Google

Google Computer Science Education Workshop

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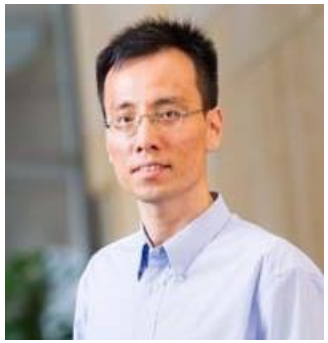


Julia Robinson Mathematics Festival

GLOBAL MATH PROJECT
Uplifting Mathematics for All

Tencent AI Lab
Make AI Everywhere

COMPUTER SCIENCE CHALLENGE 電腦科學大挑戰 2018

Gathering 4 Gardner
PRESENTS
Celebration of Mind

Why Computer Science?

Computer Science is a way of doing mathematics that could have a practical impact. R. E. Tarjan

1) Learn problem-solving skills and advanced mathematics

2) Learn math behind fun games and puzzles with applications to Computer Science

3) Algebra Game, Word Ladders, Bridg-It Game, Magic Square Maze, Artificial Intelligence

Problem-Solving Tips for Student

Do something — get hands dirty

Start Simple

Organisation

Find Patterns

Draw a picture

Facilitating Tips for Teacher

Ask Guiding Questions

Resist telling right or wrong

Ask Students to make Educated Guess

Encourage students to collaborate and help one another

See Math through the eyes of students

George Polya

George Polya, 1887-1985
The Father of Problem Solving in Mathematics Education

Guessing comes to us naturally.

Everybody tries to guess and does not have to be taught to do so.

What has to be taught is reasonable guessing, and especially to not believe your own guesses, but to test them.

And students' activity will start much better if you start them by guessing.

Let us Teach Guessing 1966

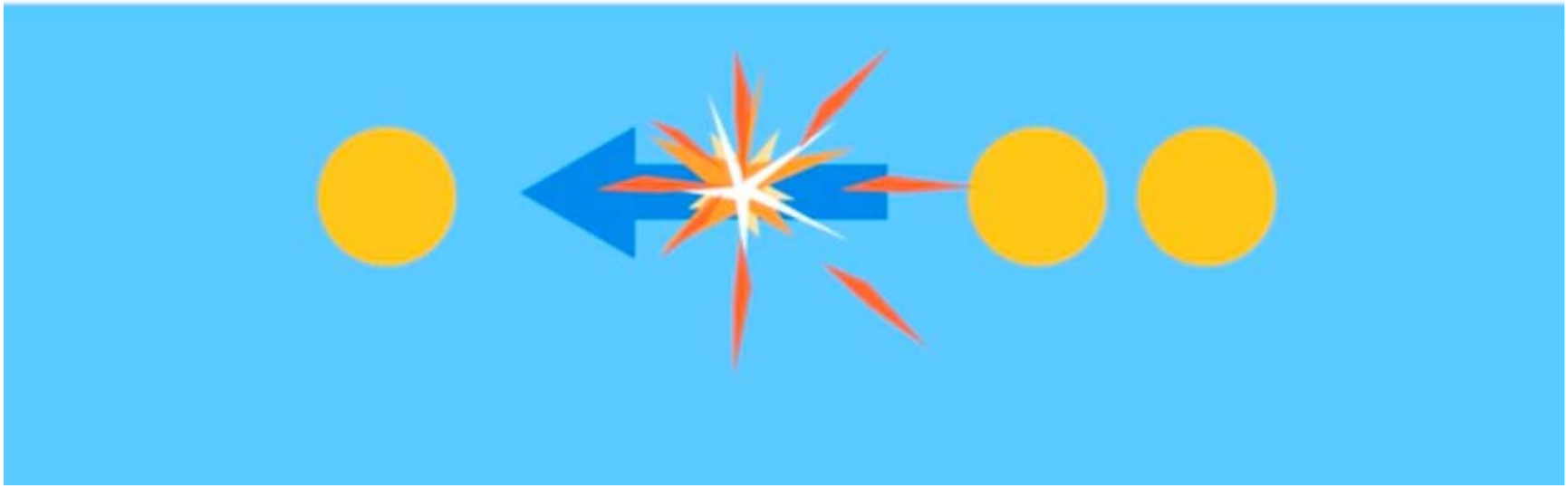
https://www.youtube.com/watch?v=h0gbw-Ur_do&list=PLEFlLBK7r-brpLfhTu2XmlEVZU92NsqRN

EXPLODING DOTS!

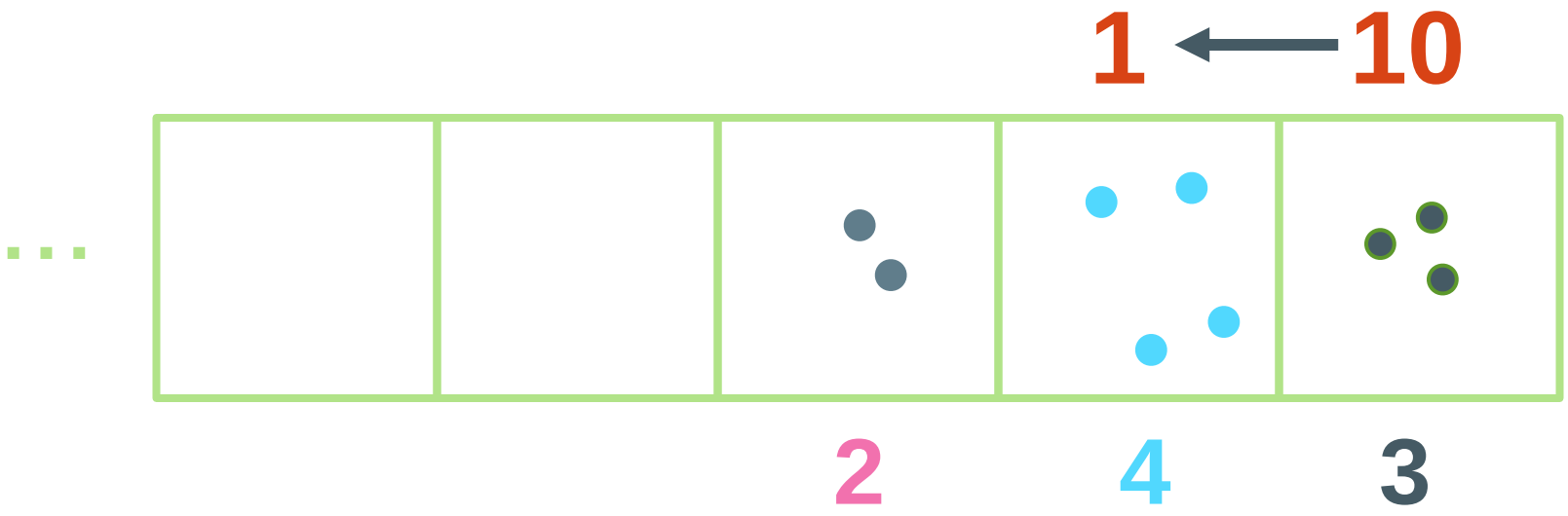
GLOBAL MATH PROJECT

Uplifting Mathematics for All

The Global Math Project



Speaking Our Language



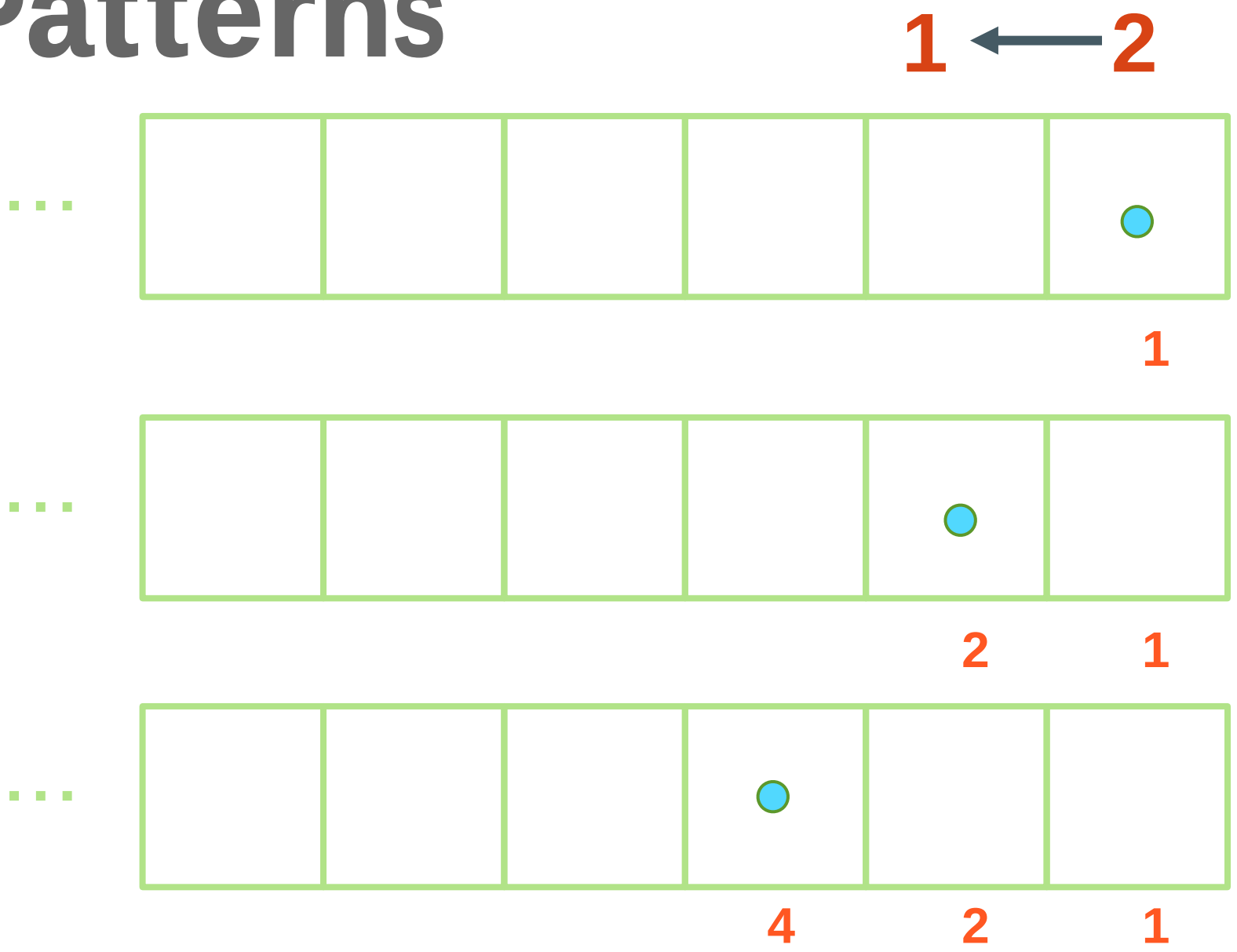
In our language, 243 means:

Two HUNDRED(S)

Forty (four TENS)

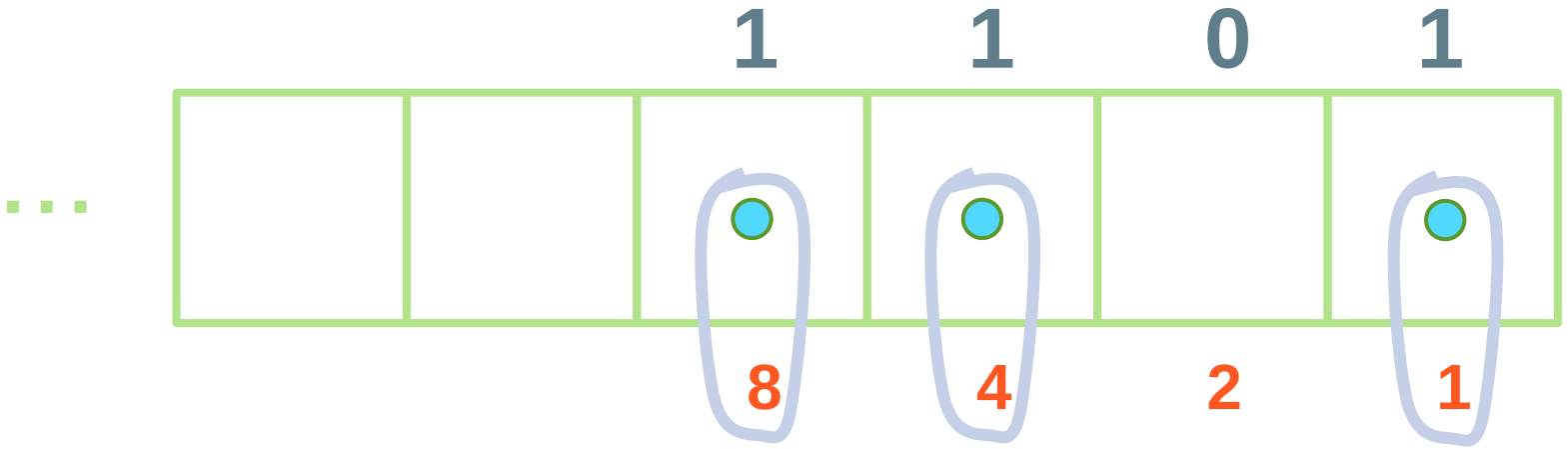
Three (ONES)

Patterns



number: machine code

1 ⟵ 2

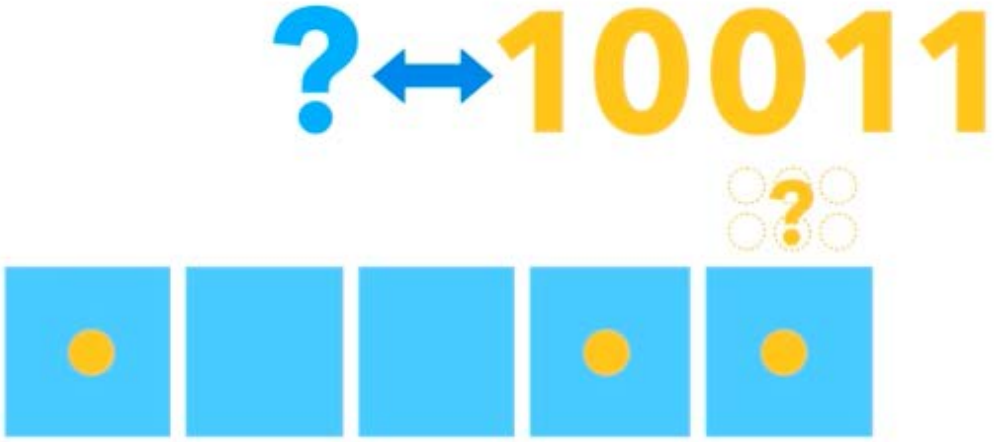


1	x	8	=	8
1	x	4	=	4
0	x	2	=	0
1	x	1	=	1

13 : 1101

13

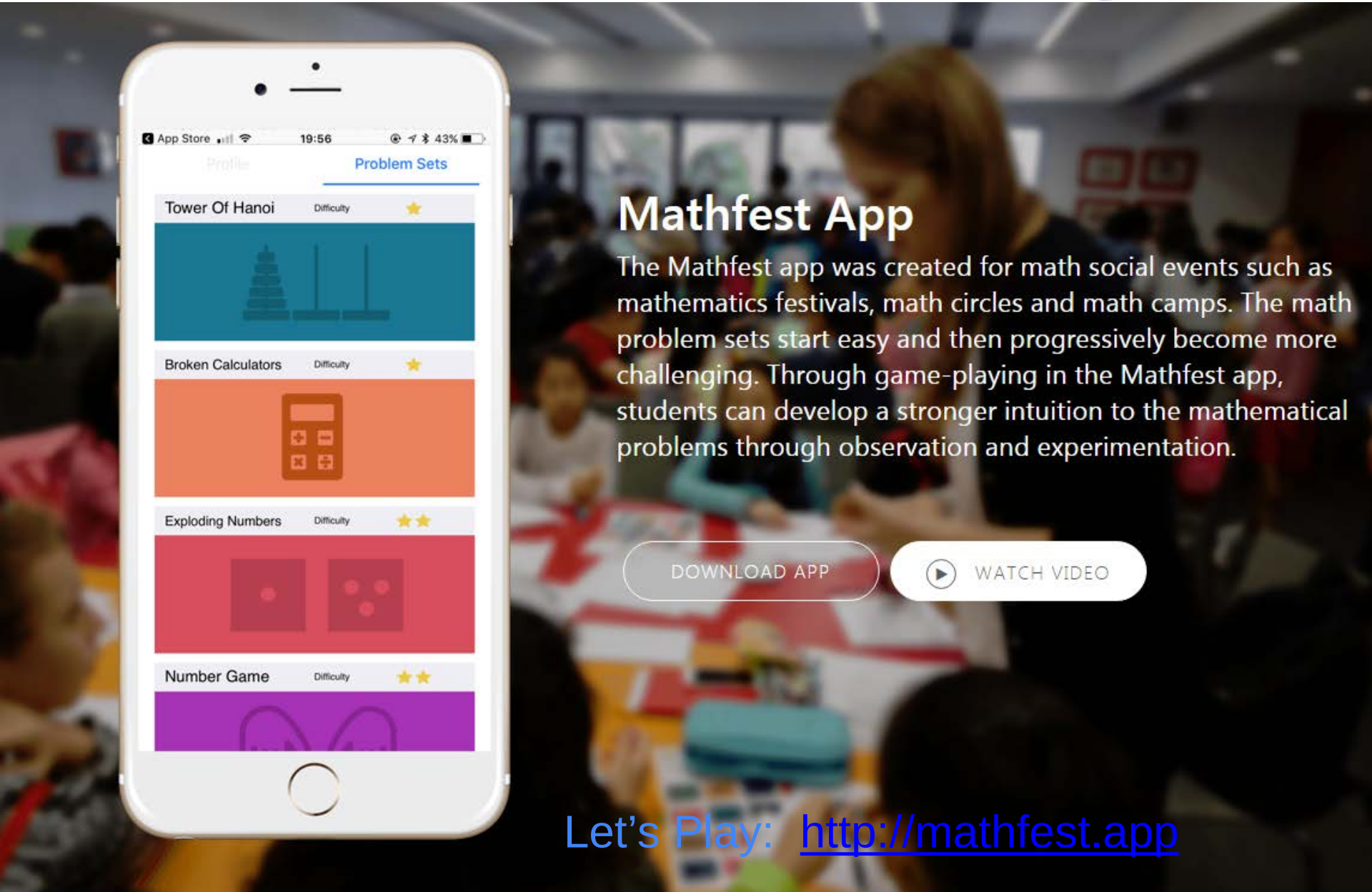
#VNPS Time!



1↔1
2↔10
5↔101
12↔1100
?↔10011

The Global Math Project

MathFest App



Let's Play: http://mathfest.app

数学嘉年华 Math Carnival App

App Store Preview

This app is only available on the App Store for iOS devices.

数学嘉年华 Math Carnival

Chee Wei Tan

Free

Let's play: https://itunes.apple.com/us/app/%E6%95%B0%E5%AD%A6%E5%98%89%E5%B9%B4%E5%8D%8E-math-carnival/id1331317067?mt=8

Games with Binary Number System

Nim

Two players take turns removing objects from distinct heaps. On each turn, a player must remove at least one object, and may remove any number of objects provided they all come from the same heap. The goal of the game is to avoid being the player who must remove the last object.

Let’s Play!!

Games with Binary Number System

The mathematics behind Nim

Patented Sept. 24, 1940 2,215,544

UNITED STATES PATENT OFFICE

2,215,544

MACHINE TO PLAY GAME OF NIM

Edward U. Condon, Edgewood, and Gereld L. Tawney and Willard A. Derr, Wilkinsburg, Pa., assignors to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

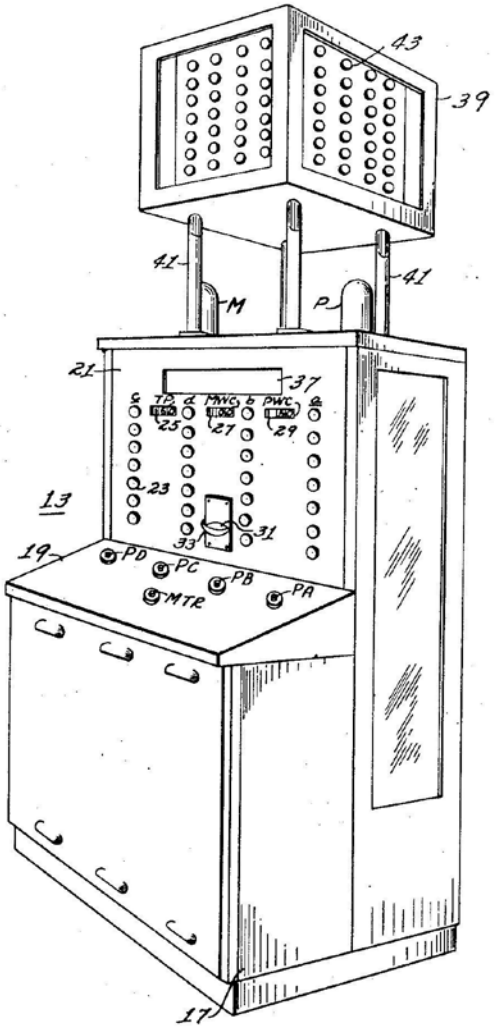
Application April 26, 1940, Serial No. 331,784

17 Claims. (Cl. 273—130)

Our invention relates to control apparatus and has particular relation to electrical apparatus for

Initially the array of sets may be analyzed as follows:

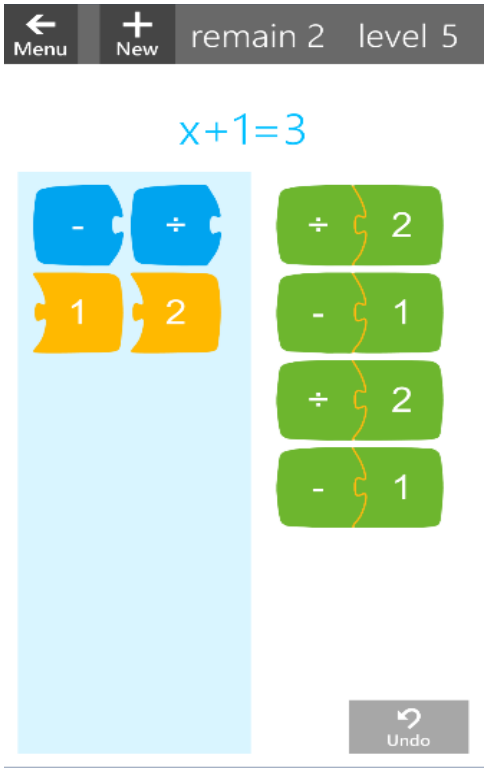
For a better understanding of Nim and the manner in which it is played, we may consider an example. Assume that originally there are three sets of like elements; 9 elements in set No. 1; 7 elements in set No. 2, and 5 elements in set No. 3. In playing the game, each player, in his turn, may remove any number of elements from set No. 1, set No. 2, or set No. 3. He may, for example, remove 6 elements from set No. 1 in making his first play and after the other player moves, he may remove any number of elements from the same or another set, say set No. 3. The player removing the last element is the winner.

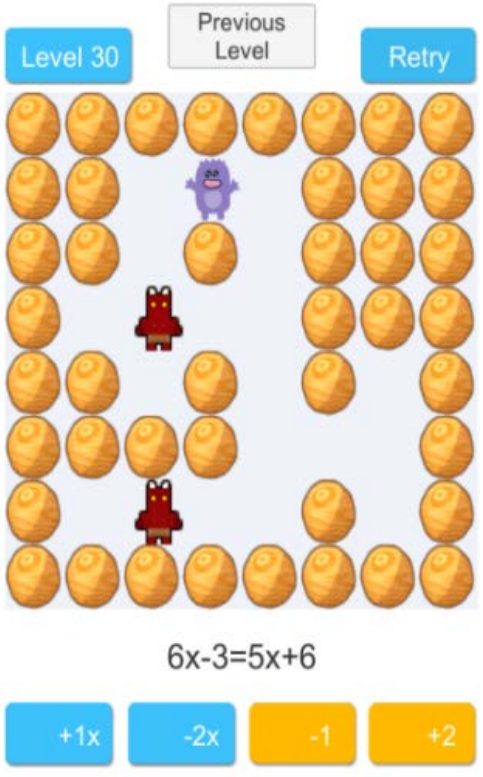


Algebra Games to Learn Mathematics

http://www.algebragamification.com

1





The set of problem-solving skills needed to solve algebra problems is somewhat similar to the set of skills needed to solve puzzle-type computer games, in which a certain limited set of moves must be applied in a certain order to achieve a desired result. - **Terence Tao** (2012)

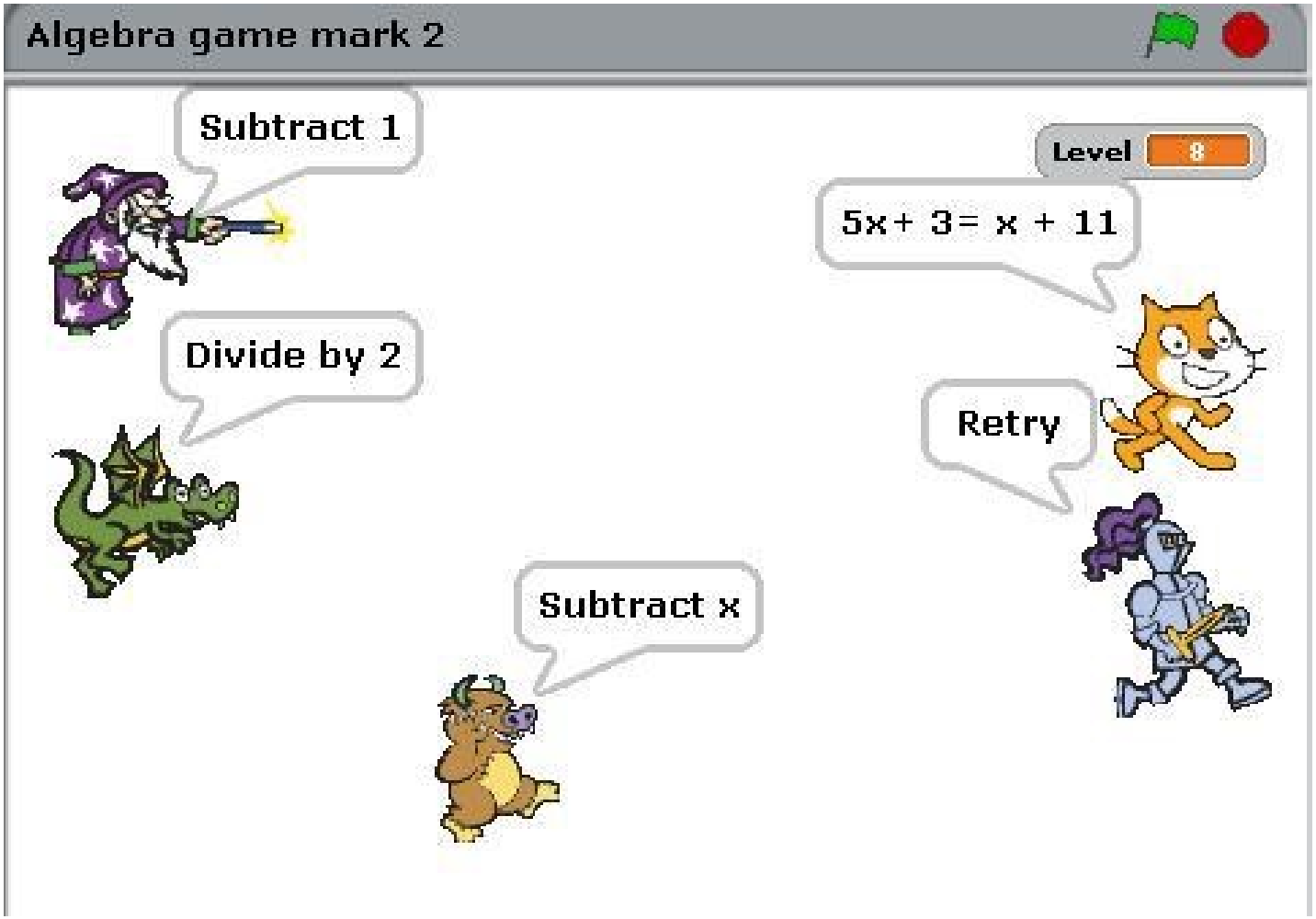
Terence Tao

Professor of Mathematics at University of California Los Angeles Field Medalist

"Mozart of Math"

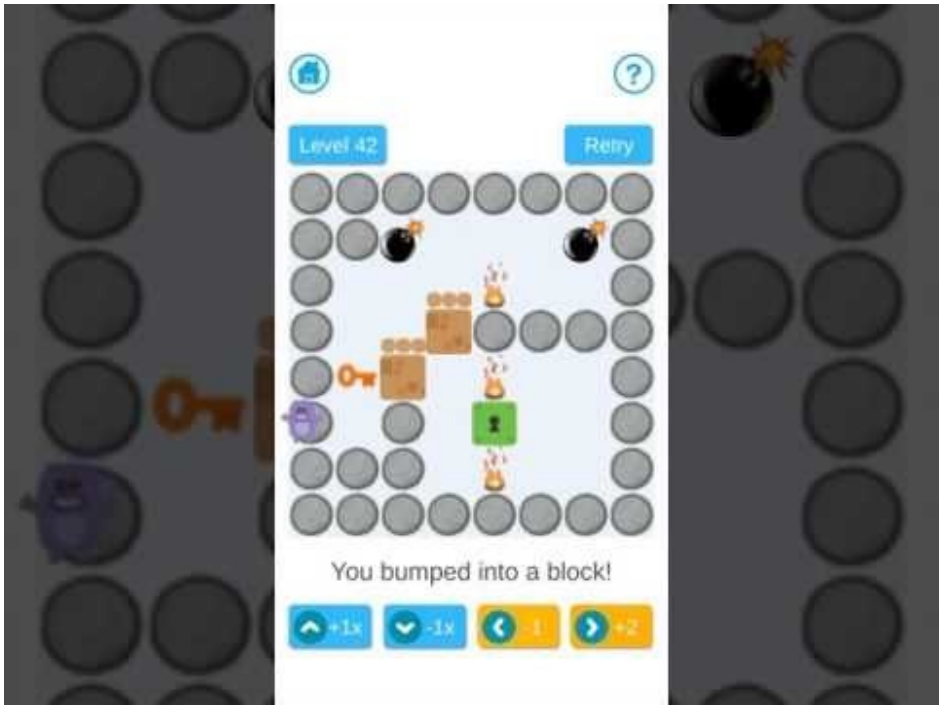
10yr old Tao with Paul Erdős in 1985

Algebra Game



https://scratch.mit.edu/projects/2477436

Online Tutorials of Algebra Games



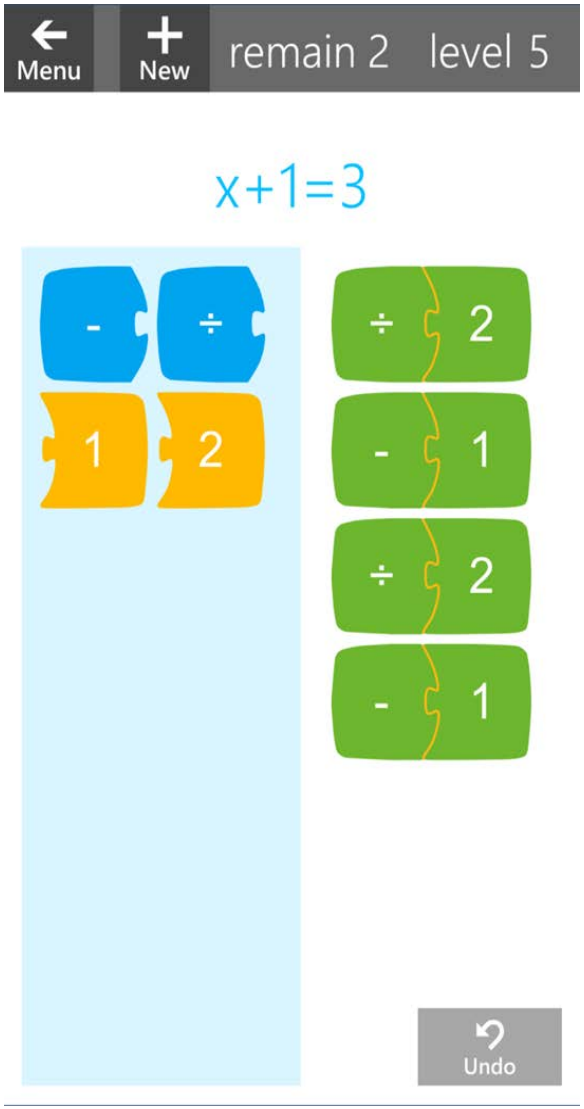
Get it on Google play

Available on the App Store

Get it on Google play

Available on the App Store

Example

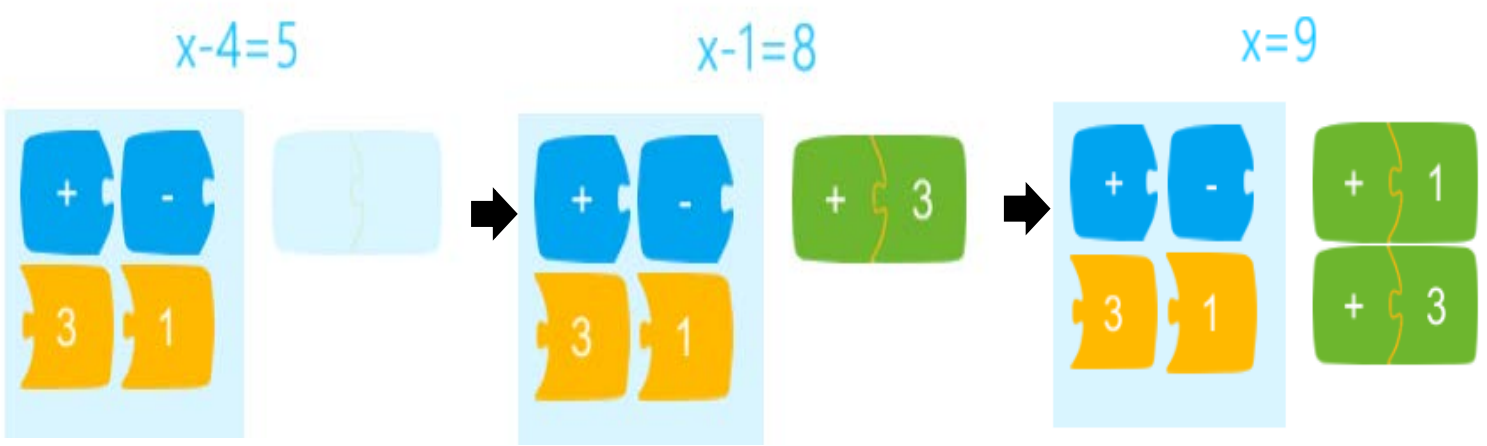


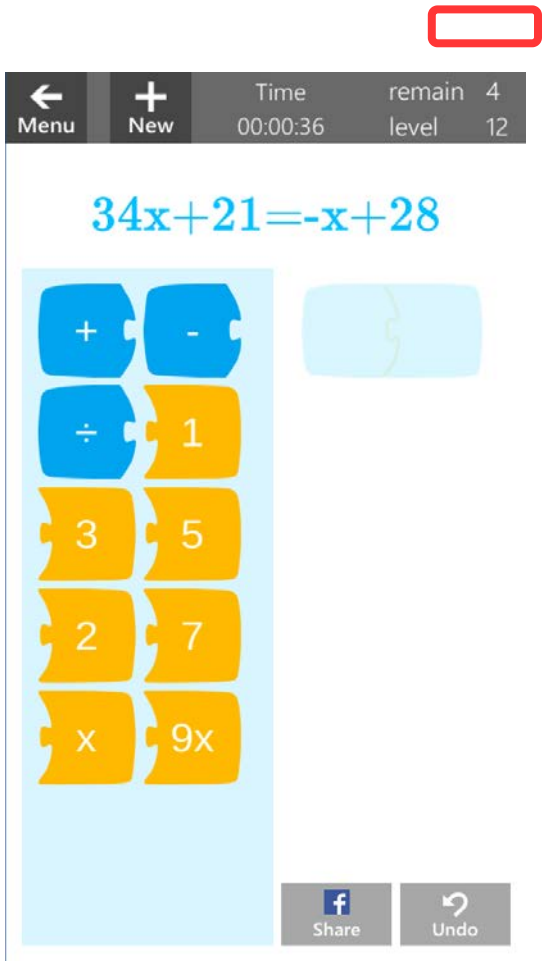
Only 2 simple steps:

1. Pair the operator clue and number clue by drag and drop to change the equation step by step.
2. Complete the level when the puzzle state is "**x = solution_value**" and the remaining number of moves allowed is zero or more (indicated by **remain**).

Algebra Game

$$x - 4 = 5 \xrightarrow{\{+, -, 1, 3\}} x = 9$$

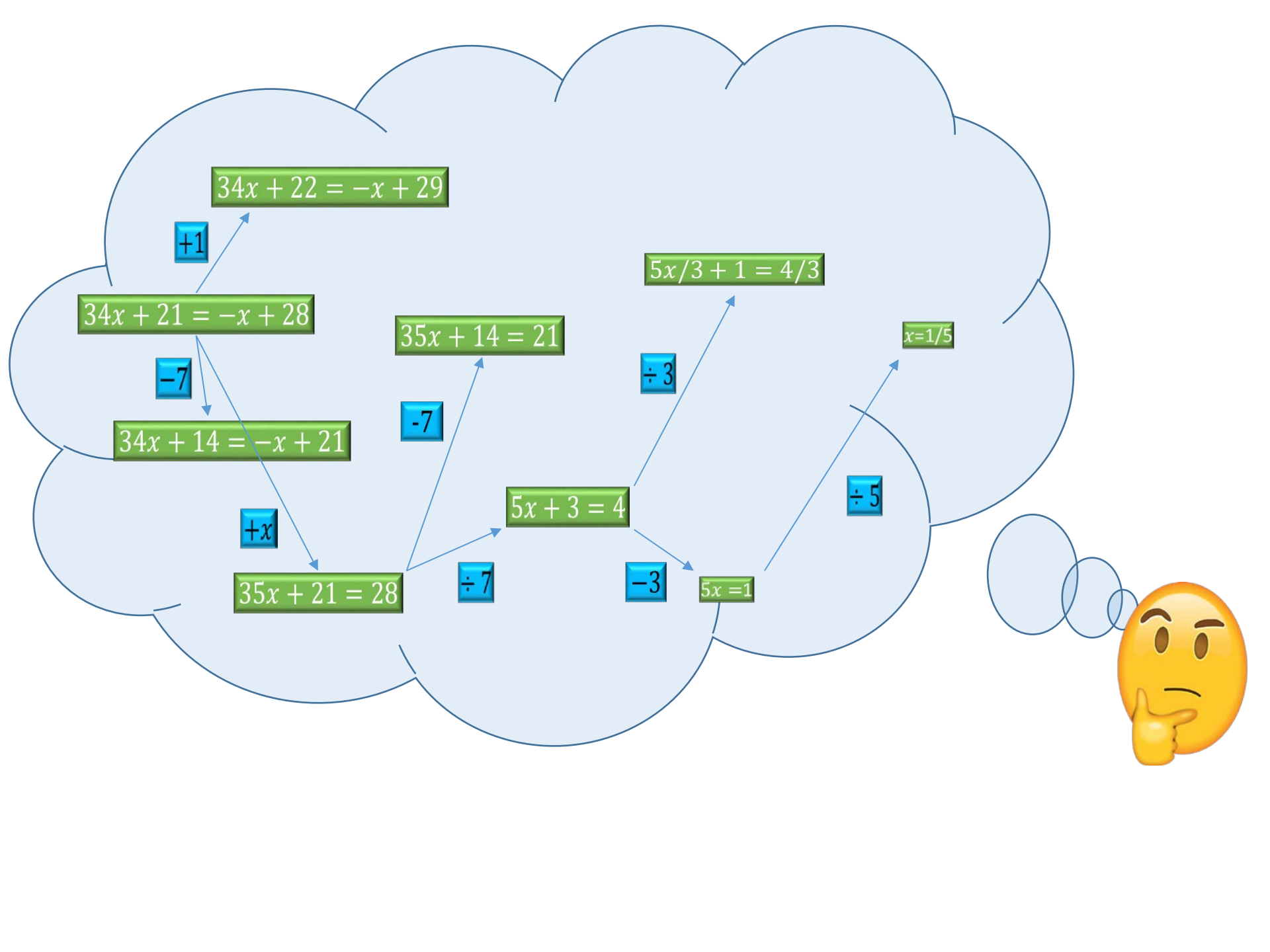




Suppose we don't allow multiplication and division by x-terms.

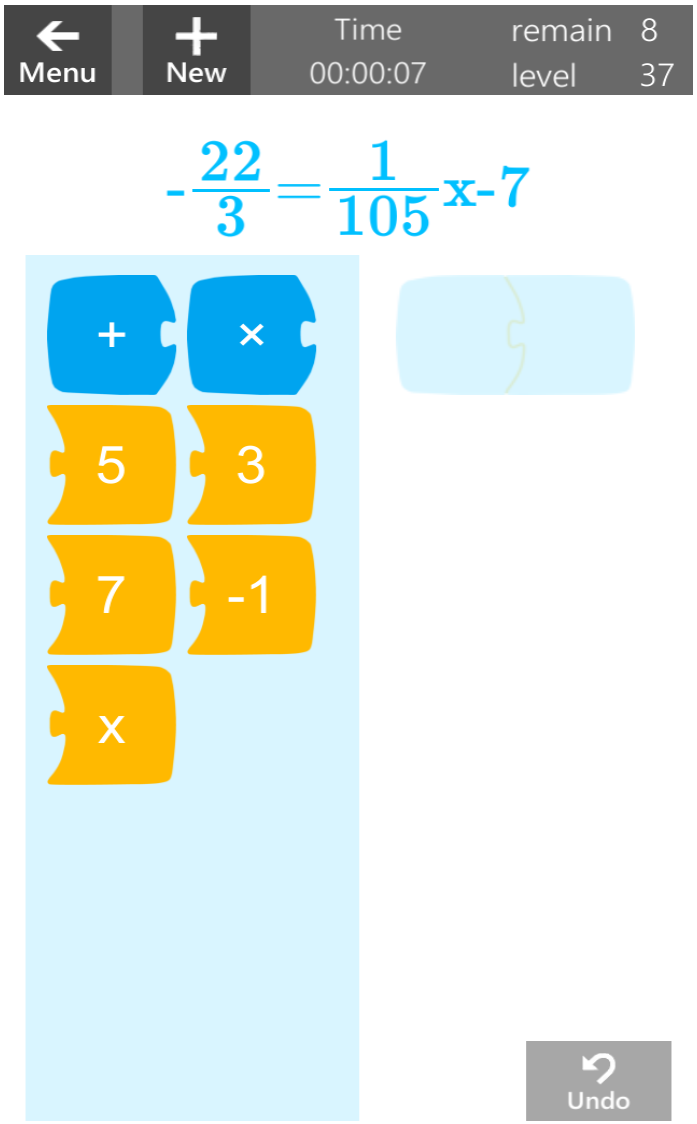
Then, there are 130,321 combinations of given operators !

What's your strategy to reach the required equation $x = \frac{1}{5}$ in four moves?


34x + 22 = −x + 29
+1
34x + 21 = −x + 28
−7
34x + 14 = −x + 21
+x
35x + 21 = 28
-7
35x + 14 = 21
÷ 7
5x + 3 = 4
÷ 3
5x/3 + 1 = 4/3
−3
5x =1
÷ 5
x=1/5

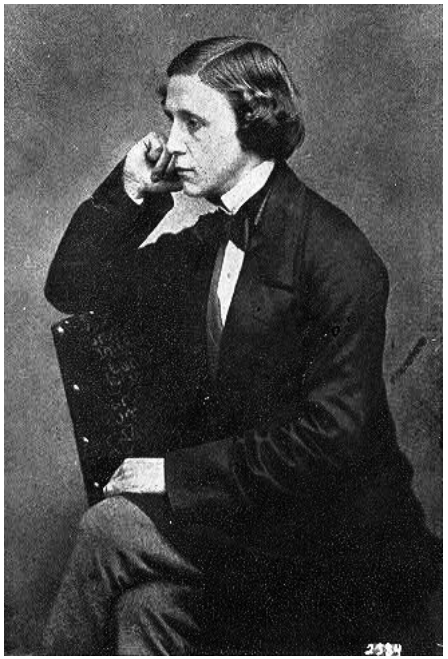
Mental Exercise !

Can you reach the required equation $x = -35$ in seven moves?



Word Ladder Game

A word ladder puzzle begins with two words, and to solve the puzzle one must find a chain of other words to link the two, in which two adjacent words (that is, words in successive steps) differ by one letter. Lewis Carroll invented the game on Christmas day in 1877



Word Ladder Game

From HEAD to TAIL:
H E A D → H E A L → T E A L → T E L L → T A L L → T A I L

Five moves needed. Can you come up with less than five moves? How many possible solutions? The objective of the game is to find a path with the least number of moves

Turn APE to MAN

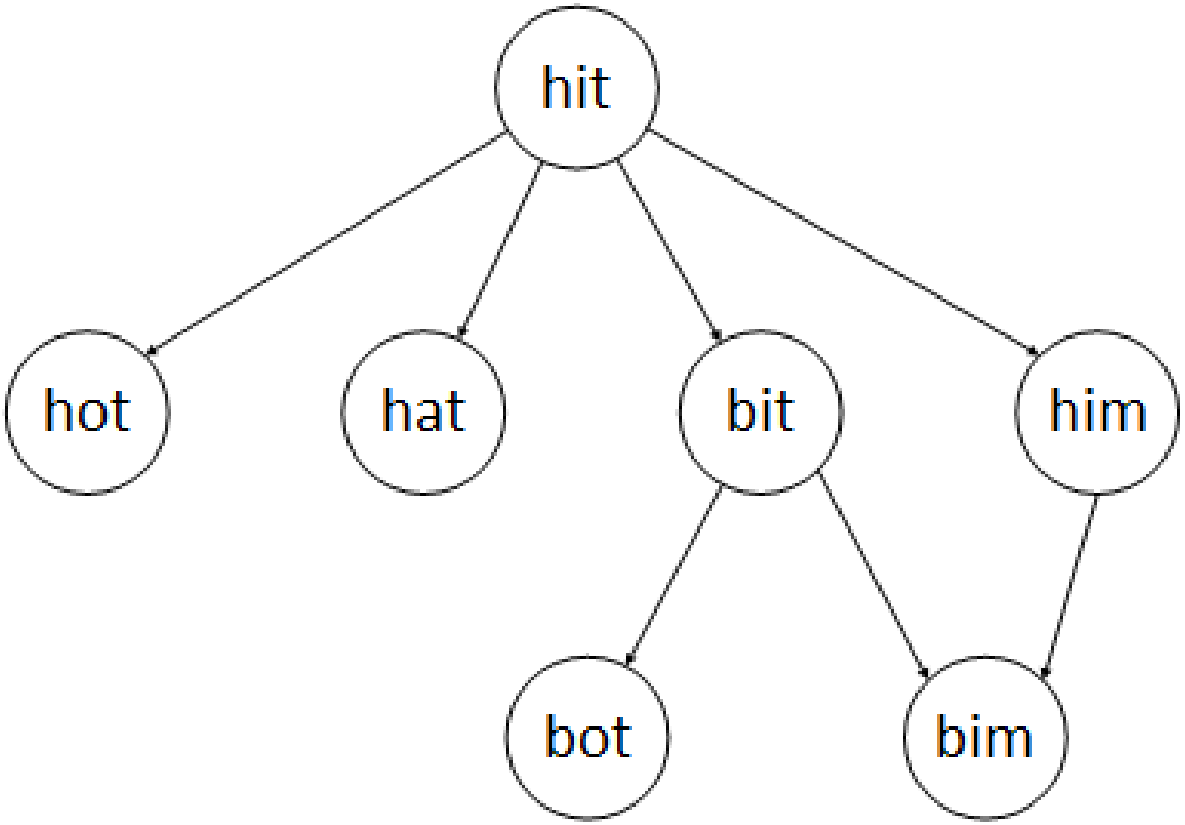
Word Ladder Challenge

Driving HORSE into FIELD

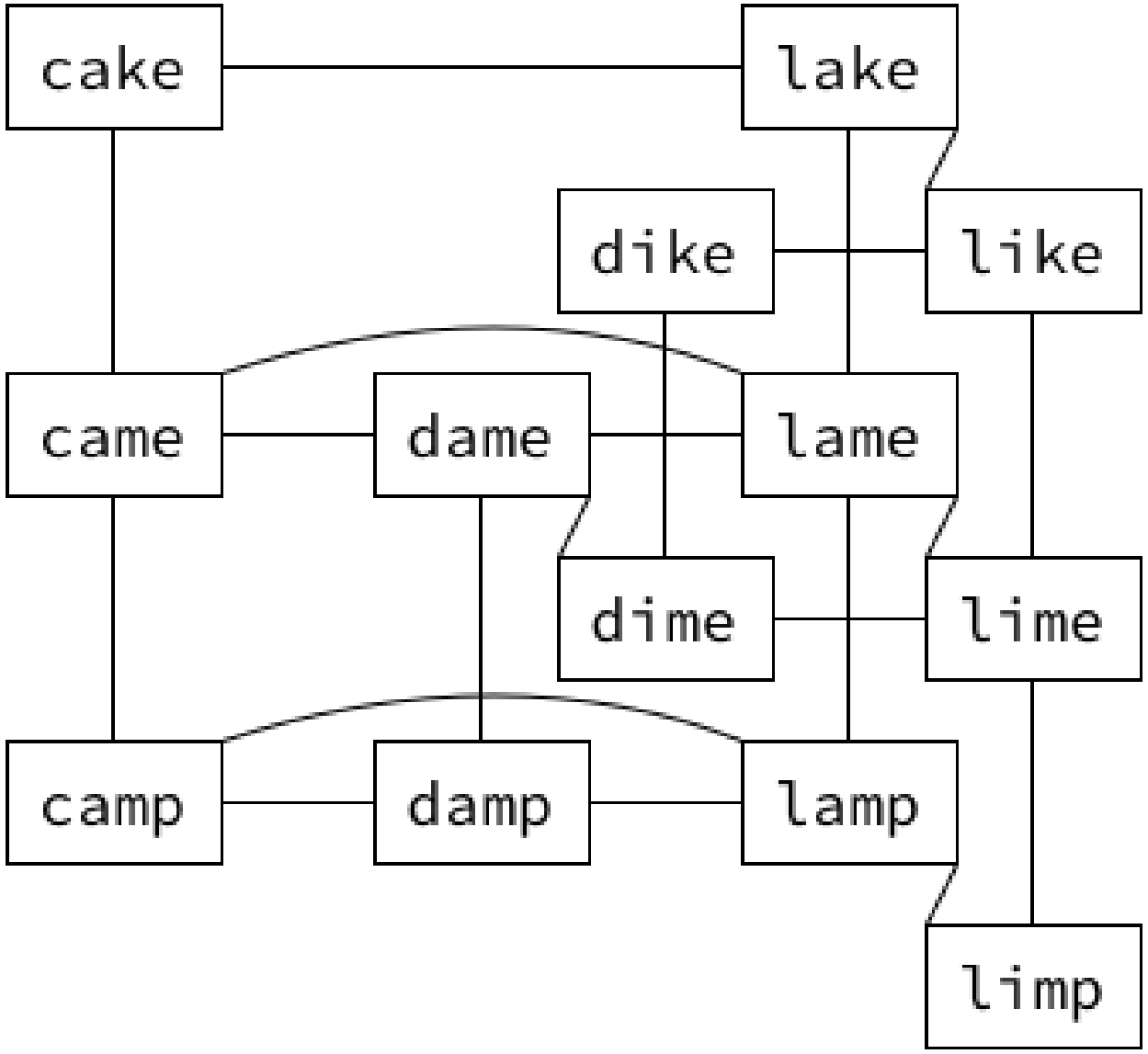
In Lewis Carroll's day, the problem remained unsolved. In last few years, this must have been accomplished using some modern words unknown in Victorian times. Can you solve it?

Graphs of Word Ladder Game

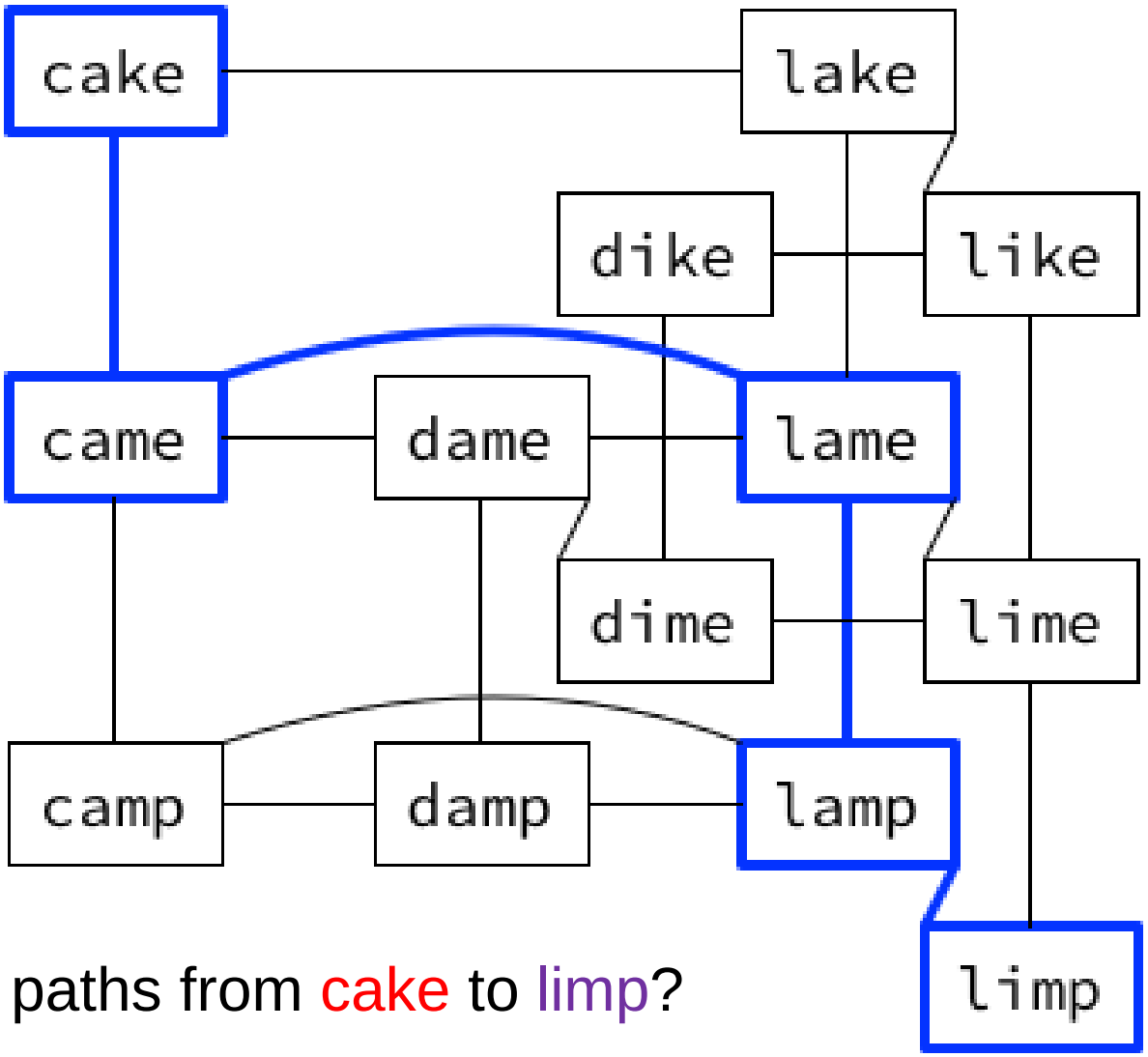
A graph is an important mathematical object:
Graph vertex or node: model a state of a game
Graph edge: model transition or relationship



Graphs of Word Ladder Game

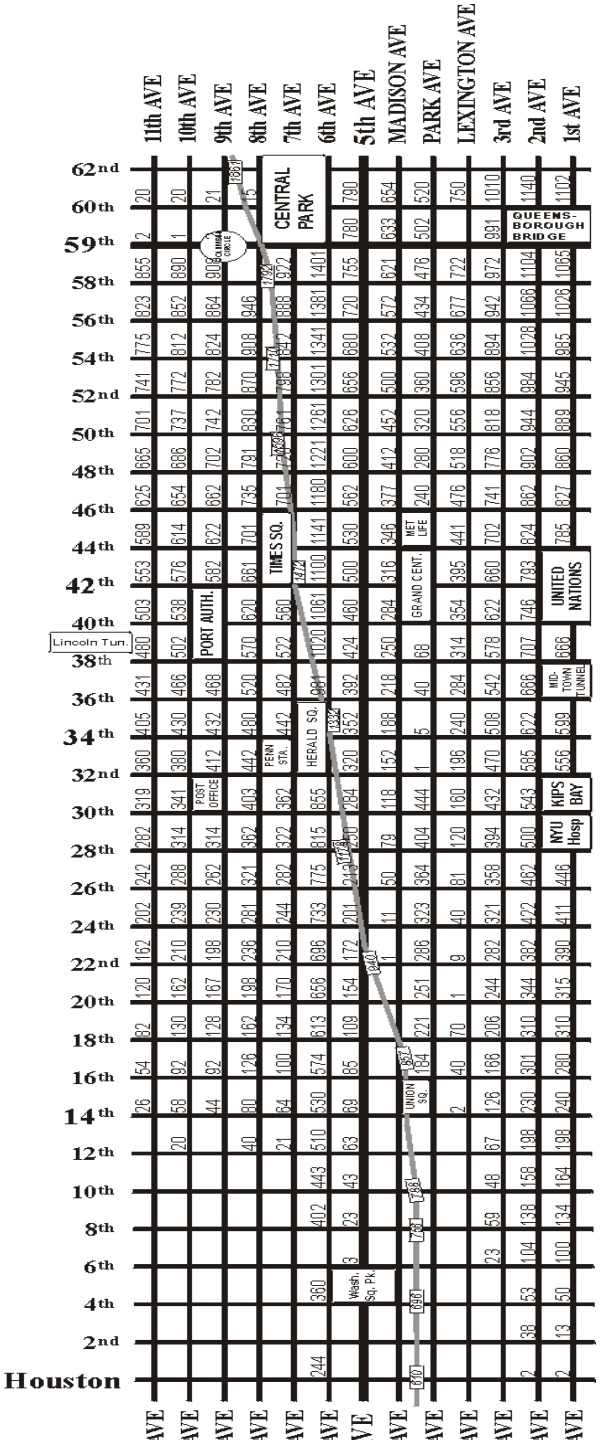


Graphs of Word Ladder Game

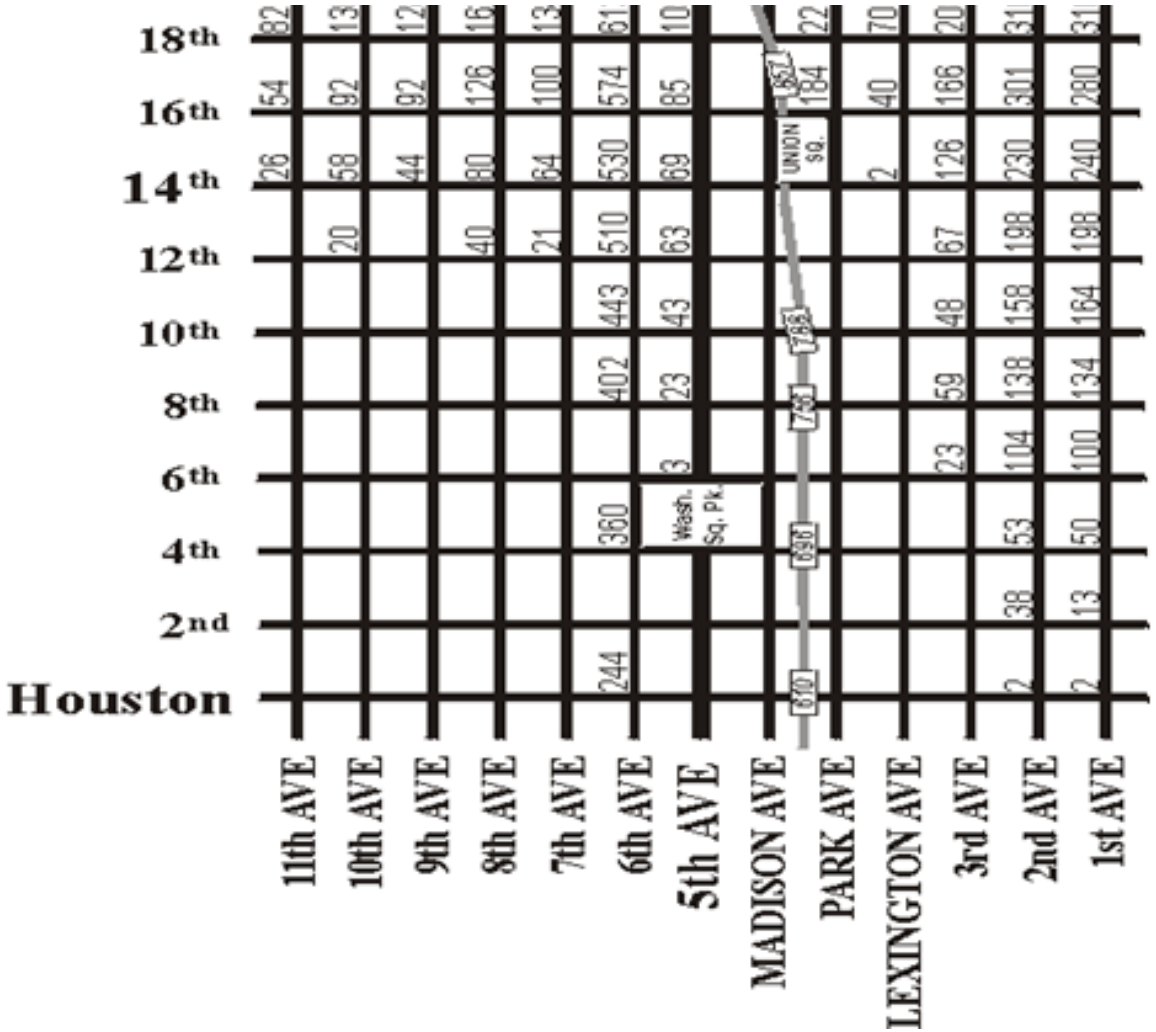


How many paths from cake to limp?

Graphs and Counting



Graphs and Counting



How many paths from Houston to Union Square (Madison Ave – 14th Street)?

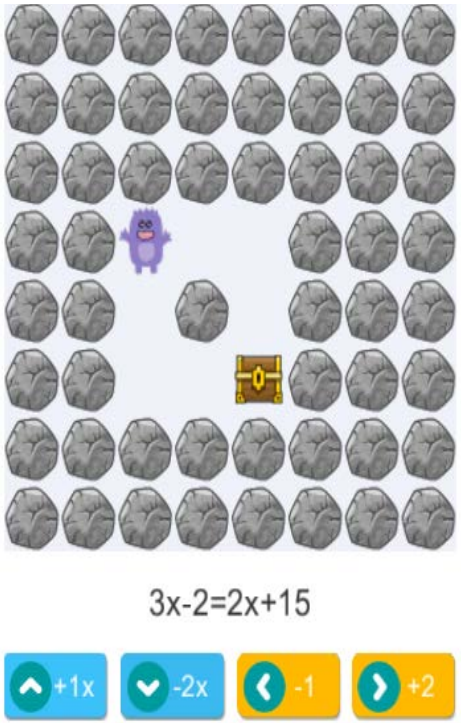
Start easy

How many paths from Houston to 10th Ave- 2nd Street?

Then progress on

How many paths from Houston to 9th Ave- 4th Street?

Algebra Maze

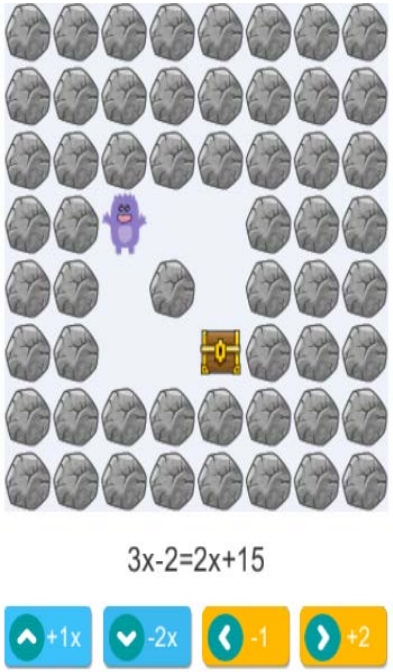



:Rick

Goal: Help Rick to find the treasure.

Once the equation is in the desired form "x =**some numerical value**", Rick will get the treasure.

From Algebra-solving to Maze-solving

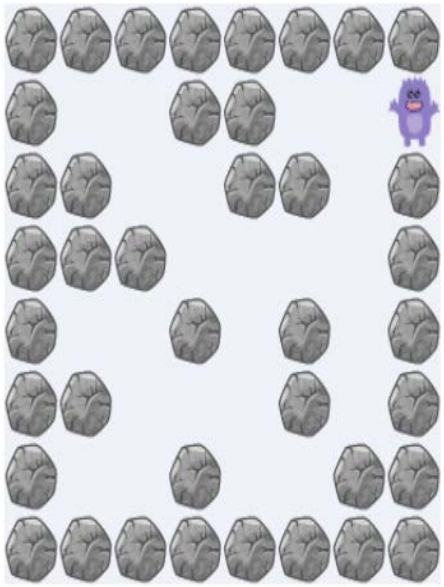


+2: Move rightward two cells, and the equation add 2 on both sides.

-1: Move leftward one cell, and the equation minus 1 on both sides.

+1x: Move upward one cell, and the equation add 1x on both sides.

-2x: Move downward two cells, and the equation minus 2x on both sides.

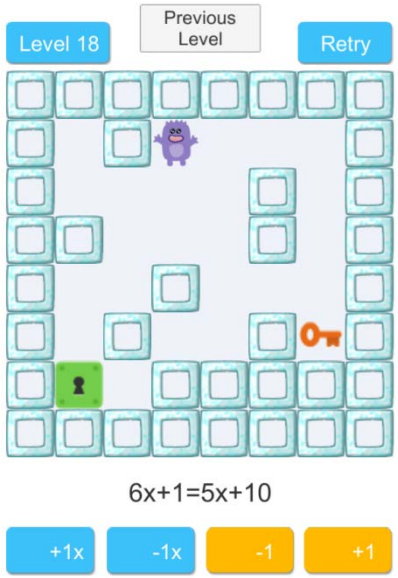


$4x+6=3x+24$

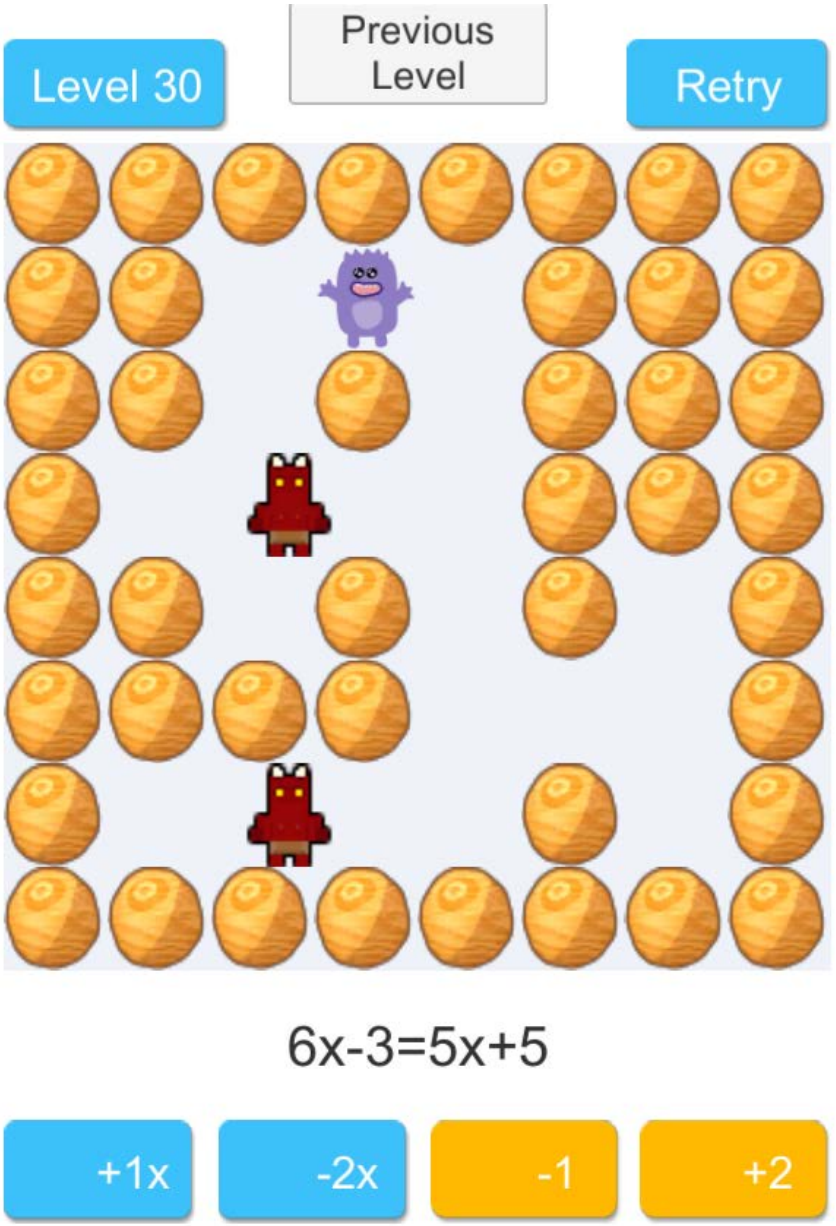
+1x -3x -1 +3

Where is the hidden treasure chest?

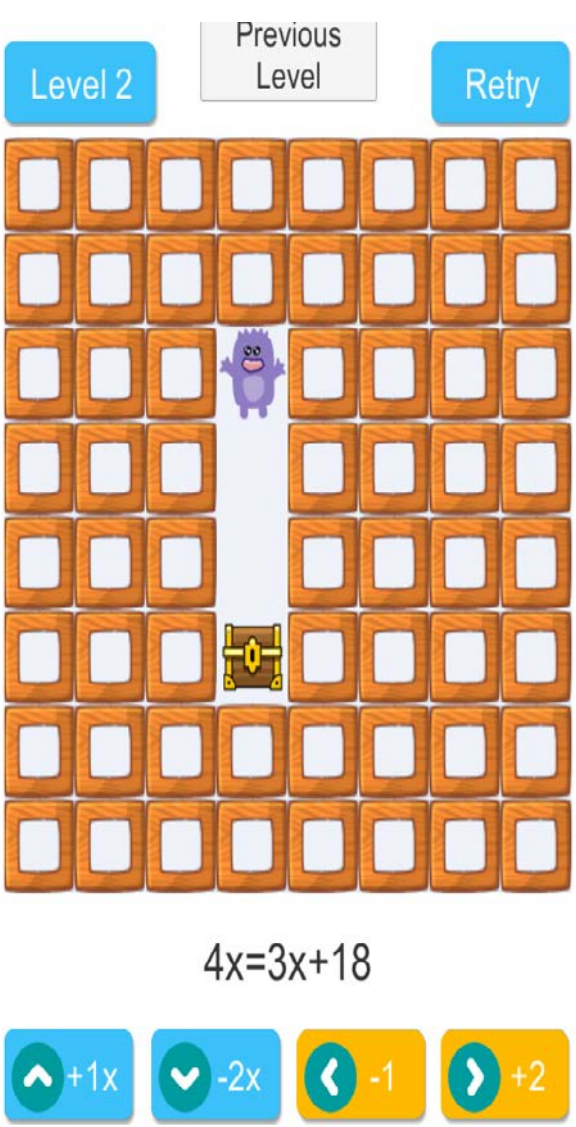
Personalized Learning Algebra

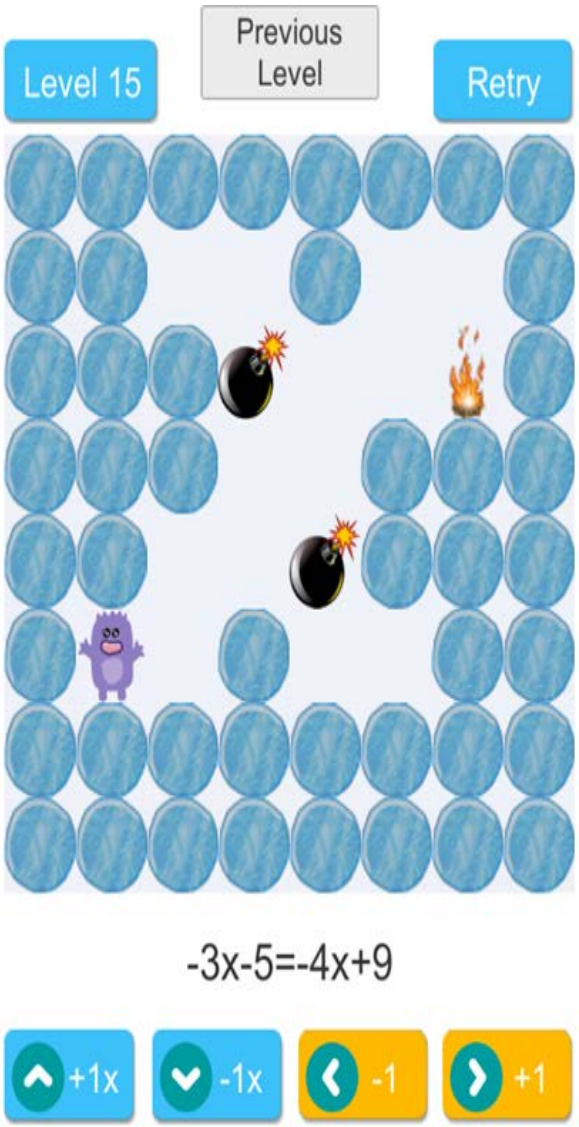


Gamify to guide learning
Seed the idea: math=fun



Maze version to resolve Algebra equations

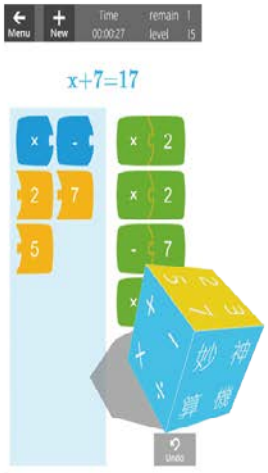




Computer Science Challenge 2016, 2017, 2018 (eSport for STEM)

COMPUTER SCIENCE CHALLENGE 電腦科學大挑戰 2018

CityU
香港城市大學
City University of Hong Kong



Computer Science Challenge 2016-2018 (https://cschallenge.cs.cityu.edu.hk)

Artificial Intelligence in Game

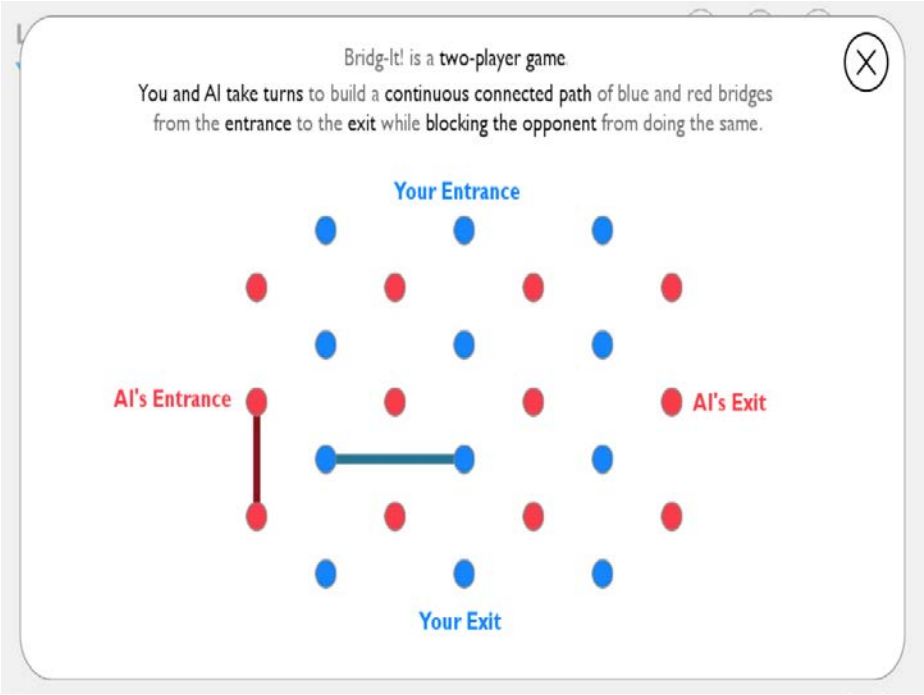
Play against Artificial Intelligence (AI) to place a connected path of bridges from one side of the board to the opposite side while blocking the opponent from doing the same. A strategic game that is easy to play for all ages!

Independently invented in the 1950-60s by the mathematician David Gale, thus known as the Game of Gale, the mathematician John Nash and also the mathematician Claude Shannon, when it was known as the Shannon Switching Game. The game has a deep mathematical root in graph theory and is challenging for users of all age groups.

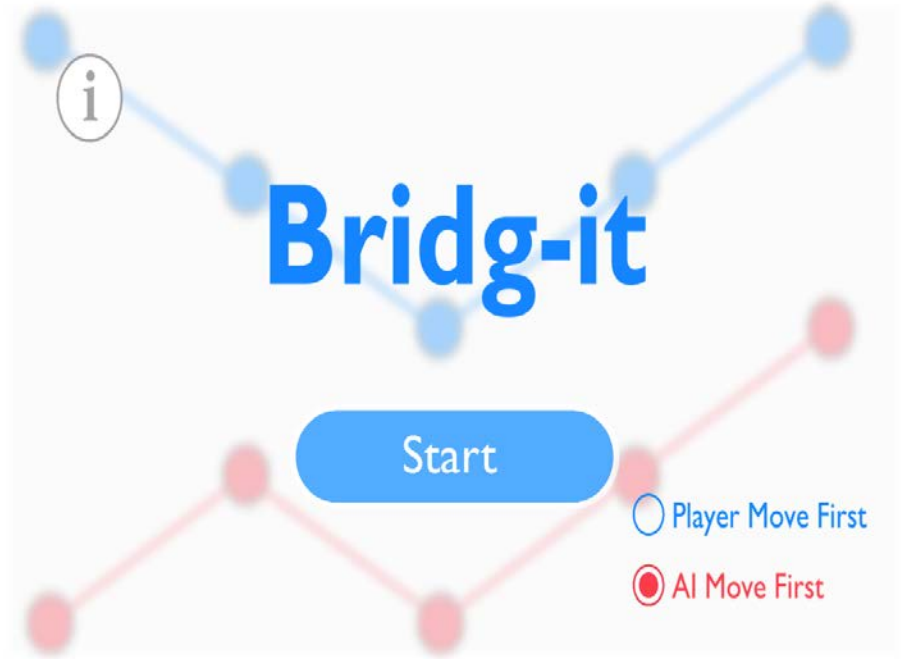
Bridg-It Game

You and AI take turns to build a continuous connected path of blue and red bridges from the entrance to the exit while blocking the opponent from doing the same.

Screen 1: Introduction



Screen 2: Menu – Select either AI or Player moves first



Follow Ups

1) Mini-Computer Science Challenge in 2019 at your school

http://cschallenge.cs.cityu.edu.hk

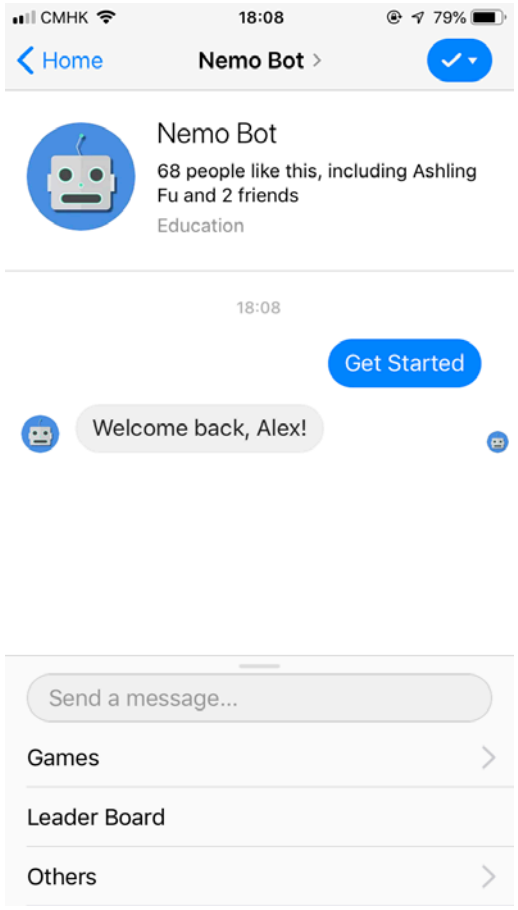
2) Workshops or seminars on Computer Science, mathematics and games, Artificial Intelligence (AI) at your school

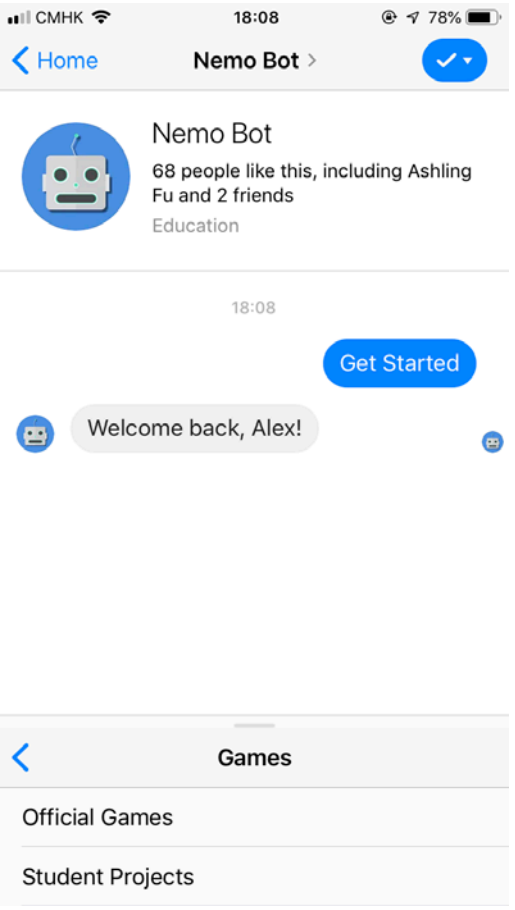
Dr. TAN, Chee Wei
Email: cheewtan@cityu.edu.hk

Google Computer Science Education Workshop 2018

Basic JavaScript & AI Chatbot Programming

Play with the Nemo Bot!





Select Games -> Official Games -> Fish-Flavored Lollipop

Can you beat Nemo in this game?

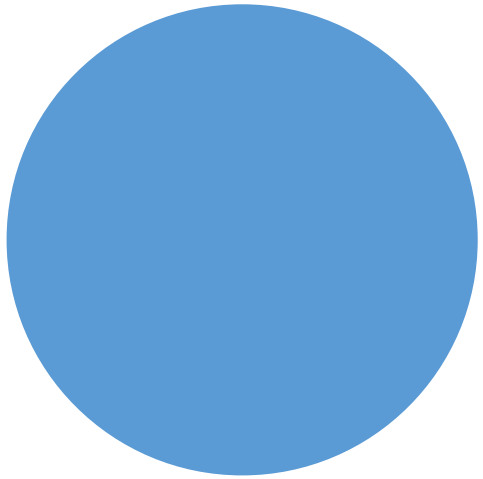
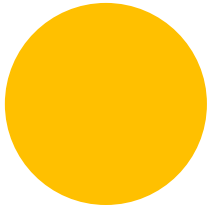
- Fish-Flavored Lollipop 🍥 is a variant of Nim, an ancient mathematic game.

- In this game, two players take turns to pick 1, 2 or 3 lollipops from a row of N lollipops. The one who take the last one (the fish-flavored one!) lose the game.

How would you program a chatbot like this?

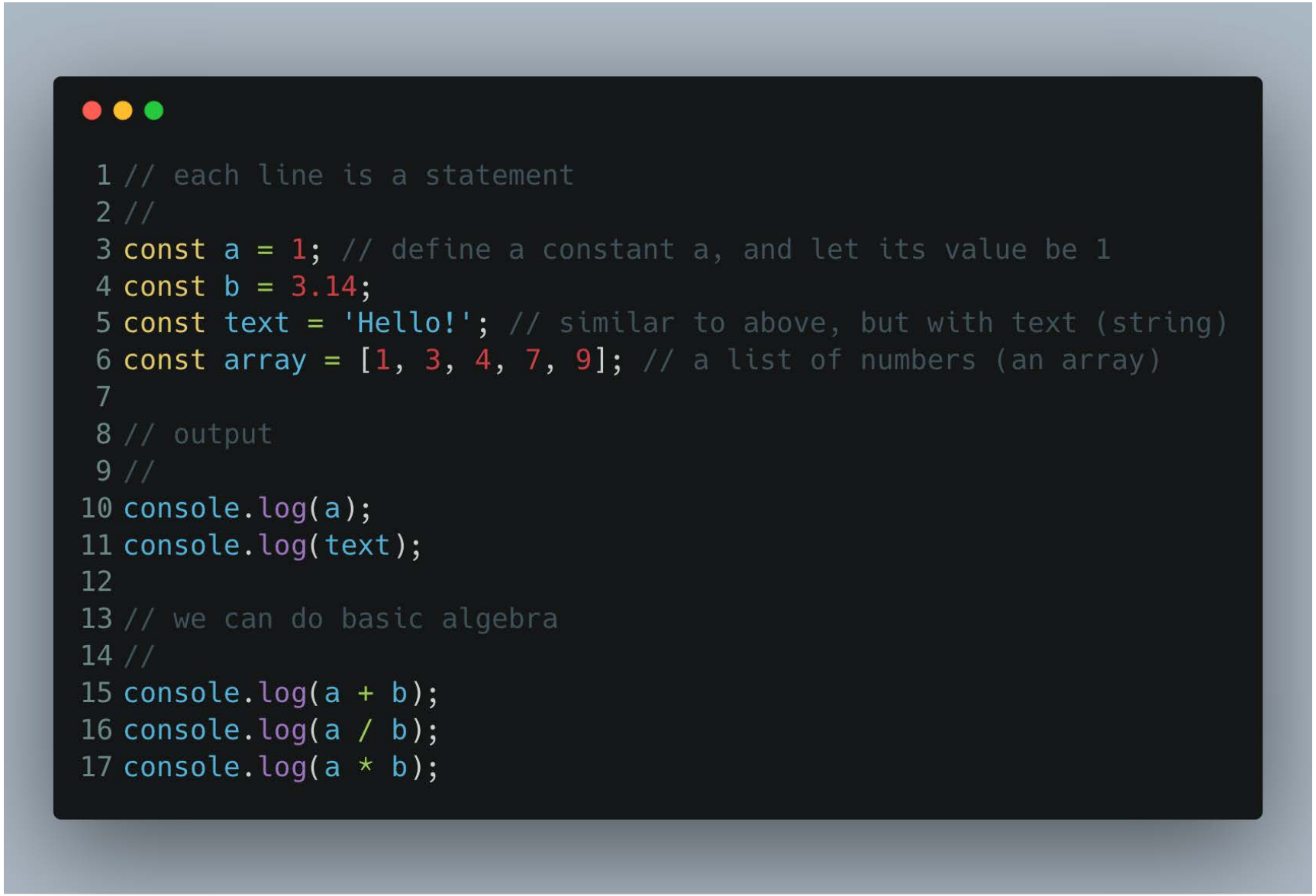
- The Fish-Flavored Lollipop takes less than 80 lines of code!

- It's so simple that even your students without programming background can understand and do it with some training!

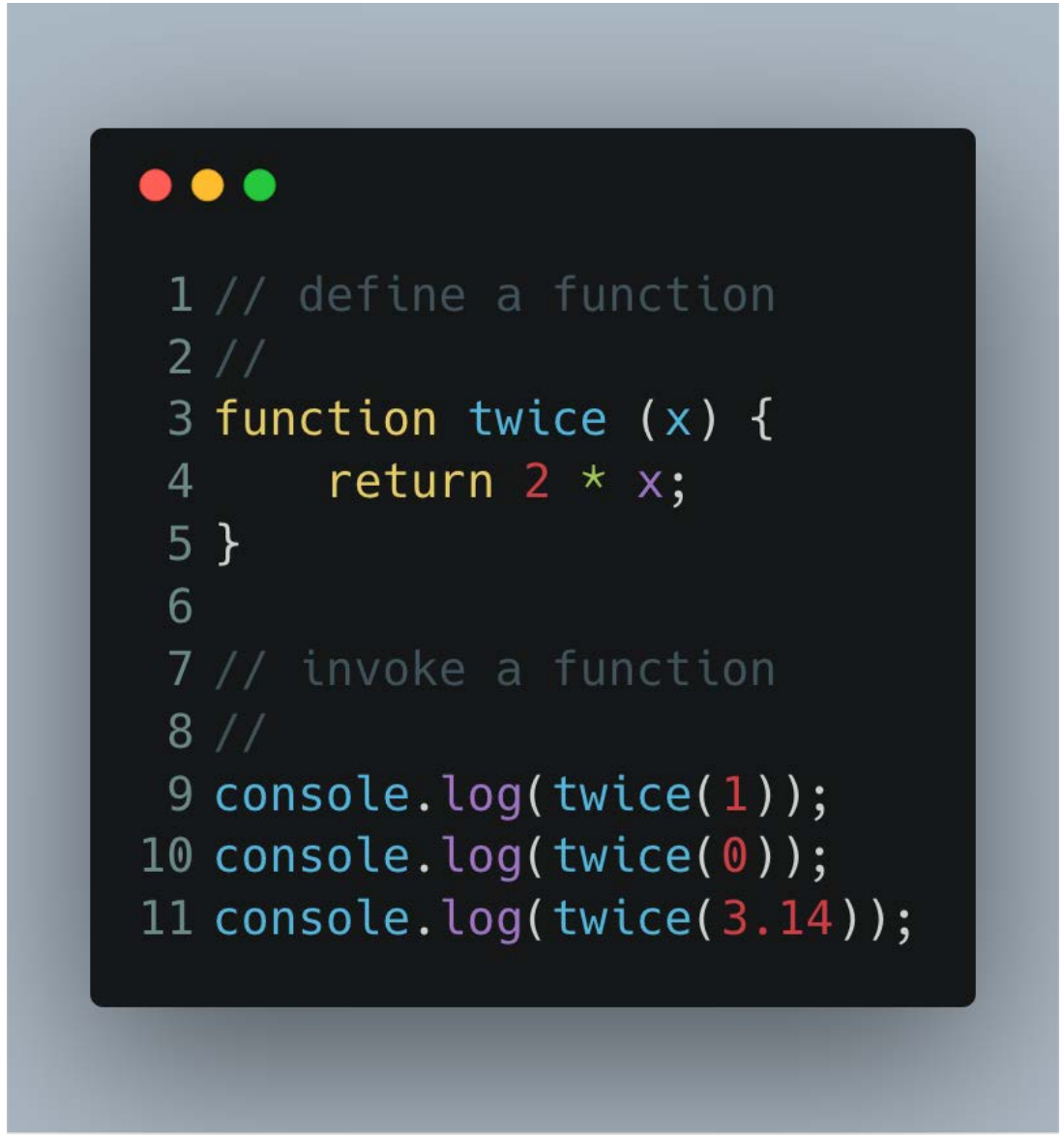



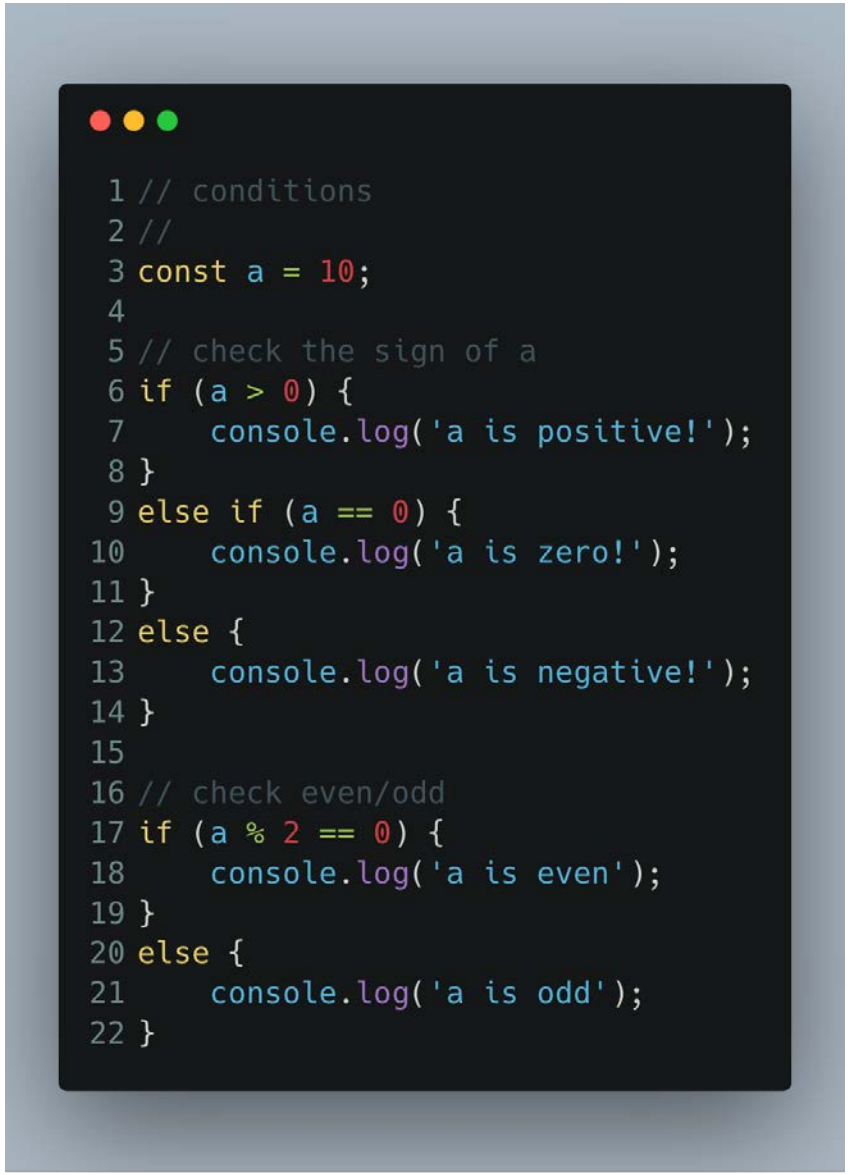
Let’s Learn Some JavaScript

Don’t worry, it’s very simple



```
// each line is a statement
//
const a = 1; // define a constant a, and let its value be 1
const b = 3.14;
const text = 'Hello!'; // similar to above, but with text (string)
const array = [1, 3, 4, 7, 9]; // a list of numbers (an array)

// output
//
console.log(a);
console.log(text);

// we can do basic algebra
//
console.log(a + b);
console.log(a / b);
console.log(a * b);
```


// define a function
//
function twice (x) {
return 2 * x;
}
// invoke a function
//
console.log(twice(1));
console.log(twice(0));
console.log(twice(3.14));



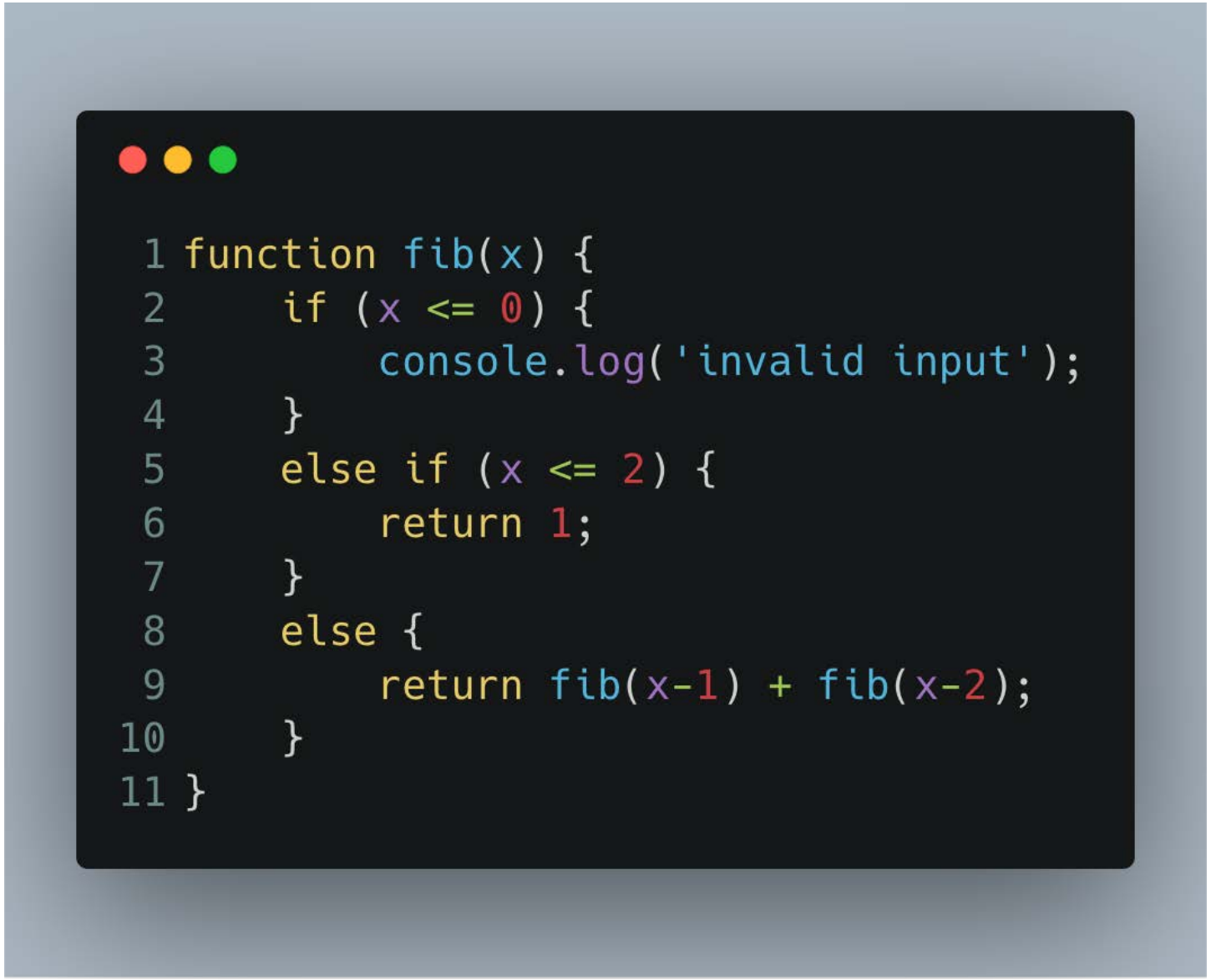
```
// conditions
//
const a = 10;

// check the sign of a
if (a > 0) {
    console.log('a is positive!');
}
else if (a == 0) {
    console.log('a is zero!');
}
else {
    console.log('a is negative!');
}

// check even/odd
if (a % 2 == 0) {
    console.log('a is even');
}
else {
    console.log('a is odd');
}
```


And that’s pretty much all you need to know about JavaScript!

Quick Exercise

- How would you define a function that takes an input x (x > 0) and outputs the x-th Fibonacci number?

- i.e., a function f(x), such that
- f(1) = 1, f(2) = 1, f(3) = 2, f(4) = 3, f(5) = 5 …


function fib(x) {
if (x <= 0) {
console.log('invalid input');
}
else if (x <= 2) {
return 1;
}
else {
return fib(x-1) + fib(x-2);
}
}

Let’s apply what we just learned to program a chatbot!

Hello World in Nemo

Google AIY is coming to Hong Kong!

Made by you with Google

What is AIY?

A portfolio of hardware components, software tools and kit-based projects that showcase on-device artificial intelligence

Designed for professionals, makers, educators, and students using low-cost and generally available materials

AIY encourages the use of natural human interaction, such as voice, vision and motion

Voice Kit

Hardware

- Raspberry Pi Zero WWH (included)
- VoiceBonnet
  - Dual mics built in
  - Codec for audio in/out
  - MCU for PWM and servo control
  - GPIO Breakout
  - Crypto chip for secure cloud
- 24mm RGB arcade button
- Cardboard form

Software - Voice Recognition

- Raspbian Linux
- Google Assistant API (cloud service)
- Cloud Speech API (cloud service)

works with the Google Assistant

Vision Kit

Hardware

- Raspberry Pi Zero WWH (included)
- Raspberry Pi Cam 2 (included)
- VisionBonnet
  - Intel/ Movidius MA2450 ML accelerate chip
  - 2 x Camera Support
  - FPC to Raspberry Pi ZW
  - GPIO Breakout
  - MCU for PWM and servo control
  - Crypto chip for secure cloud
- 24mm RGB arcade button
- Cardboard form

Software - Image Recognition

- Raspbian Linux
- TensorFlow Inception/MobileNet (on device)
- Facial detection and expressions (on device)
- General object recognition (on device)

AIY In Action with Students

https://www.youtube.com/watch?v=X93Xn1YfY7k

- Watch what these students in Seattle, USA did with AIY in a matter of just a few days, and imagine what your students can accomplish with AIY kits!

AIY is coming to Hong Kong!

- AIY Voice Kit and Vision Kit retail starts in Hong Kong soon (late Q4 2018 - early Q1 2019)
- Enabling you to build Google Assistant voice controlled apps, and TensorFlow based ML for AI vision recognition apps
- Great opportunity for you to integrate AI/ML in your future curriculum!

Call for Action

- Start learning about AIY at aiyprojects.withgoogle.com
- Thinking and planning leveraging AIY kits in your future classes, helping students learning AI/ML
- Planning hands-on activities such as workshops, codelabs, contests, etc. that encouraging students using AIY kits building AI applications
- Get ready to pre-order AIY kits - watch out for the retail announcement from Google and local partners

Google Computer Science Education Workshop 2018

Bridg-It Workshop

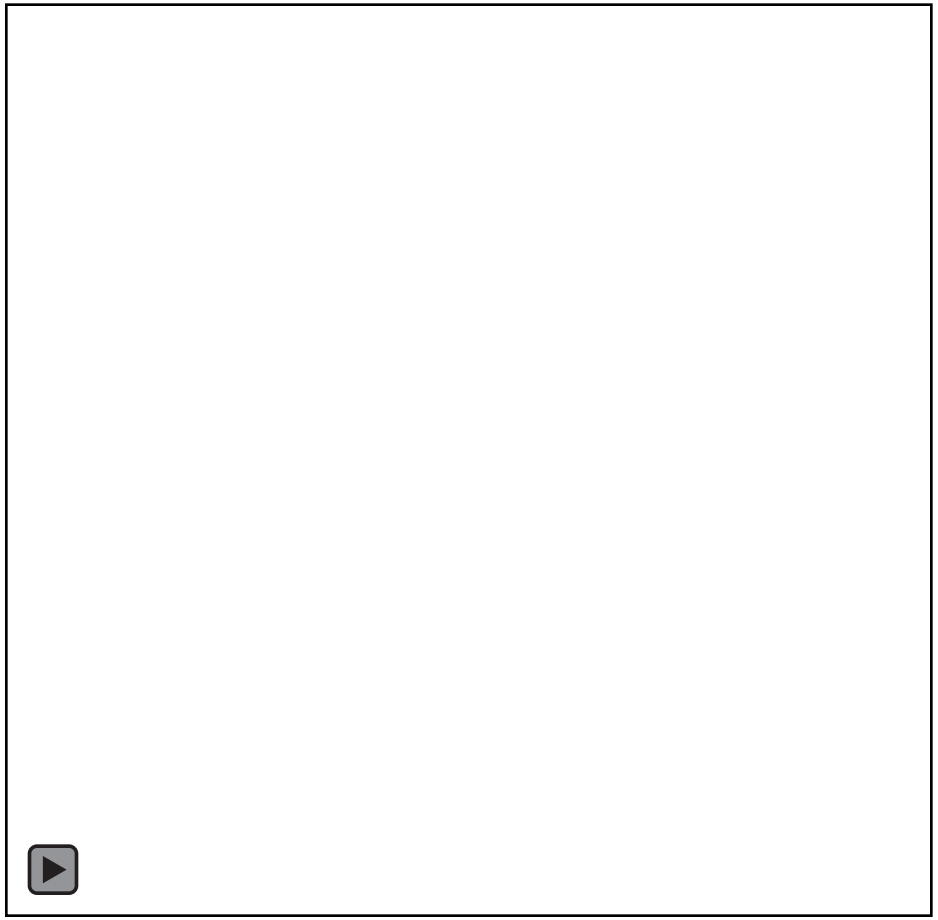
Instructor: Cassandra Lee

(Math graduate and writer)

What is Bridg-It?

- 2-player game

Short demo + explanation



What is Bridg-It?

- 2-player game
- Aim:
  - Connect the pair of opposite sides assigned to you
  - Block your opponent from joining their sides
- How to play:
  - Join two points with a straight line – only horizontally or vertically
- The winner is…
  - the first player to connect their sides successfully

Downloads

Bridg-It is included in the PolyMath App

PolyMath App: downloads →

Apple iOS

Google Play

Warm-up Activity #1 (est. time: 15 min)

1. Find a partner > two-player
2. Play on 5x4 board (and then 6x5)
   - Touch the space between any two points to connect those points
3. Which player wins? 1st or 2nd player?
4. Play for 2 more times on 5x4 (6x5).

Questions after playing:

- What can be a winning strategy?
- Is a tie possible?

Hands-on Activity #2 (est. time: 15 min)

1. Play against the AI
2. Which player wins? AI or you?
3. Play for 2 more times.

Questions after playing:

- What can be a winning strategy?
- How would you know you are losing?
- What is the difference between different Levels of the game?

Warm-up Activity #3 (est. time: 15 min)

1. Find a partner (can be same as #1) > two-player
2. Play on 5x4 (6x5) board – customize > limit the bridges to 7 (10, 13)
   - Touch the space between any two points to connect those points
3. Which player wins? 1st or 2nd player? Or none?
4. Play for a few more times (if time allows).

Questions after playing:

- How does limiting the bridges affect the winning strategy?

For more, please visit…

- Computer Science Challenge
  - http://cschallenge.cs.cityu.edu.hk
  - Bridg-It is one of the games there

Q & A

Thank you for your participation

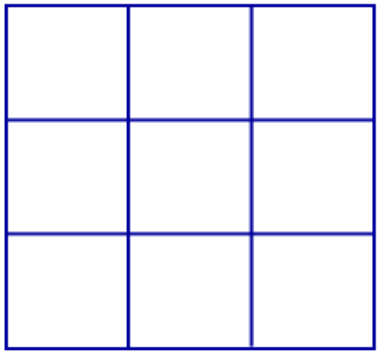
Magic Square

Google Computer Science Education Workshop 2018

Clara Hui, Lu Lin

What is a magic square?

a square divided into smaller squares each containing a number, such that the figures in each vertical, horizontal, and diagonal row add up to the same value.



Let’s try to build a magic square!

Tear up an A4 paper into nine pieces and form a Magic Square with number 1-9.

Something to think about…

1. How many odd numbers and even numbers are there?
2. Which number do you want to put in the middle?
3. How many possibilities/patterns are there?

There are 8 possibilities. They are reflections/rotations of 1 pattern.

8	1	6
3	5	7
4	9	2

6	1	8
7	5	3
2	9	4

4	9	2
3	5	7
8	1	6

2	9	4
7	5	3
6	1	8

8	3	4
1	5	9
6	7	2

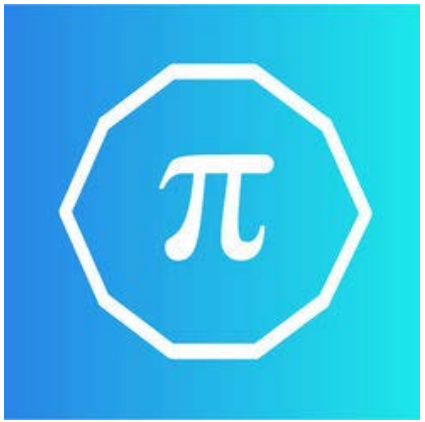
4	3	8
9	5	1
2	7	6

6	7	2
1	5	9
8	3	4

2	7	6
9	5	1
4	3	8

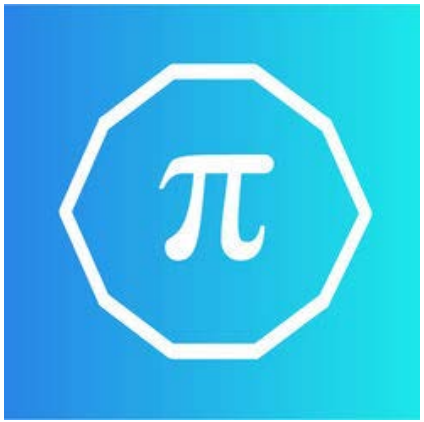
Try the 9 puzzle!

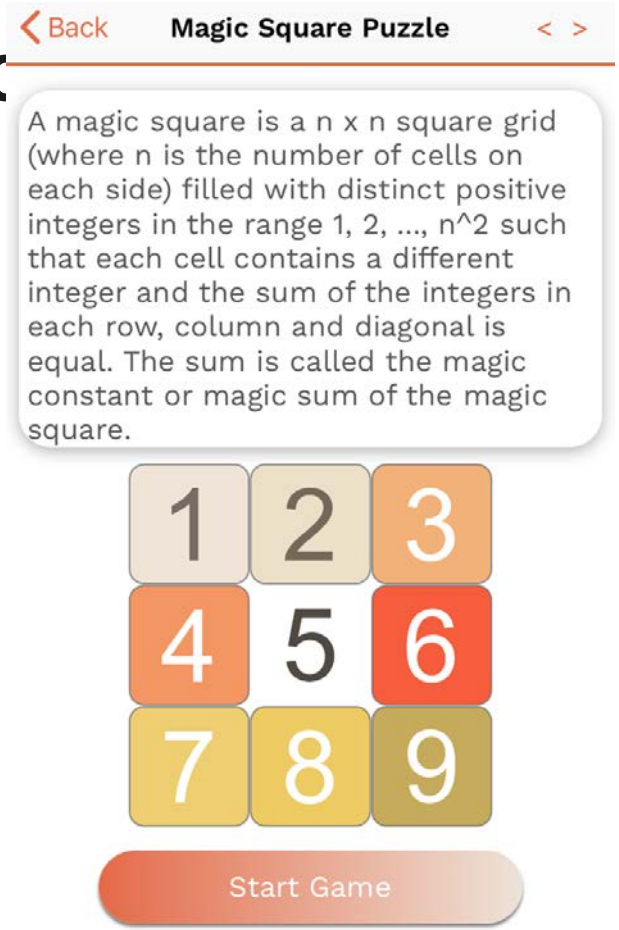
PolyMath app



Now let’s have a mini rac

PolyMath app





Number scrabble (player A and B)

Goal: Pick three numbers that sum to 15

1 2 3 4 5 6 7 8 9

Player A:

Player B:

Number scrabble (player A and B)

Goal: Pick three numbers that sum to 15

1 2 3 4 5 6 7 8 9

Player A: 8

Player B: 2

Number scrabble (player A and B)

Goal: Pick three numbers that sum to 15

1 2 3 4 5 6 7 8 9

Player A: 8 4

Player B: 2 3

Number scrabble (player A and B)

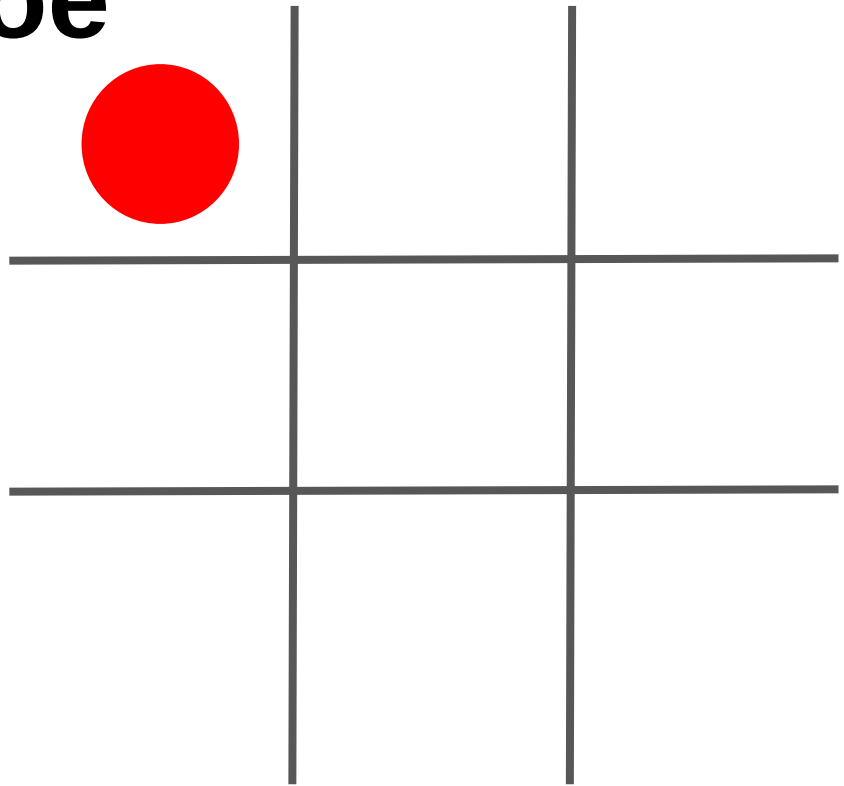
Goal: Pick three numbers that sum to 15

1 2 3 4 5 6 7 8 9

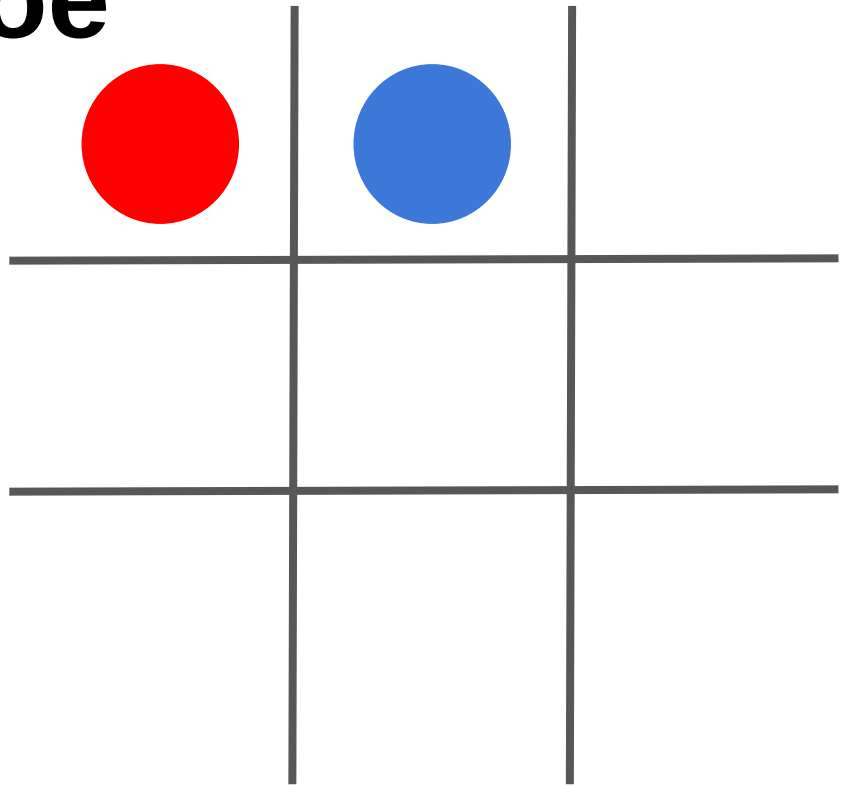
Player A: 8 4 5

Player B: 2 3 ?

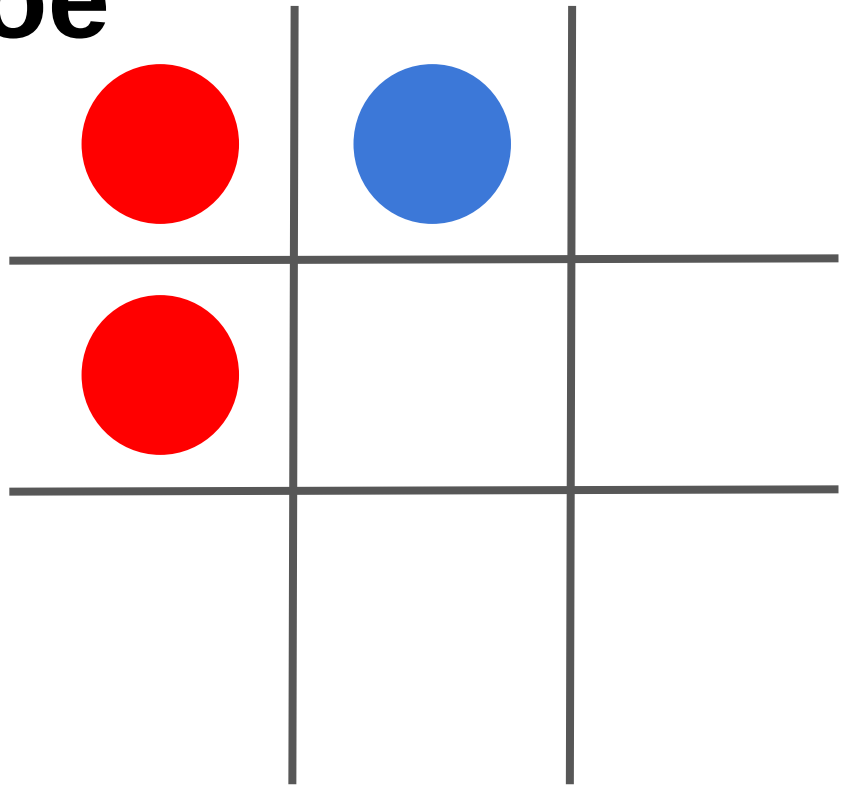
Tic-Tac-Toe



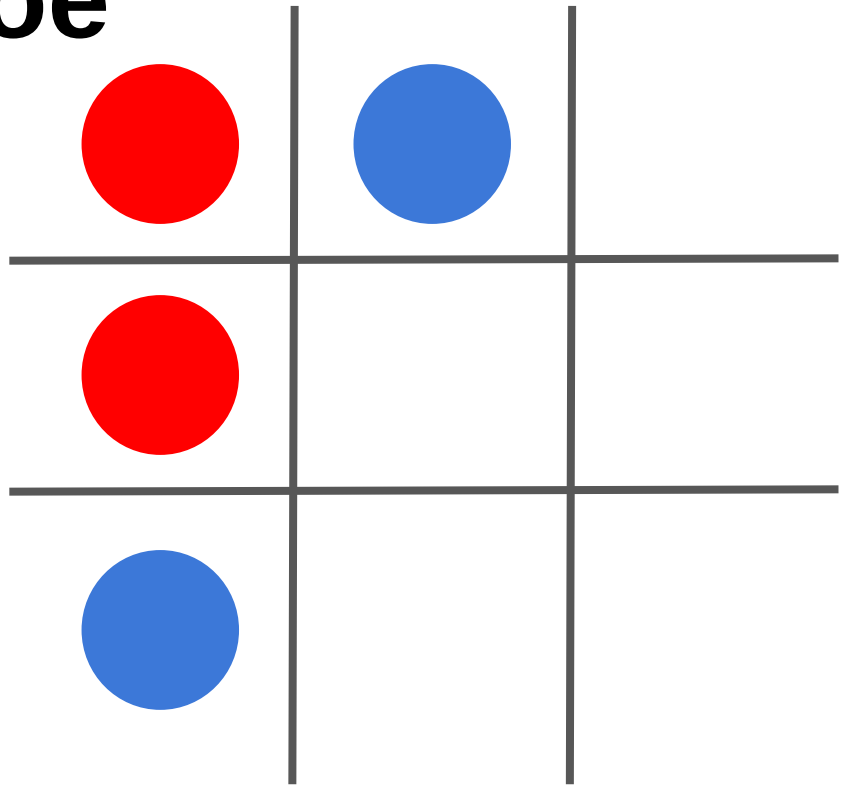
Tic-Tac-Toe



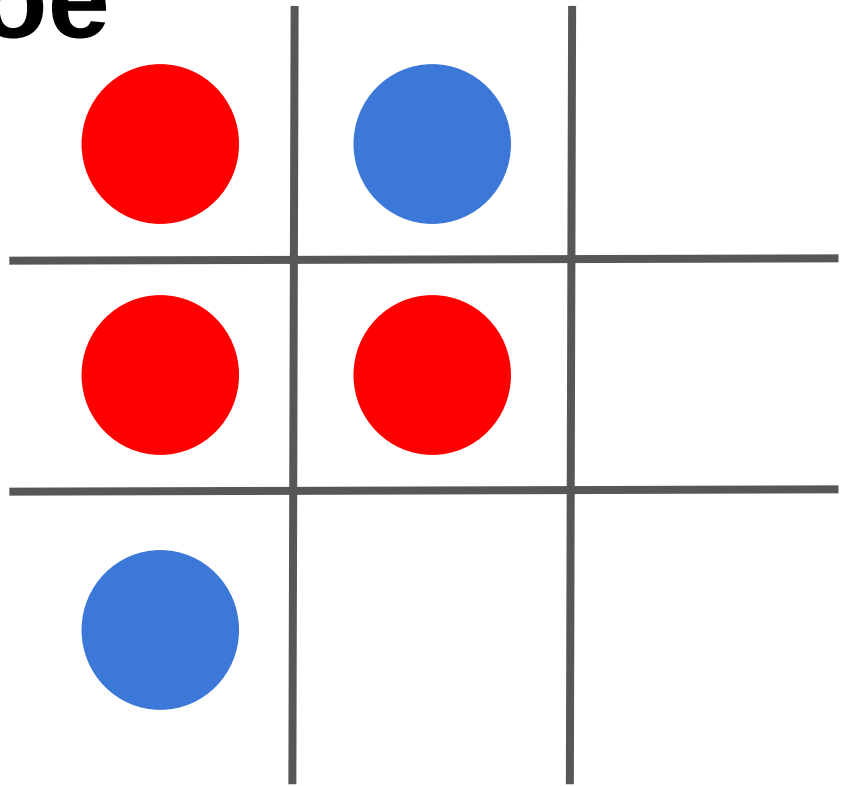
Tic-Tac-Toe



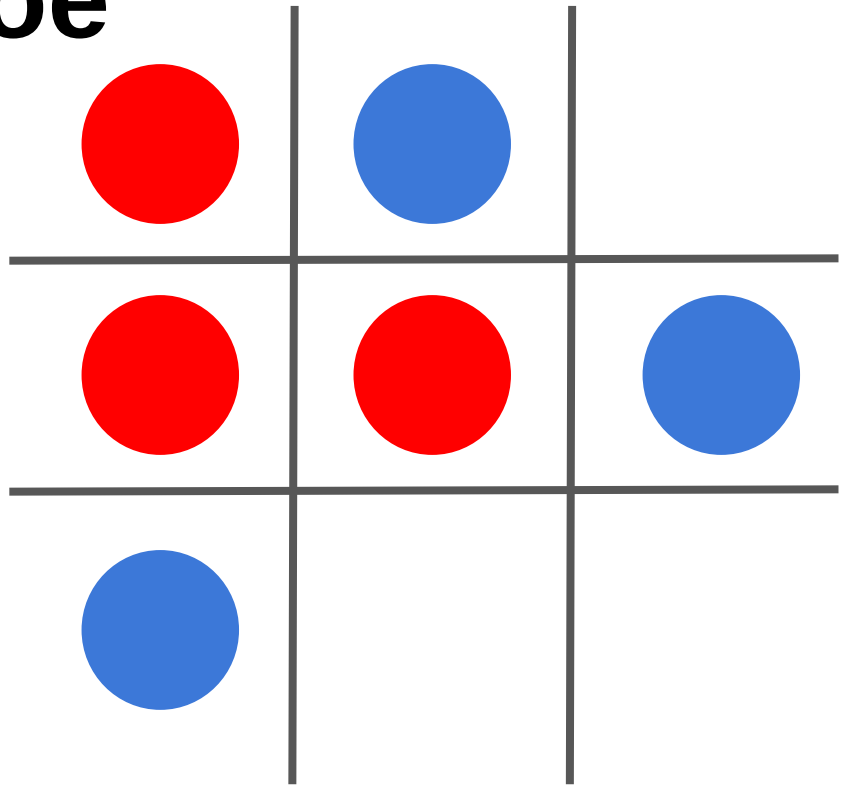
Tic-Tac-Toe



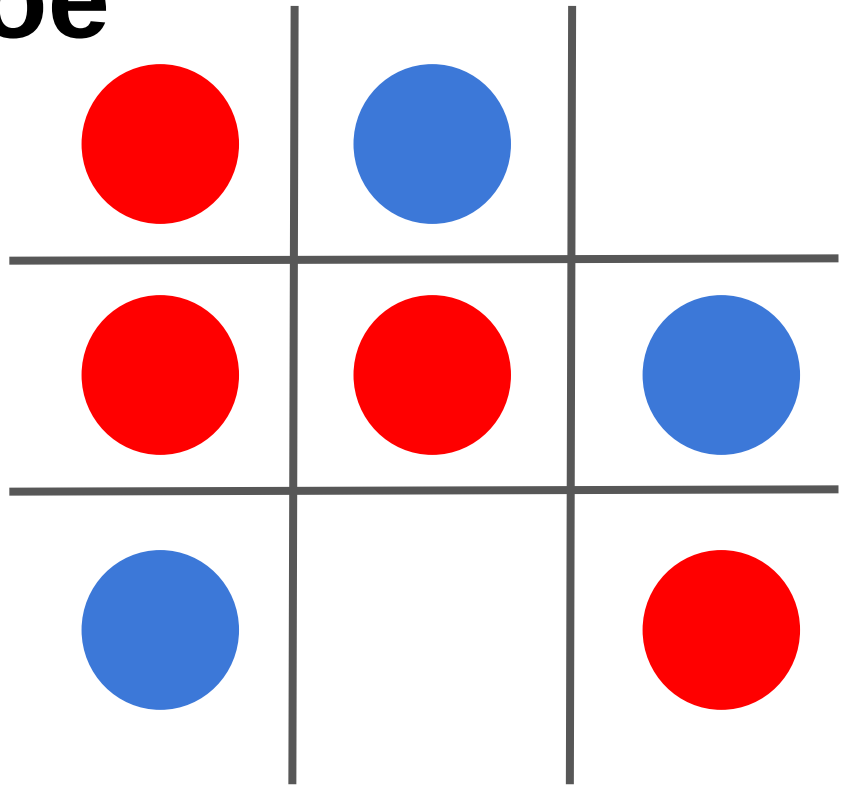
Tic-Tac-Toe



Tic-Tac-Toe

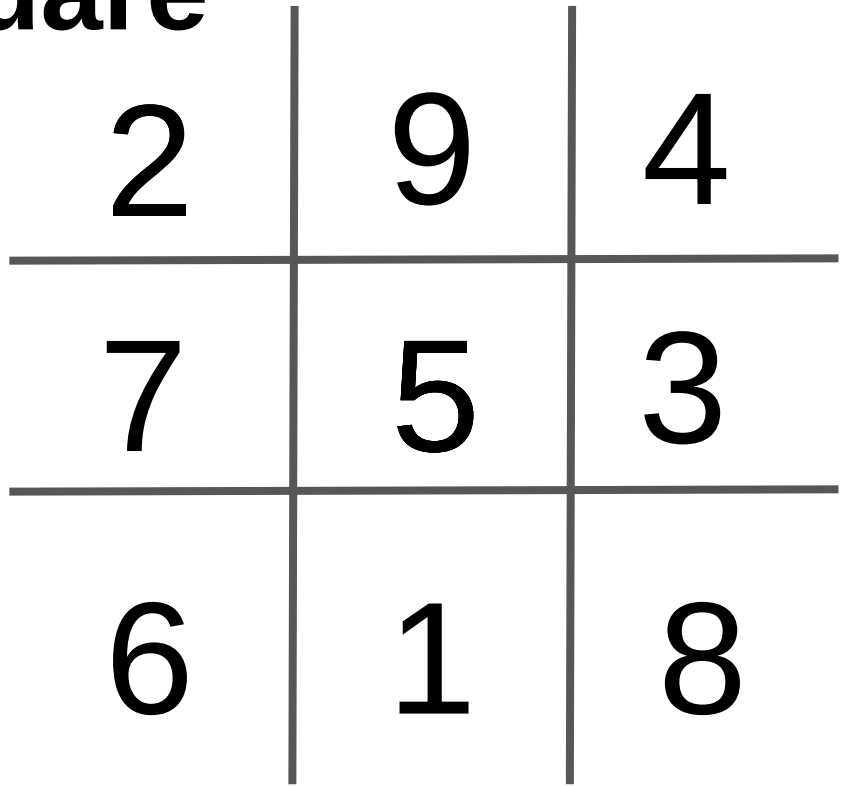


Tic-Tac-Toe



Magic Square

Recall the definition of magic square...



Magic Square

Recover the previous game...

2	9	4
7	5	3
6	1	8

Red: 2

Magic Square

Recover the previous game...

2	9	4
7	5	3
6	1	8

Red: 2
Blue: 9

Magic Square

Recover the previous game...

2	9	4
7	5	3
6	1	8

Red: 2, 7
Blue: 9

Magic Square

Recover the previous game...

2	9	4
7	5	3
6	1	8

Red: 2, 7
Blue: 9, 6

Magic Square

Recover the previous game...

2	9	4
7	5	3
6	1	8

Red: 2, 7, 5
Blue: 9, 6

Magic Square

Recover the previous game...

2	9	4
7	5	3
6	1	8

Red: 2, 7, 5
Blue: 9, 6, 3

Magic Square

Recover the previous game...

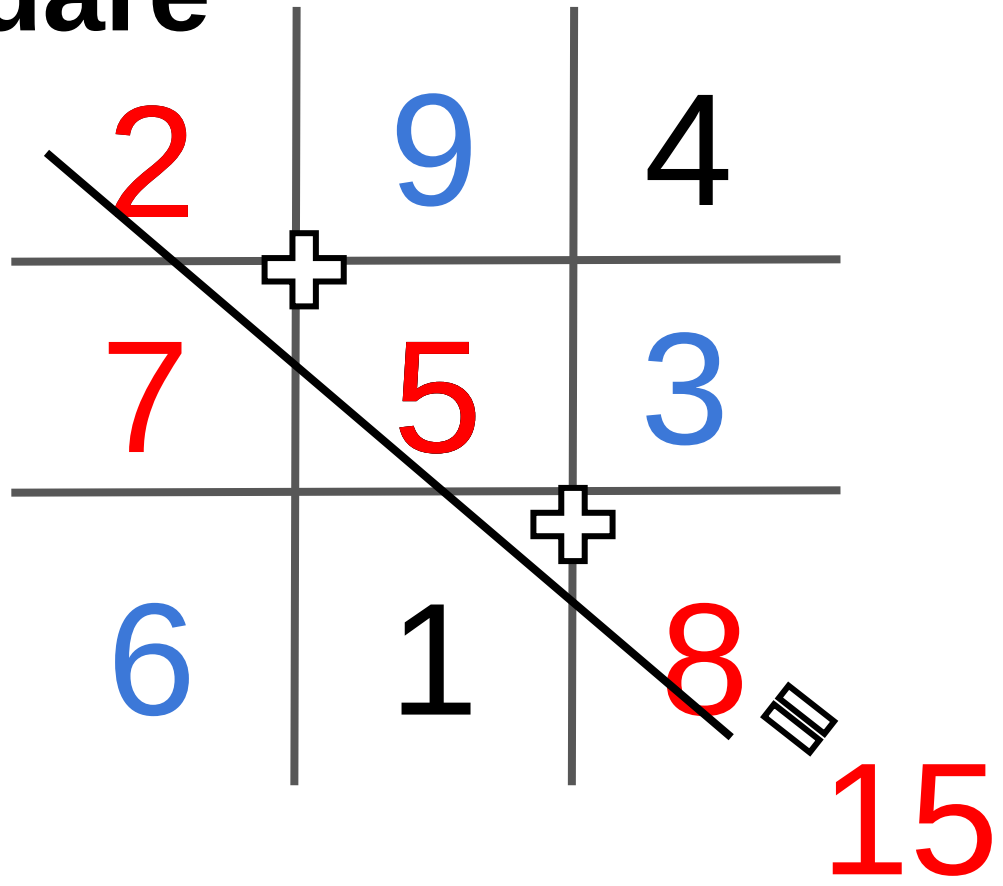
2	9	4
7	5	3
6	1	8

Red: 2, 7, 5, 8
Blue: 9, 6, 3

Magic Square

Recover the previous game...

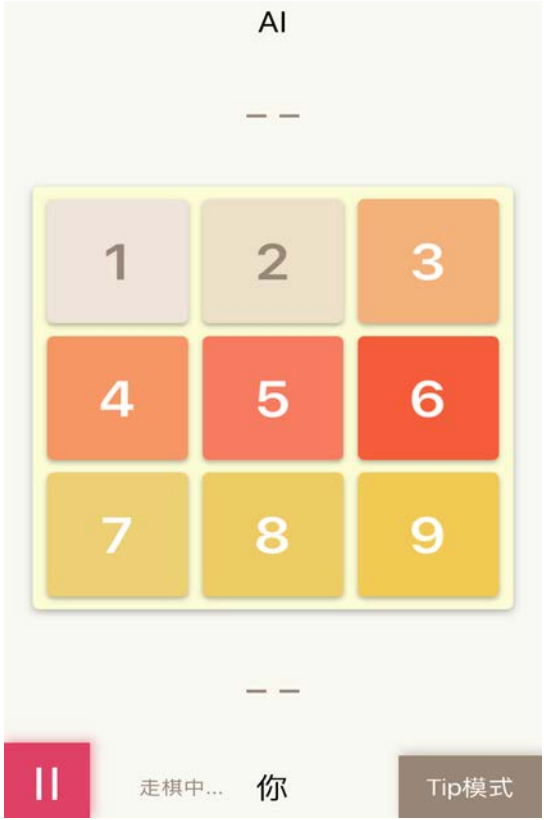
Red: 2, 7, 5, 8
Blue: 9, 6, 3



Number scrabble is isomorphic to playing tic-tac-toe in magic square

So, let’s try it with A.I.

數學嘉年華



Chen’s Prime Numbers

Definition: A prime p is called Chen prime if p+2 is a prime or a product of two primes.

Example: 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 47, 53, 59, 67, 71, 83, 89, 101, …

Chen’s prime numbers

5, 17, 29, 47, 59, 71, 89, 101, 113

Now, can you form a magic square with these prime numbers?

(let’s use the other side of the paper)

Let’s try again with the ap

數學嘉年華