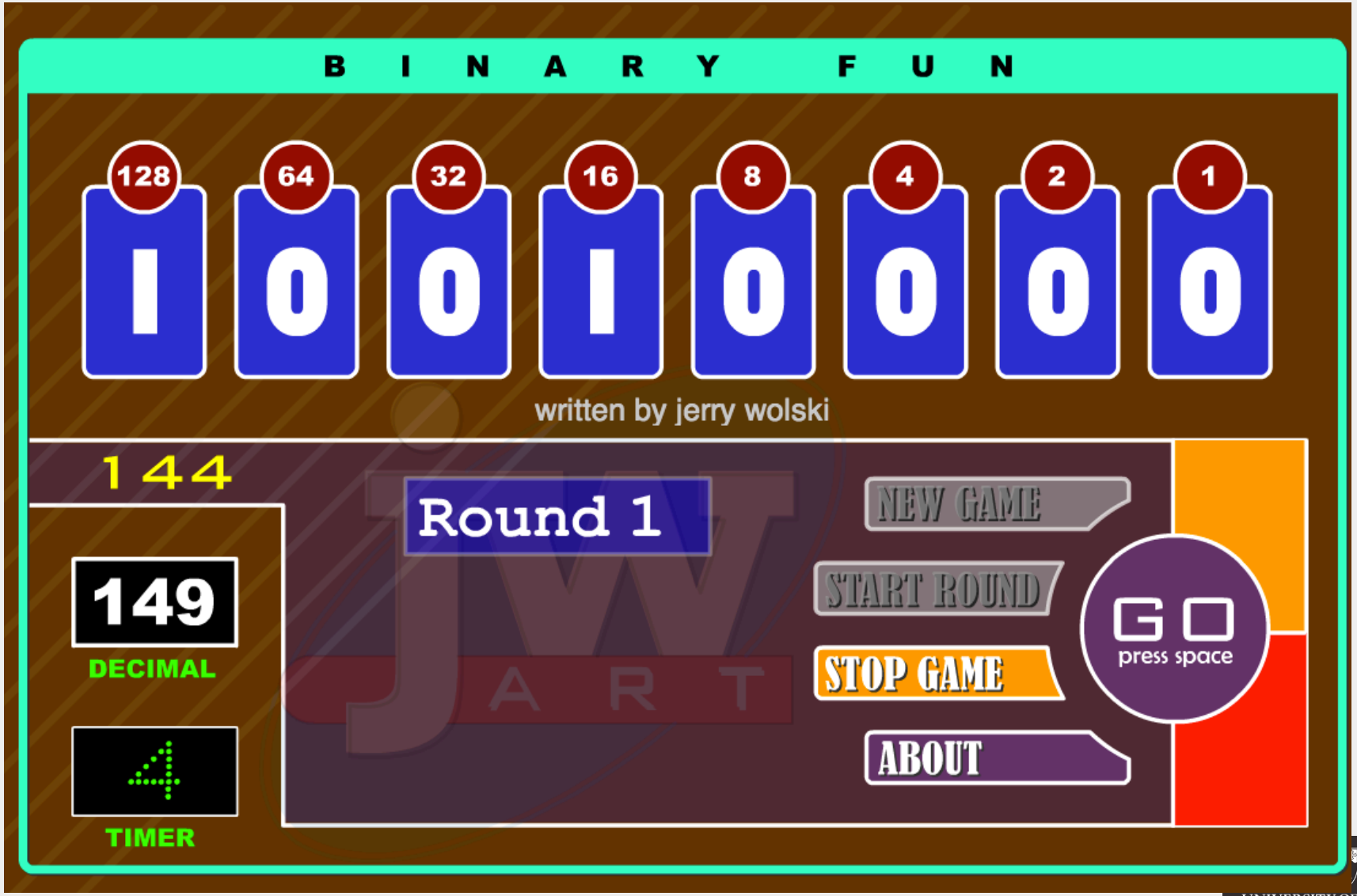
Submit Answer

<< MAIN MENU

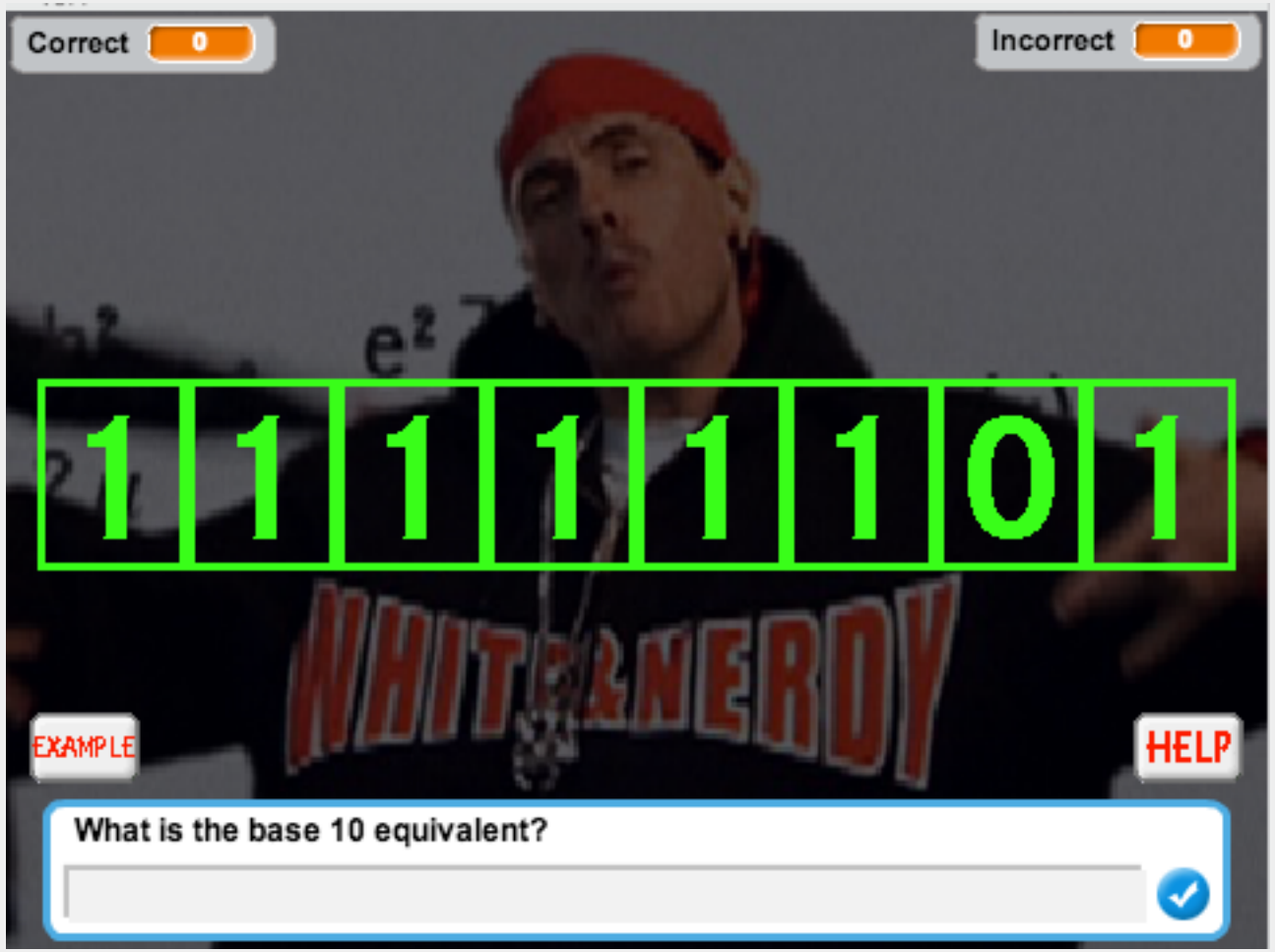
Binary number quiz



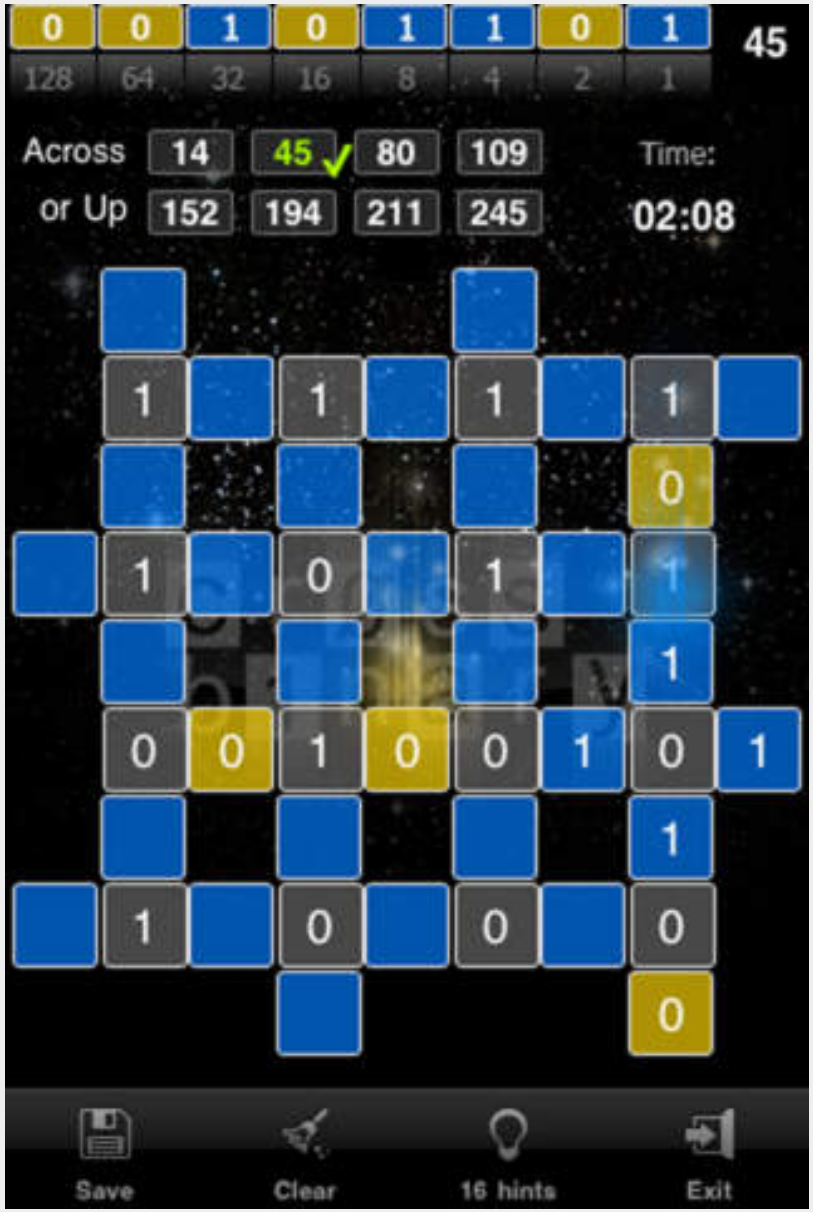
Binary fun


B I N A R Y F U N
128 64 32 16 8 4 2 1
1 0 0 1 0 0 0 0
written by jerry wolski
144
Round 1
NEW GAME
START ROUND
STOP GAME
ABOUT
GO
press space
149
DECIMAL
4
TIMER

Binary flash cards

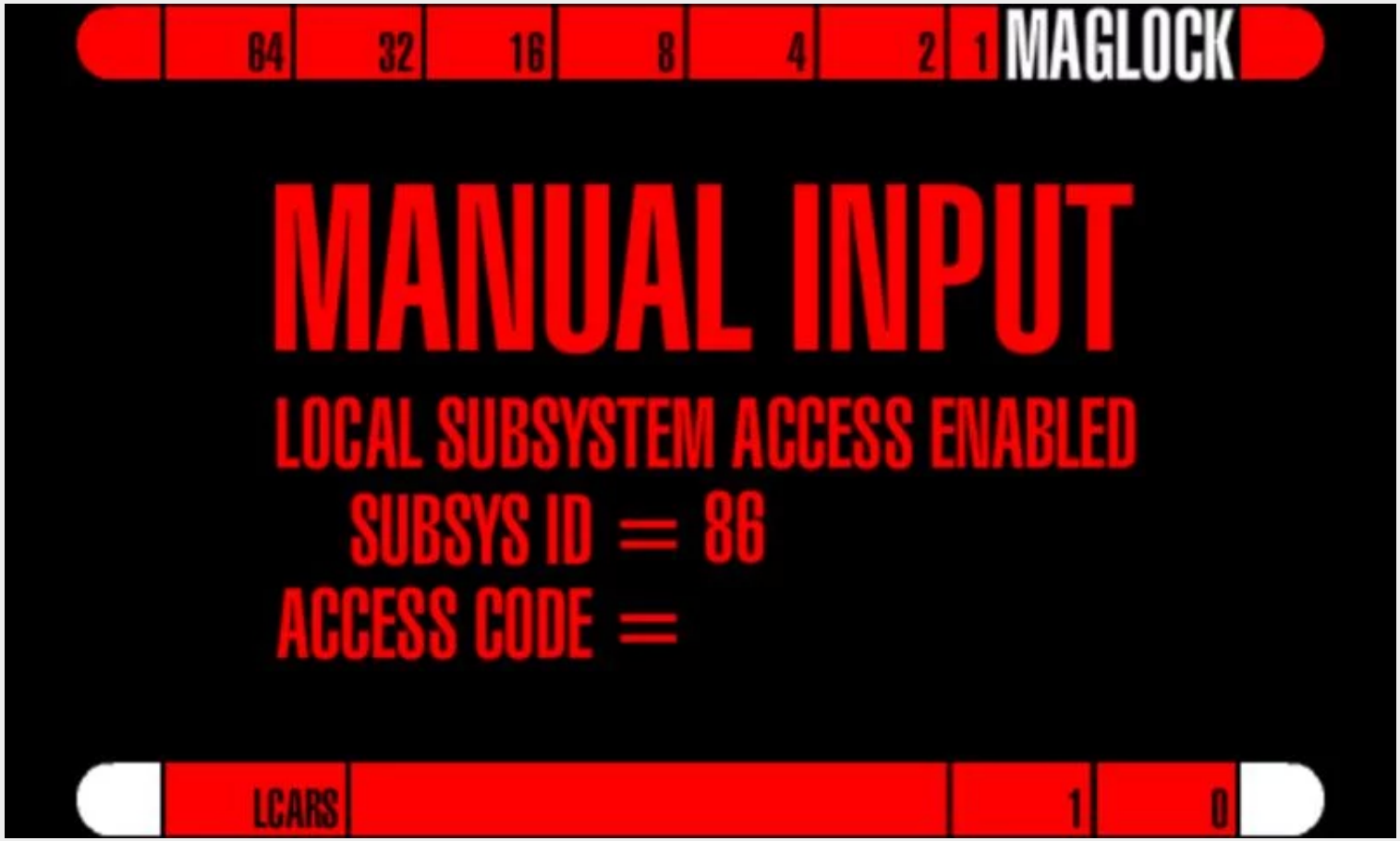


Cross-binary app



Binary game

Binary Maglock



Binary principles

- Conversion?
- Or…

  Each bit doubles range

  Adding 1

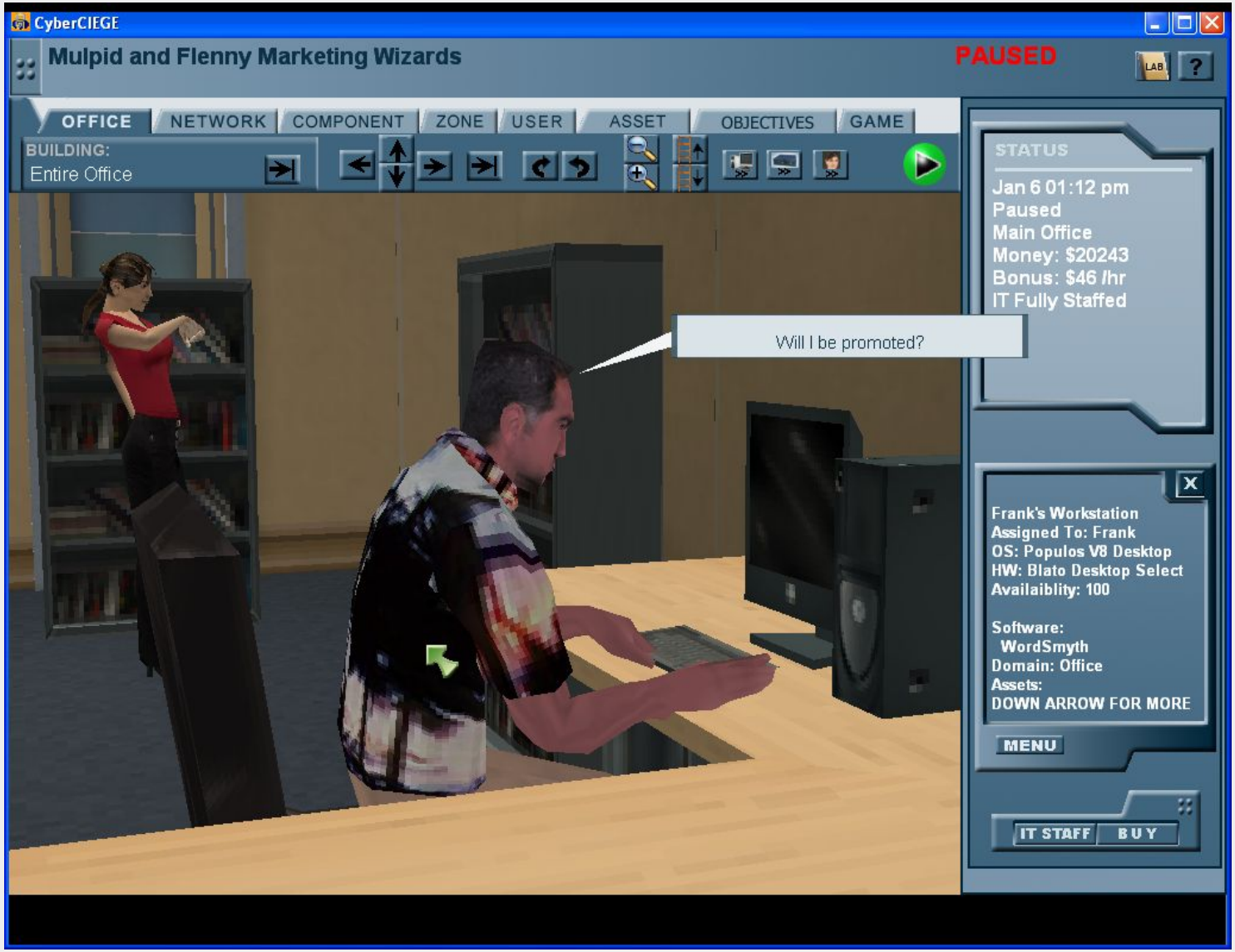
  Double a number

  8/16/24/32/64 bits

  200/1000 bit crypto

  Arithmetic and logic

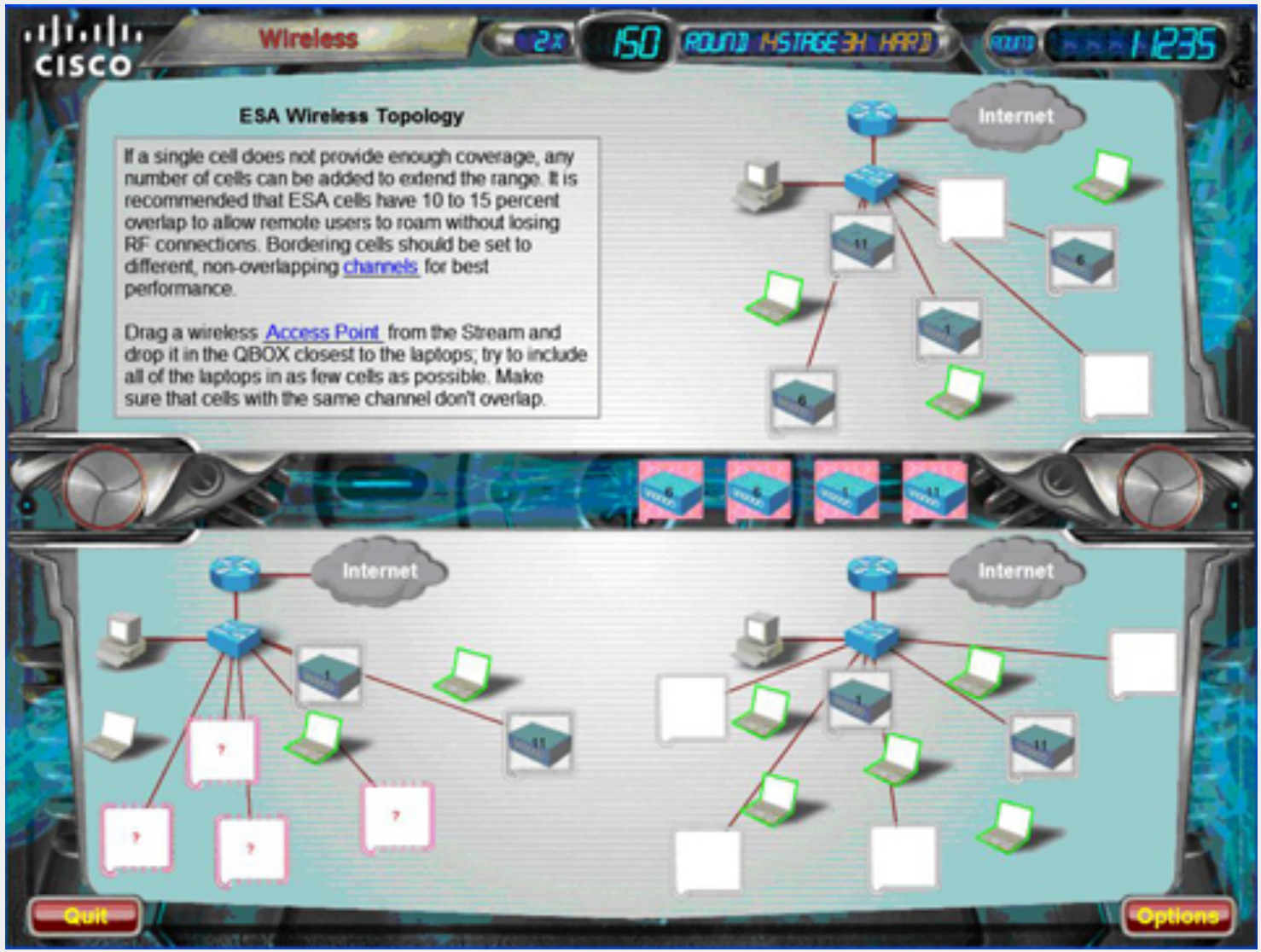
CyberCIEGE (security)



myPlanNet (history of networking)

Orange game

Mind Share (networking and binary)



[d0x3d!]

a network security game

CS games

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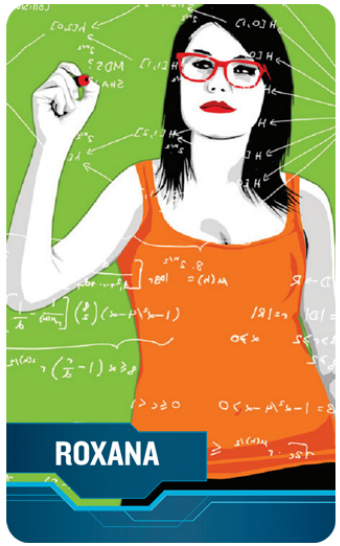
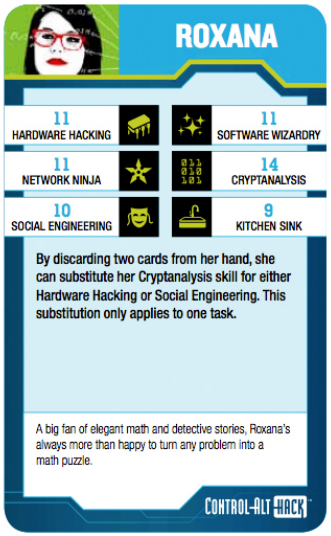
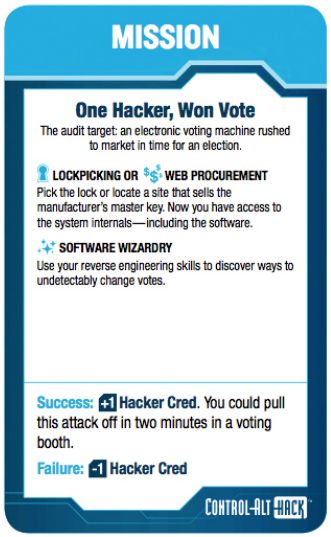
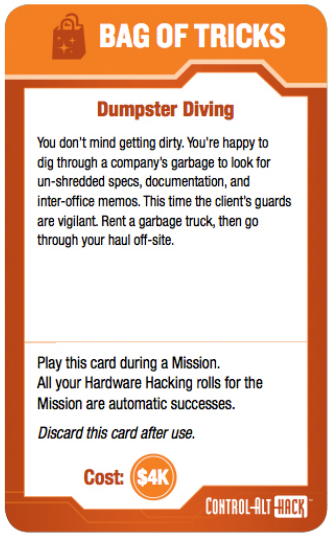
CTRL-ALT-HACK

CS games









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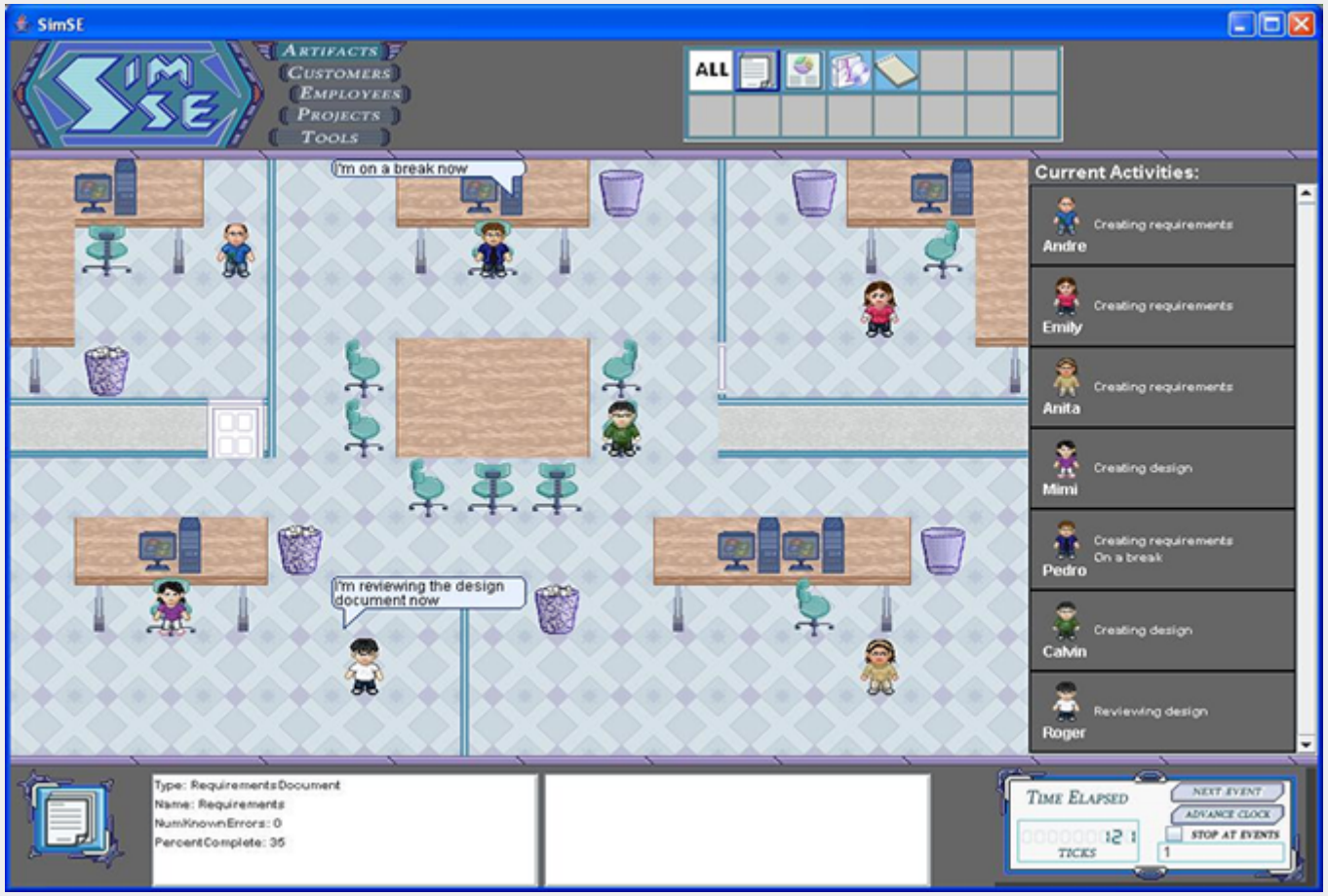
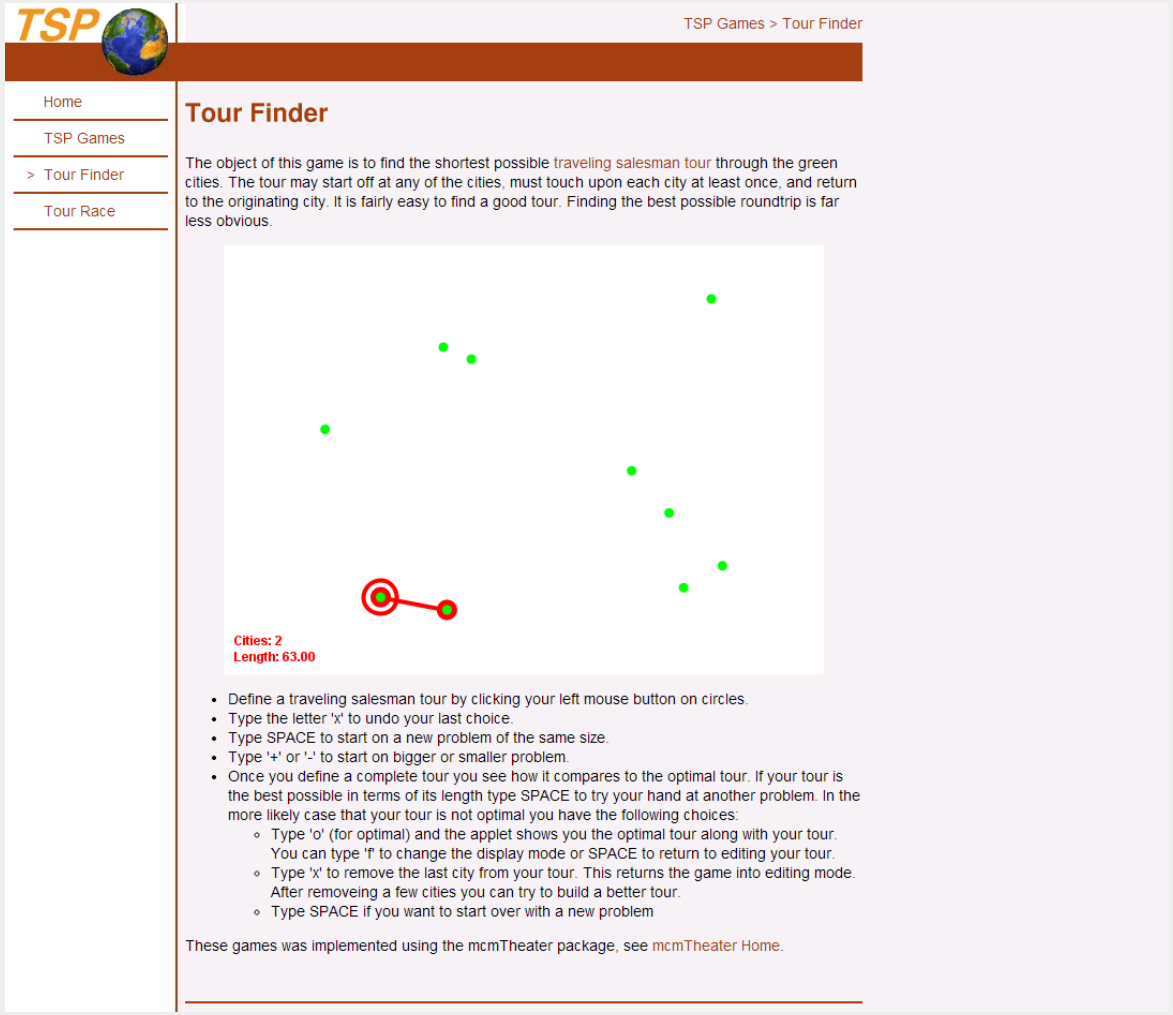
SimSE (Software Engineering)

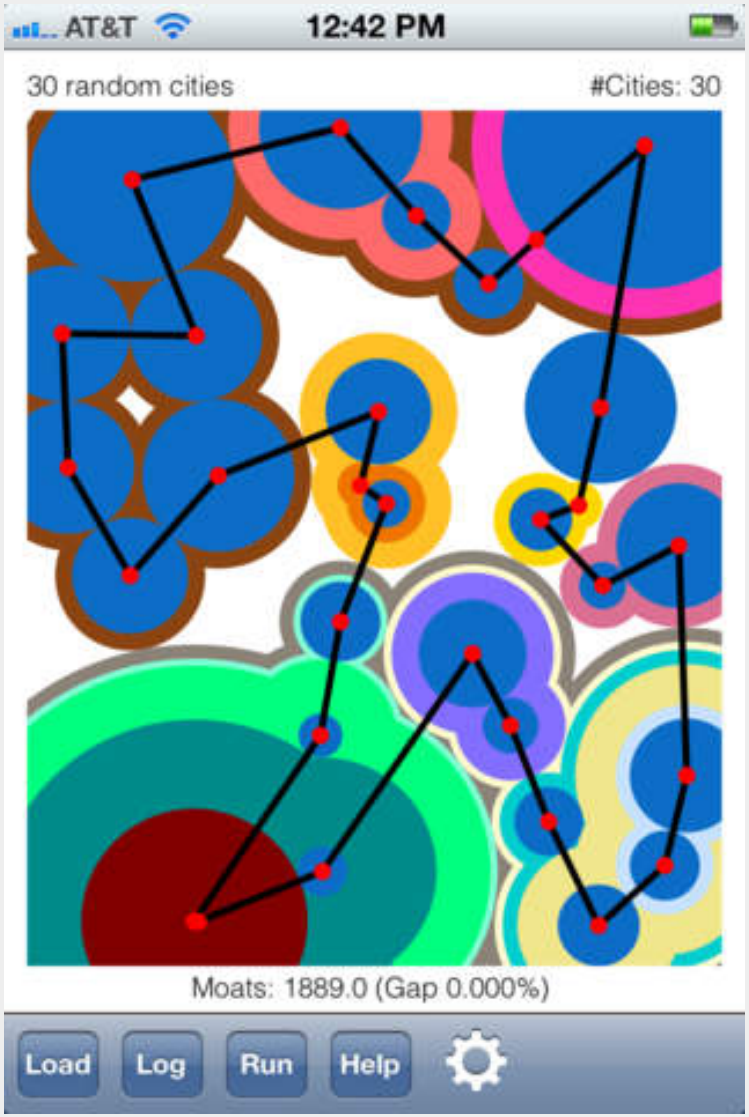


CS games

Tour finder



Concorde TSP



Game evaluation

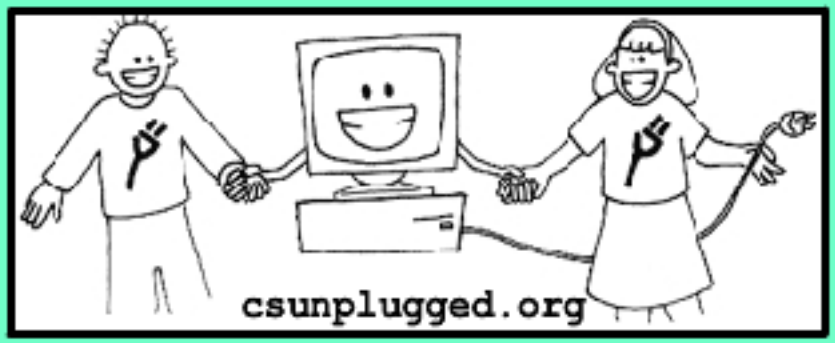
- Active/Passive
- Flow
- Longevity

Active/passive

- Active: Educational content is part of game
- Passive: Content is in instructions or support material

Binary game

CS Unplugged Binary Flash



How do you do it?

With binary numbers, the right most number is worth the least and the left most worth the most and each column is worth double the one on it's right e.g.

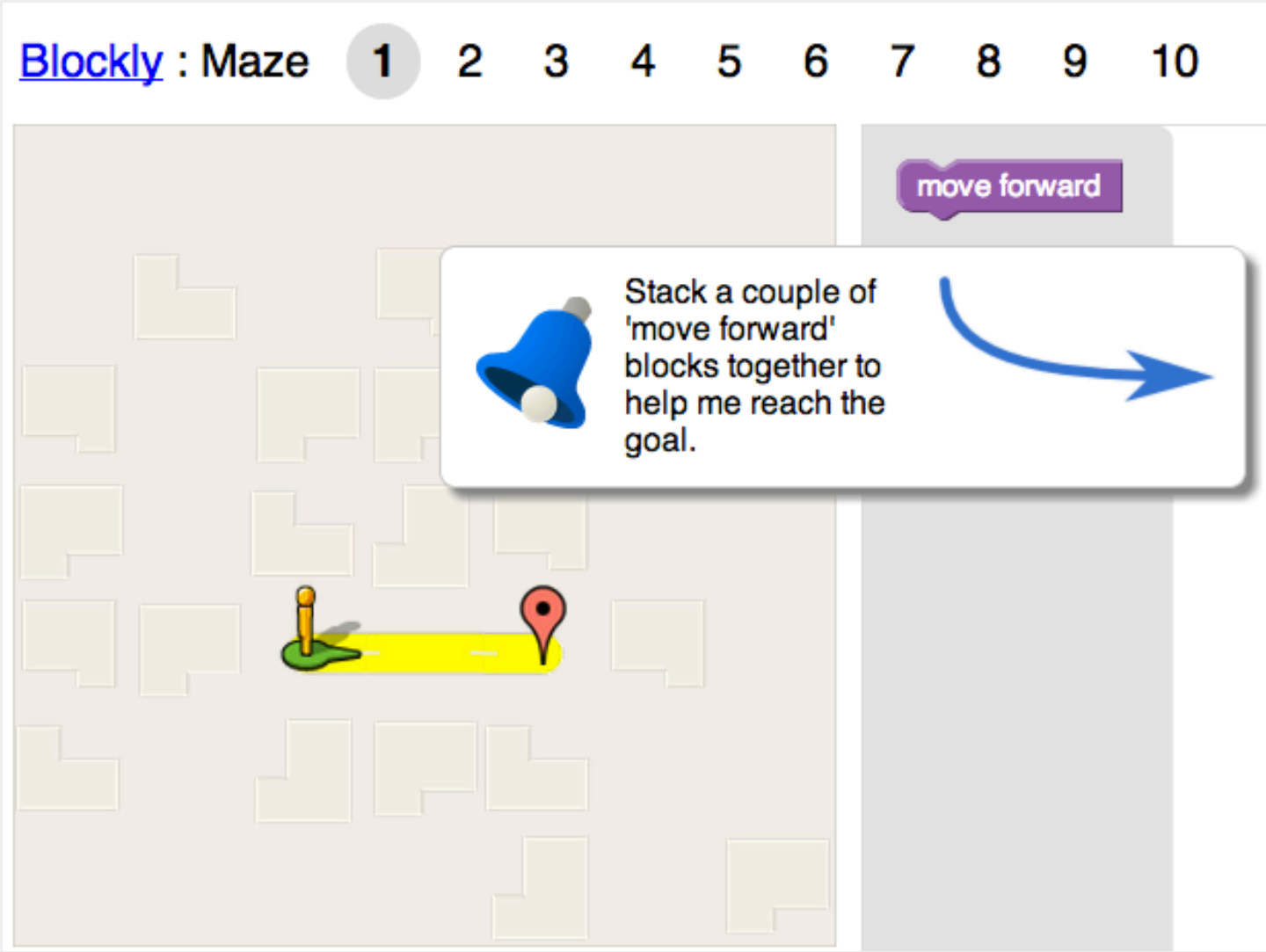
256|128|64|32|16|8|4|2|1

if there is a "1" in the column you add that value to the total, if there is a "0" you don't

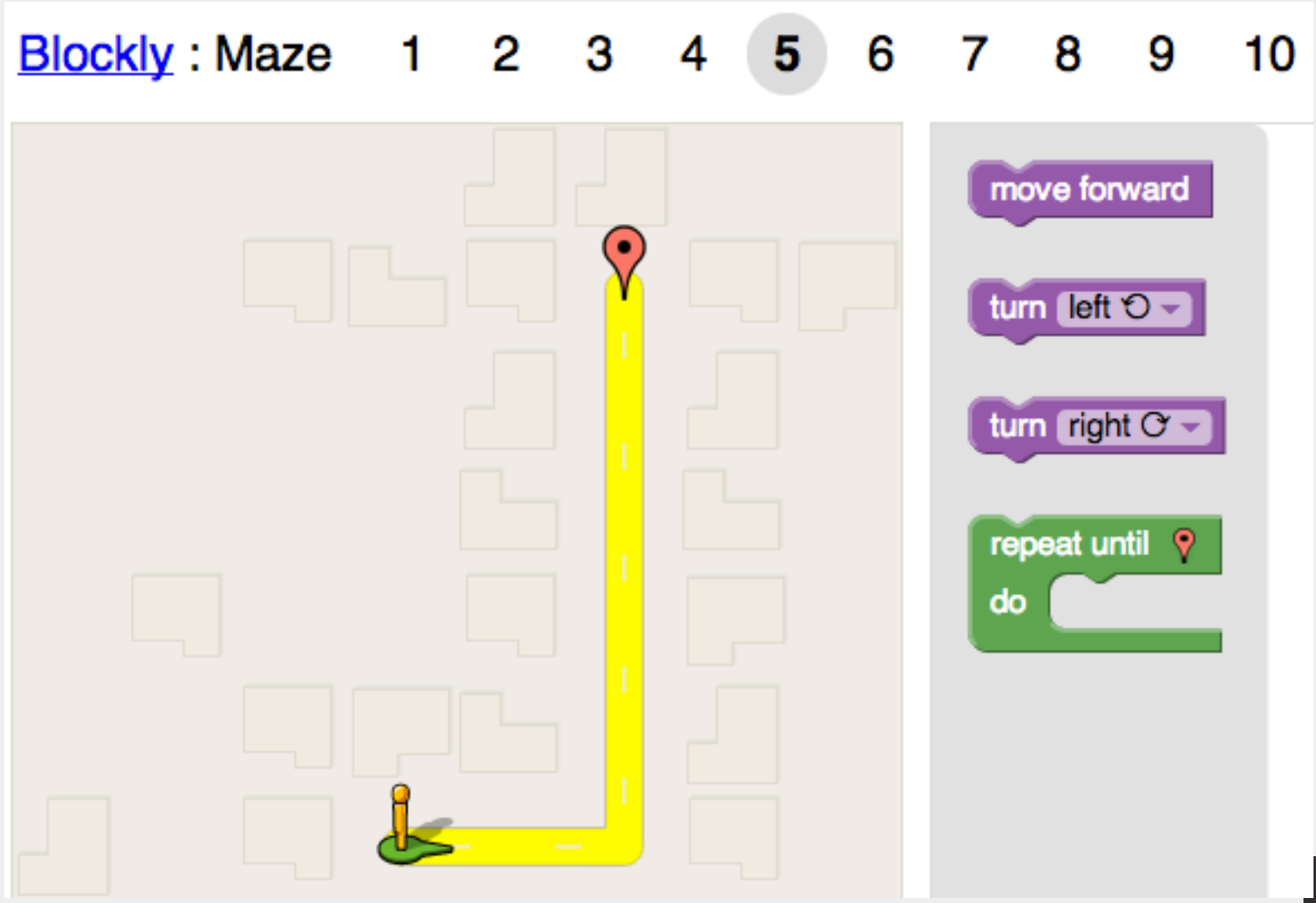
<< PREVIOUS

CONTINUE >>

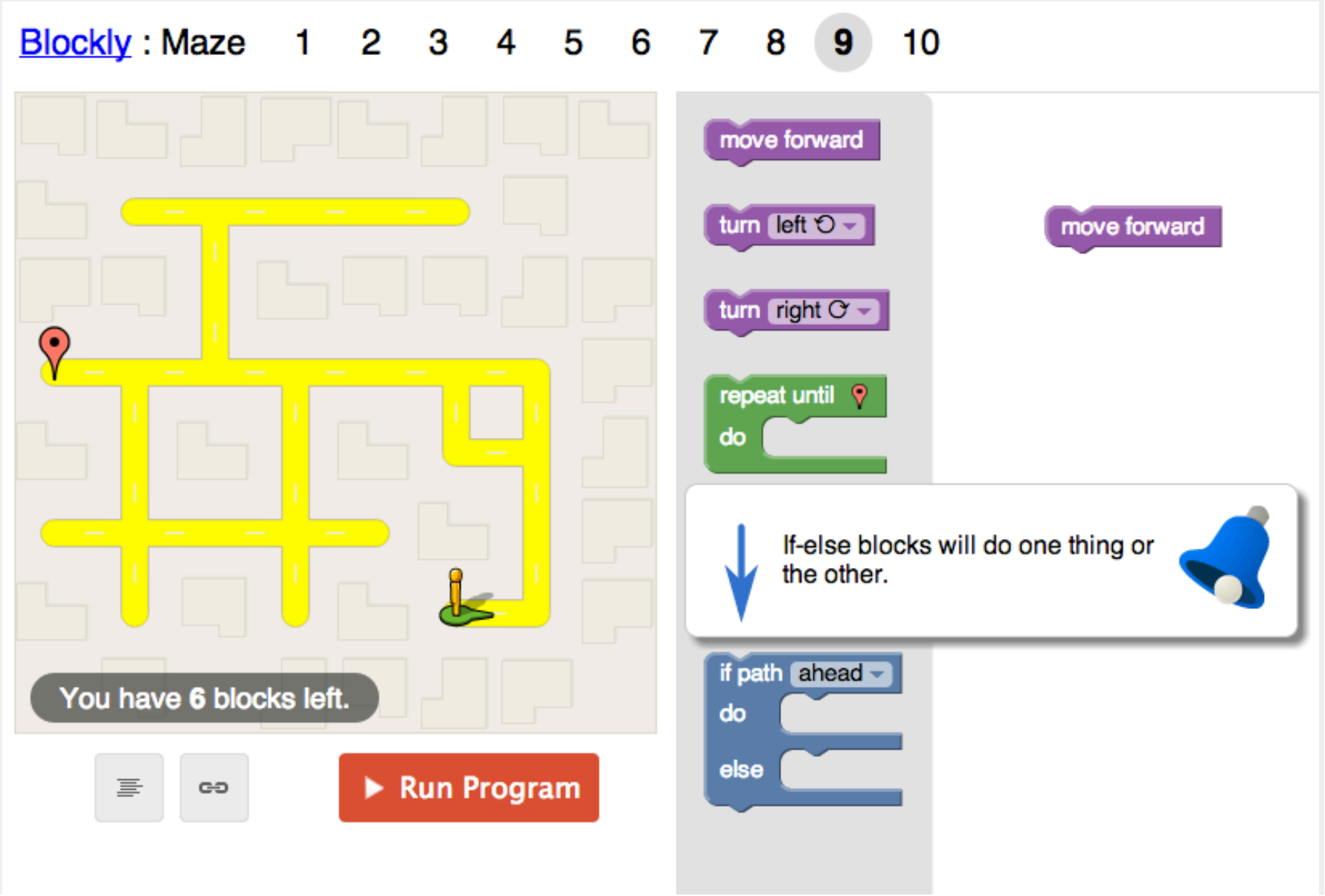
Blockly level 1



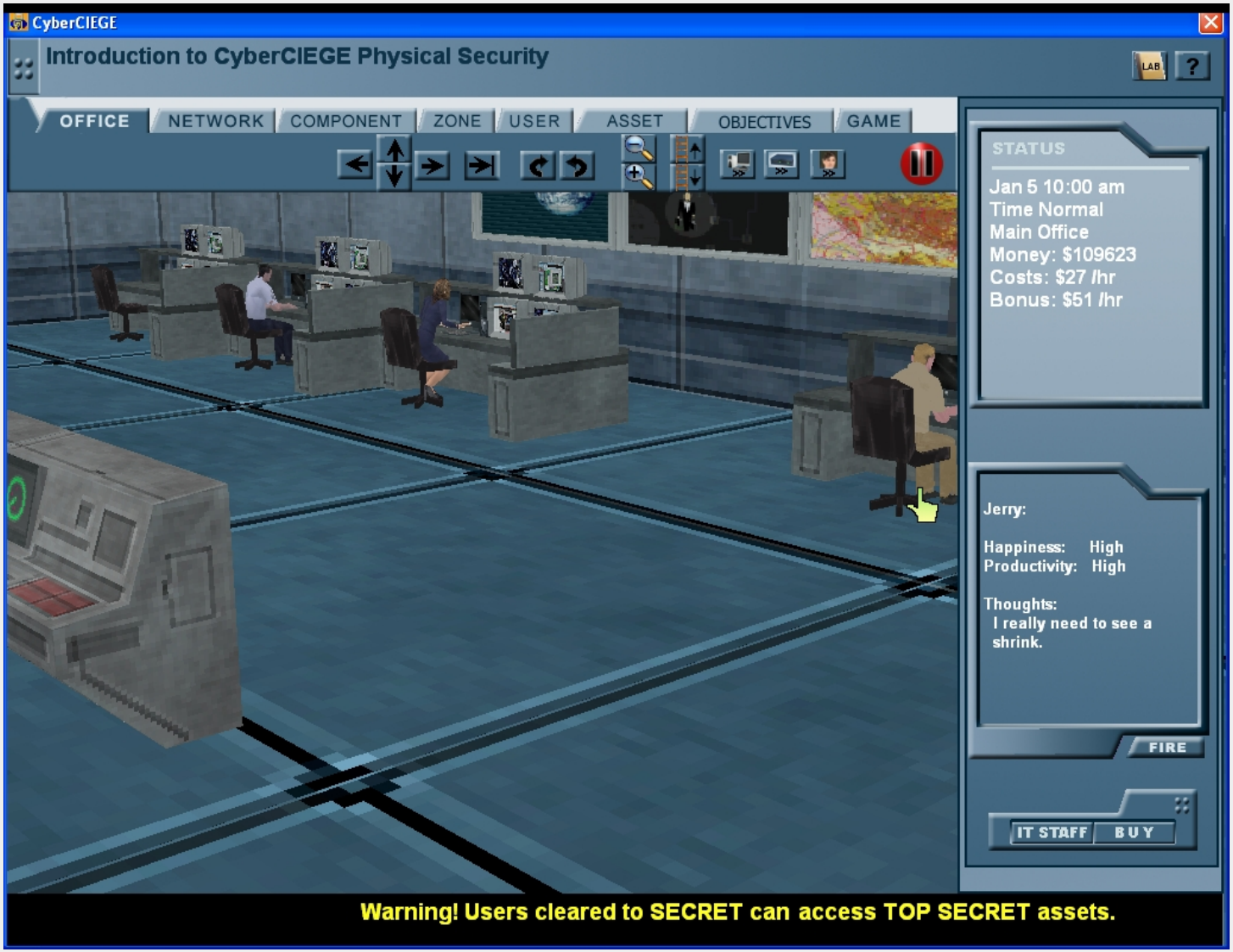
Blockly level 5



Blockly level 9



CyberCIEGE

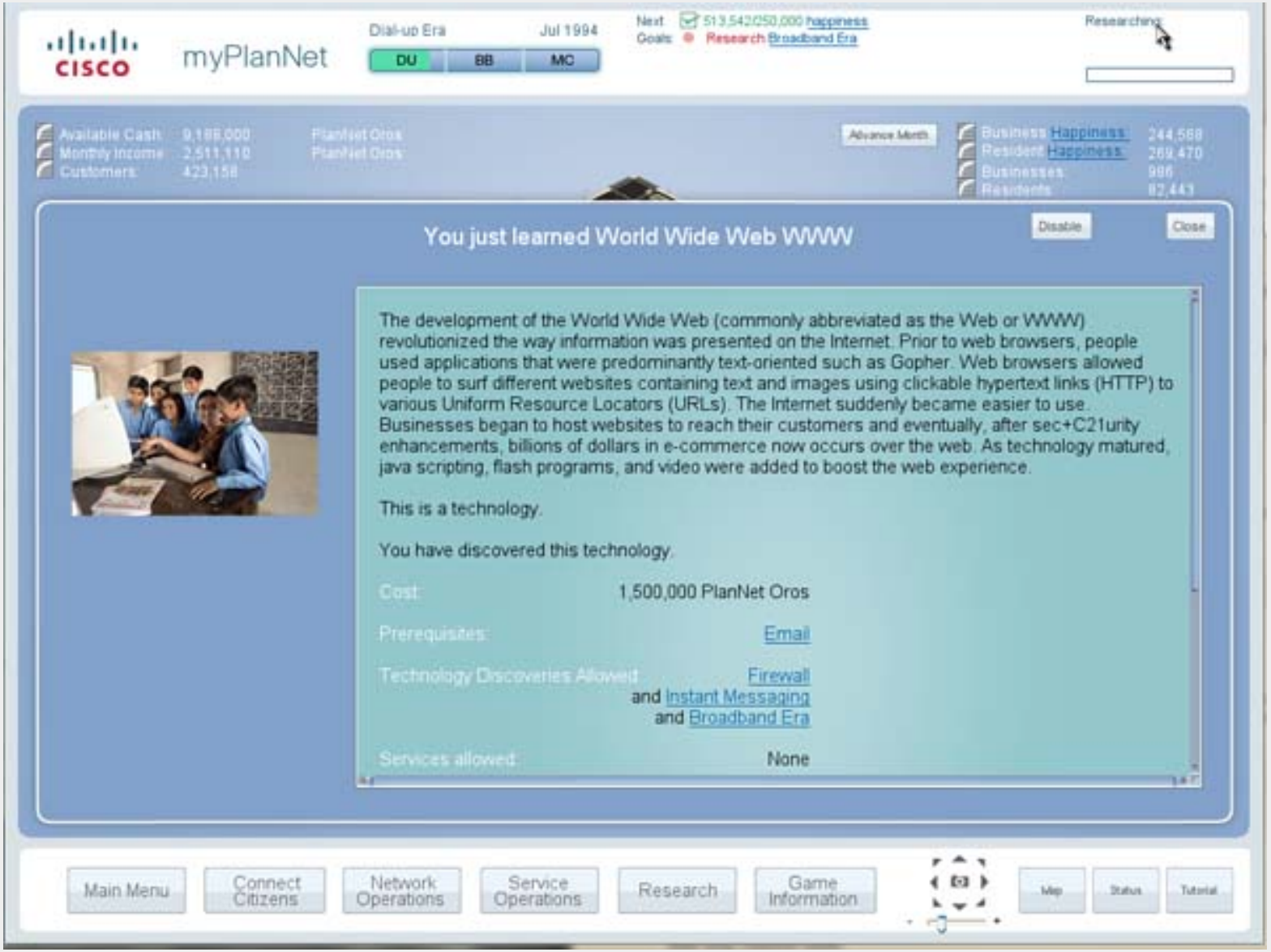


Some introduction is common

Tour Finder

The object of this game is to find the shortest possible traveling salesman tour through the green cities. The tour may start off at any of the cities, must touch upon each city at least once, and return to the originating city. It is fairly easy to find a good tour. Finding the best possible roundtrip is far less obvious.

Passive



CS games

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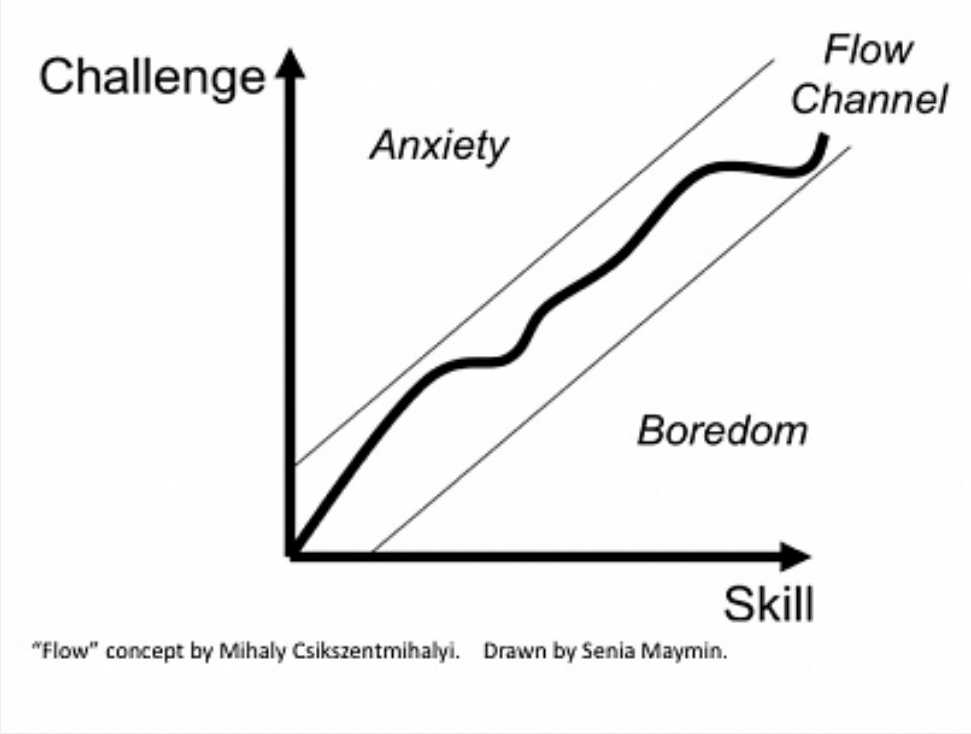
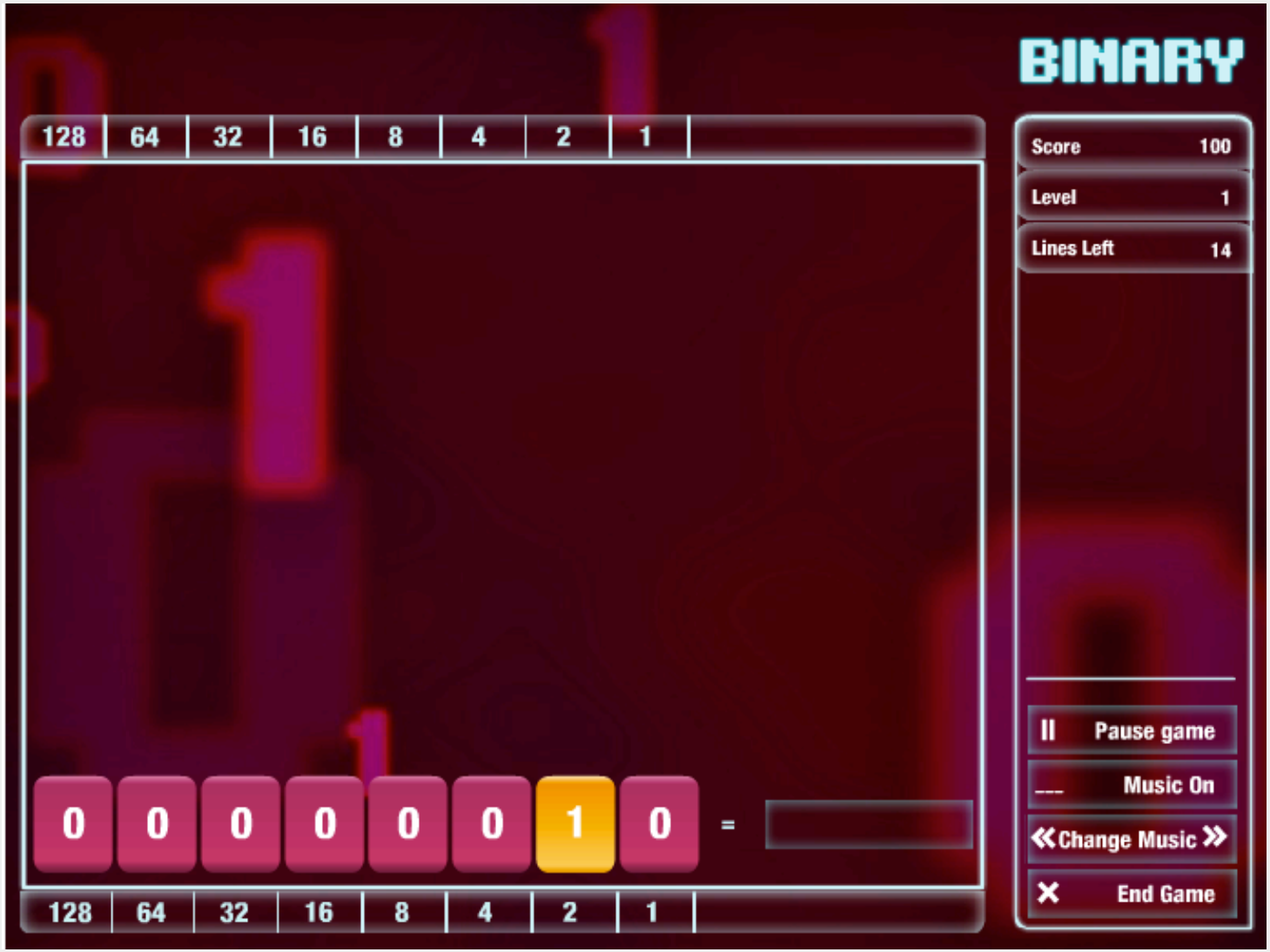
Flow

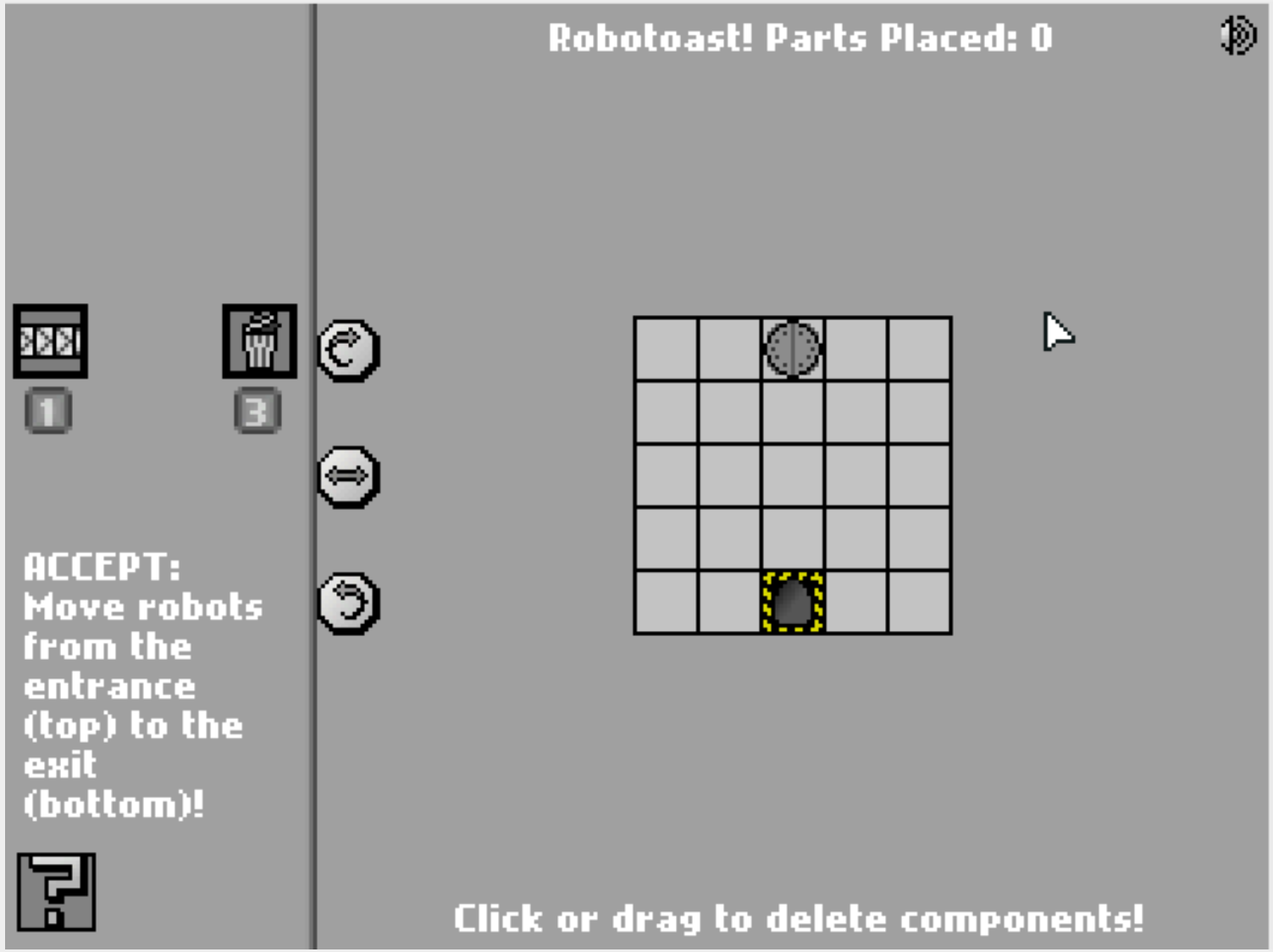
- Absorbed by activity
  - Challenging enough to be interesting
  - Not too challenging
- More time on task
- ZPD



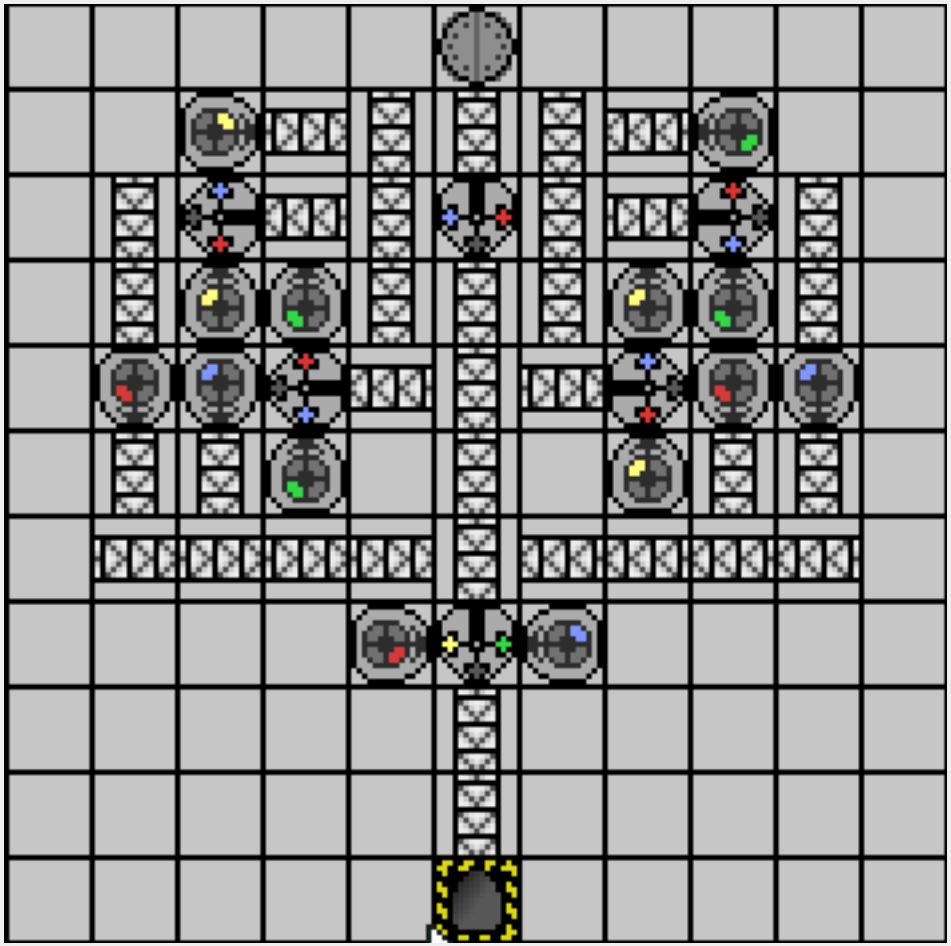
Adjust difficulty



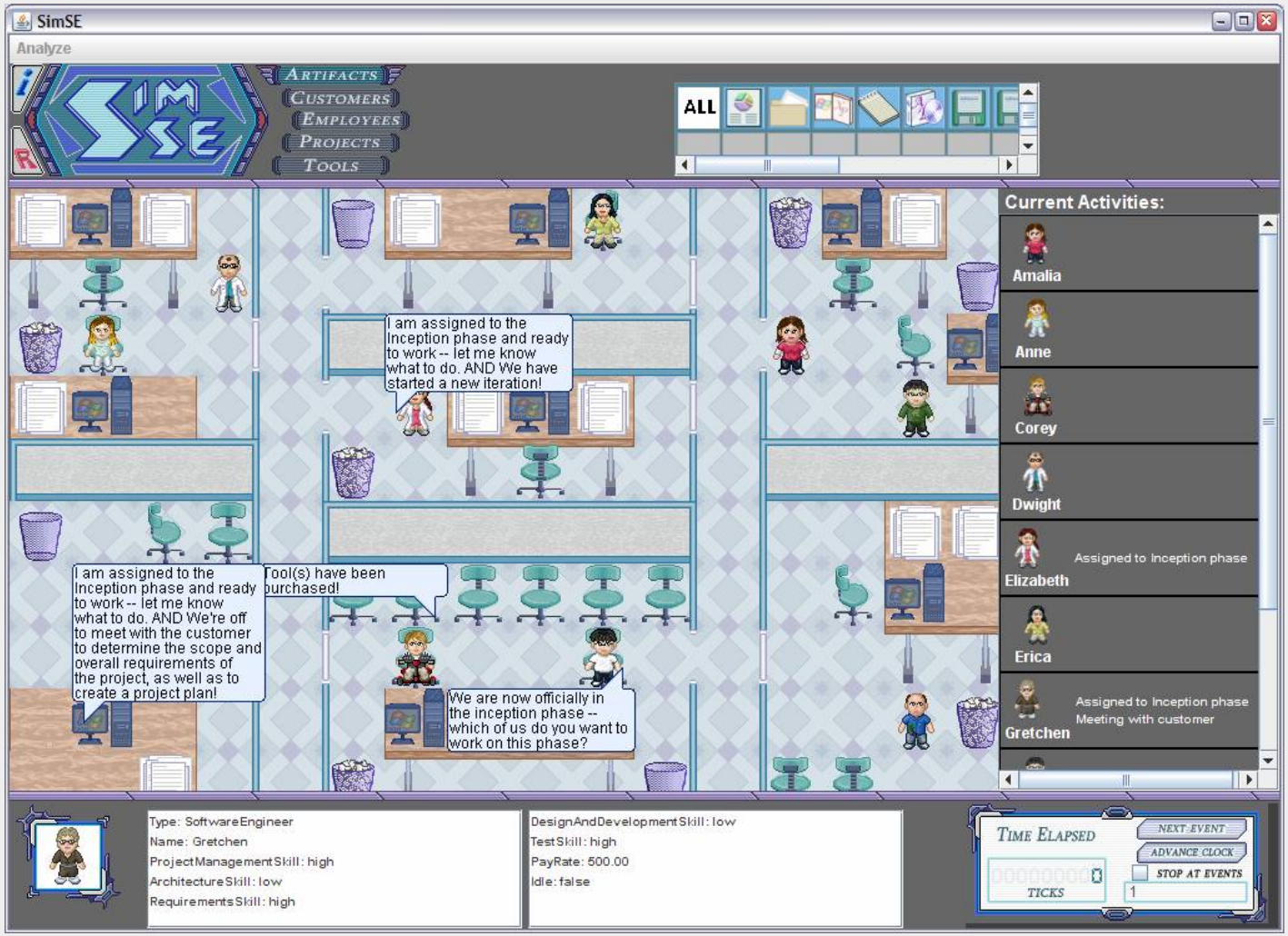
Manufactoria



Manufactoria



Limited flow



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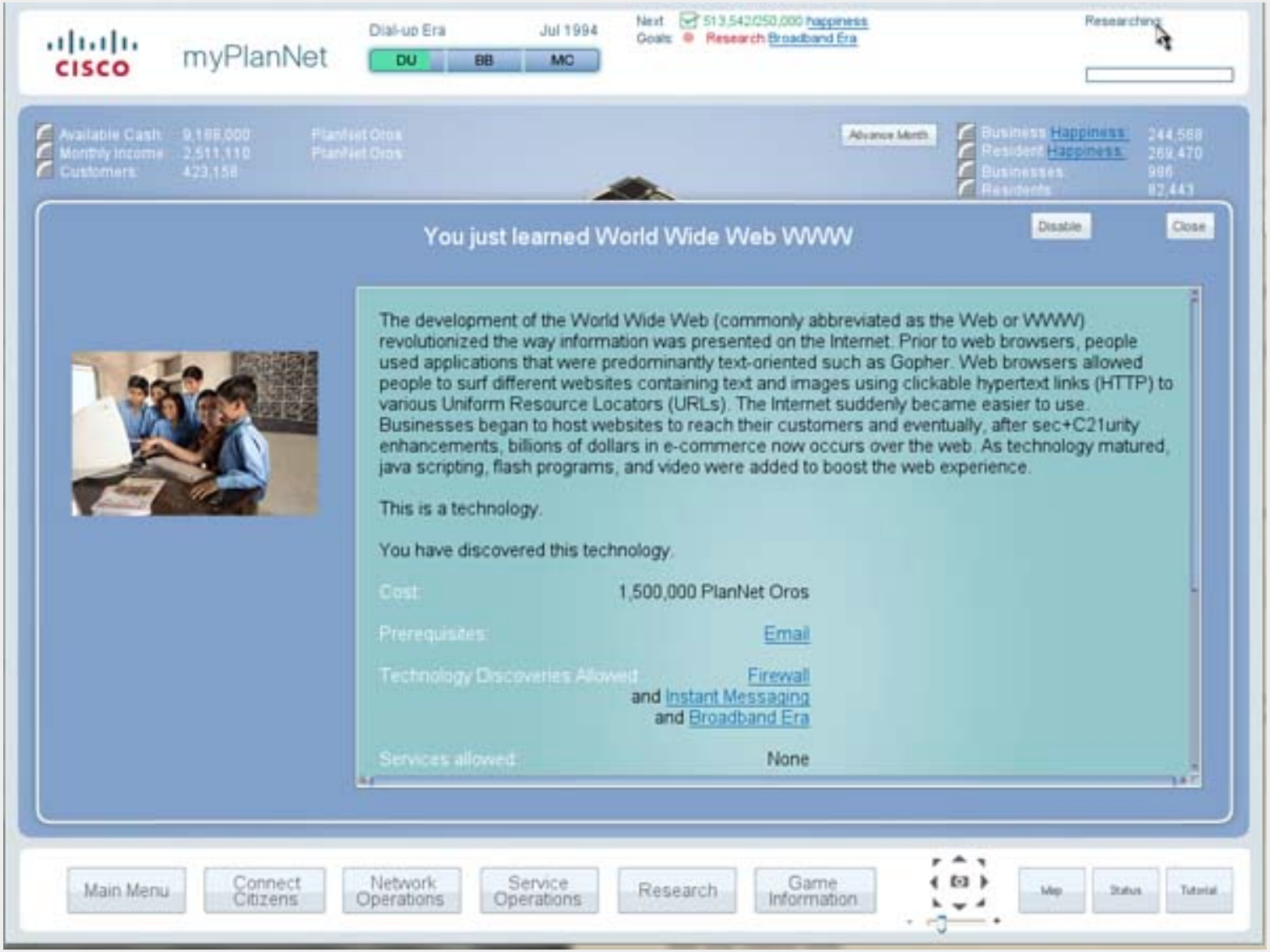
Anti-flow?



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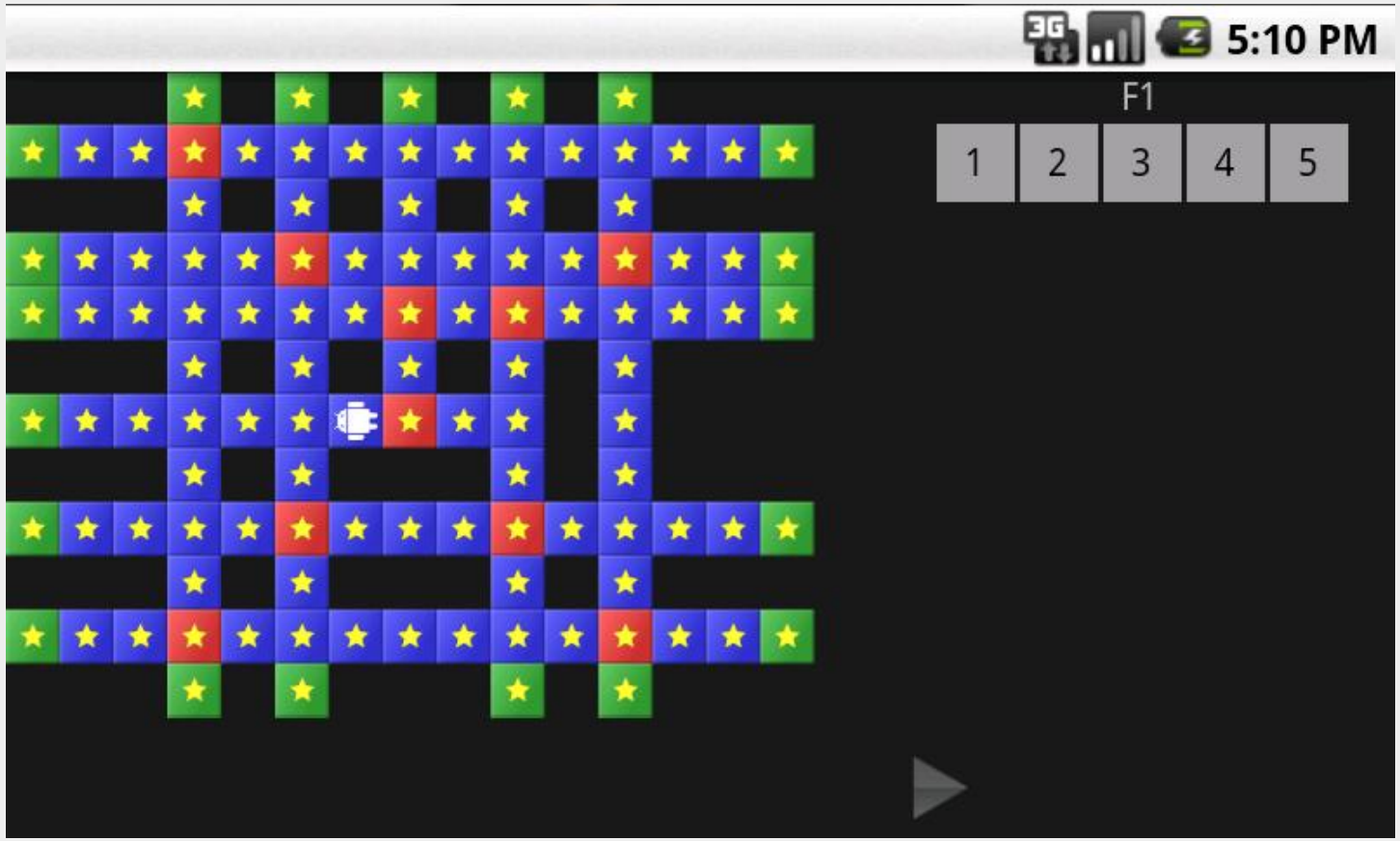
Longevity

- Time on task improves learning - generally
- Classic games replayable by definition

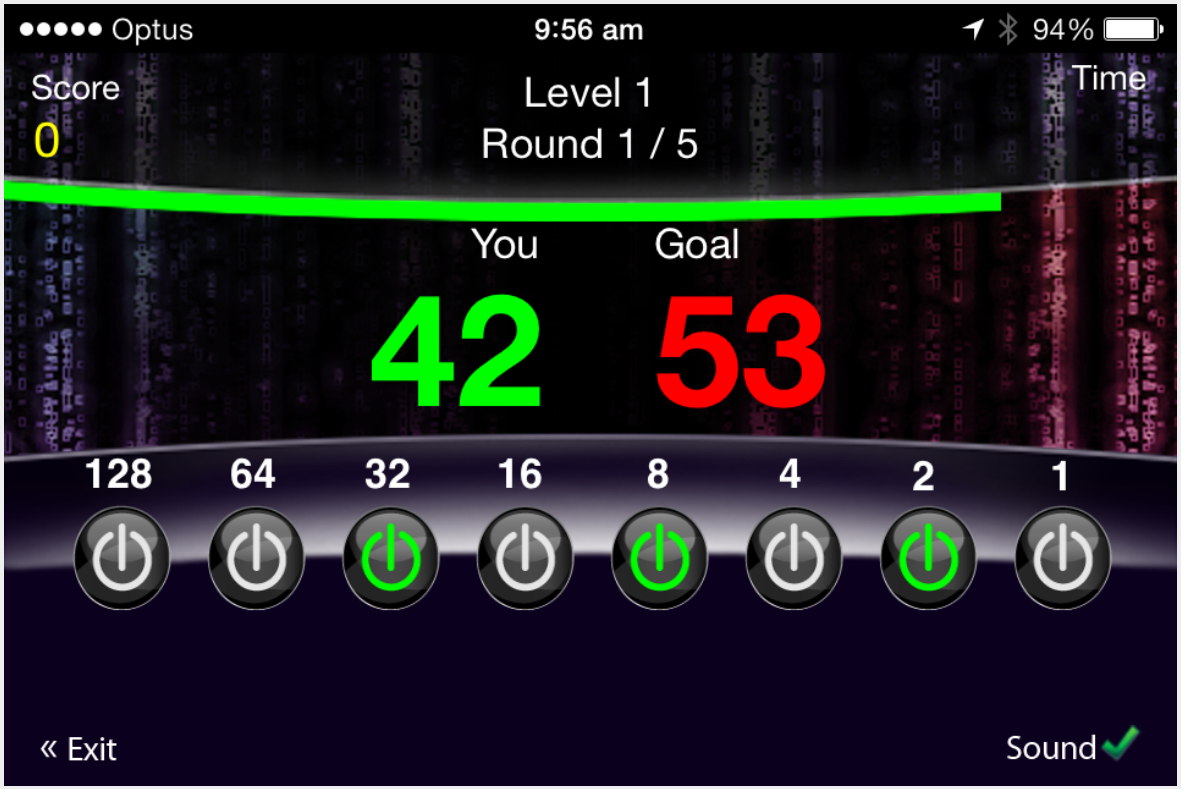
RoboZZle

- User-defined layouts



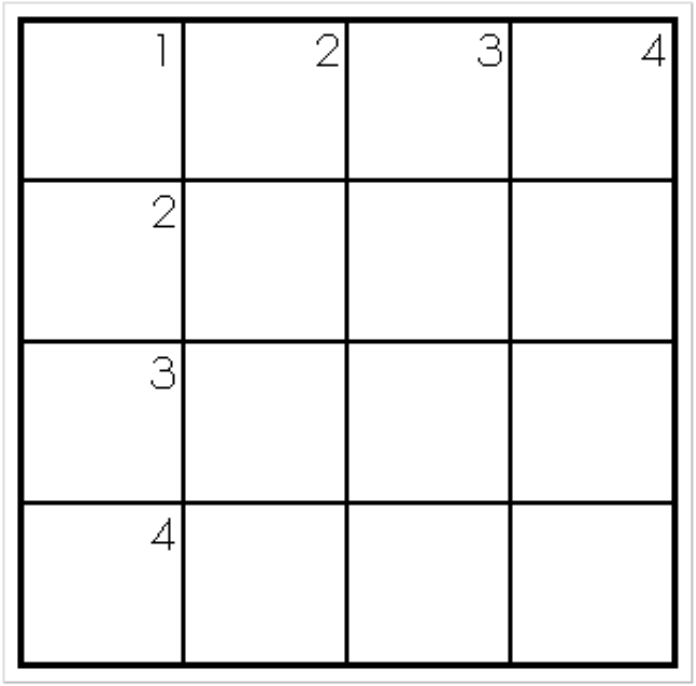
Binary games

- 8-bits only
- Speed can improve



Small games with longevity

- Only one puzzle available
- Generalisable



1	2	3	4
2			
3			
4			

Rows (Across):
1. "2 Down" x 2
2. A triangular number
3. The cube of ("4 Down" - 2)
4. "3 Across" + "3 Down"

Columns (Down):
1. NOT "2 Across"
2. NOT "1 Across"
3. "2 Across" x 2
4. "4 Across" - "1 Across"

Practical issues

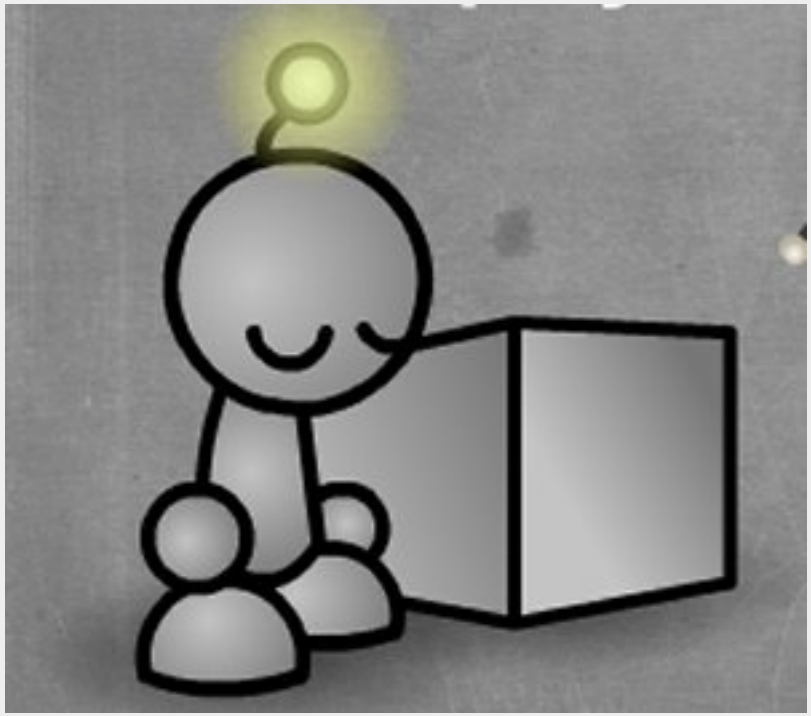
- Freedom given to players
- Length of play
- Debriefing to maximise learning
- The list is growing and shrinking

Life size RoboRally

http://www.andycollins.net/Personal/GwenCon/2005.htm

Conclusion

- Many games suitable for school use
- Limited range of topics
- Many considerations for choosing games



http://tinyurl.com/csedgames

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