# QUANTUM FUN

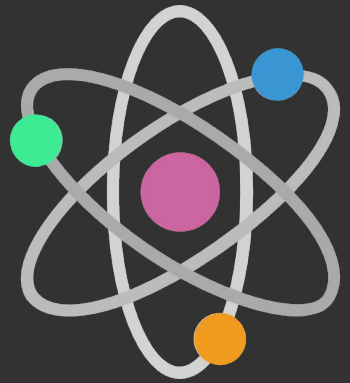
*An introduction to Quantum Computing*

Haris Amiri, Geering Up

# WHY SHOULD

# YOU CARE?

# CHANGING INDUSTRY



# DIVERSITY AND COLLABORATION

# Applications of Quantum Computing Today

Artificial Intelligence -

Google™

NASA

Energy, Environment and Nuclear -

OAK RIDGE National Laboratory

Aircraft Manufacturing and Flight Physics -

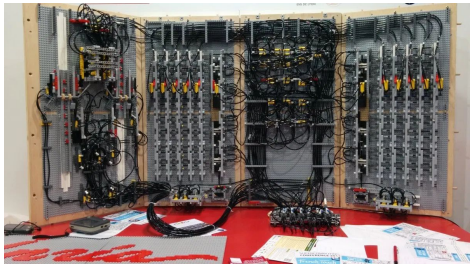
AIRBUS

Communication, Computing -

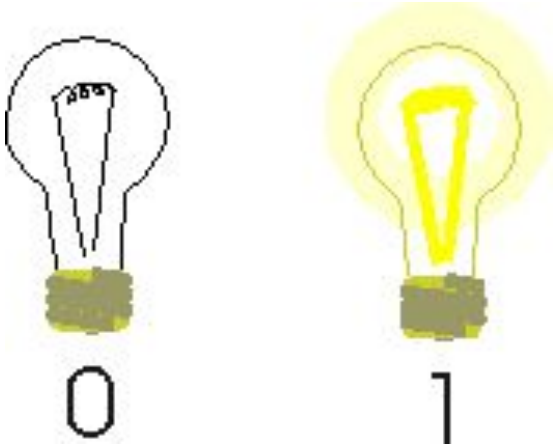
TOSHIBA

Microsoft

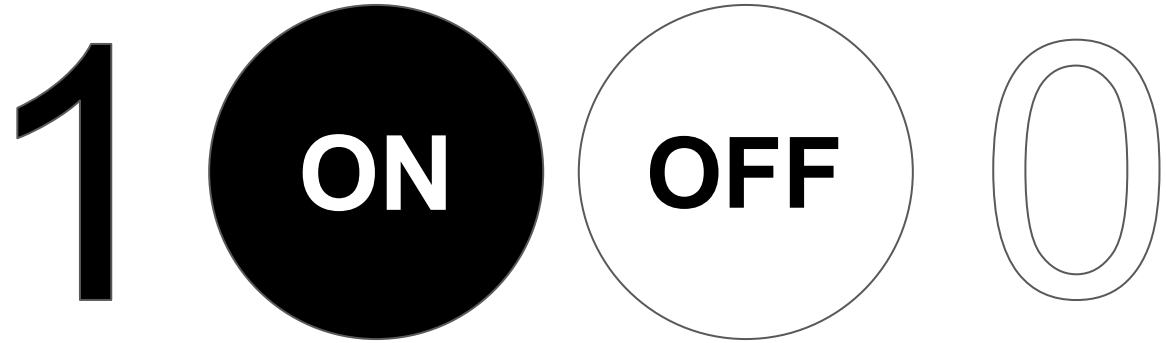
# WHAT IS A COMPUTER?



# BINARY
# Zeros and Ones



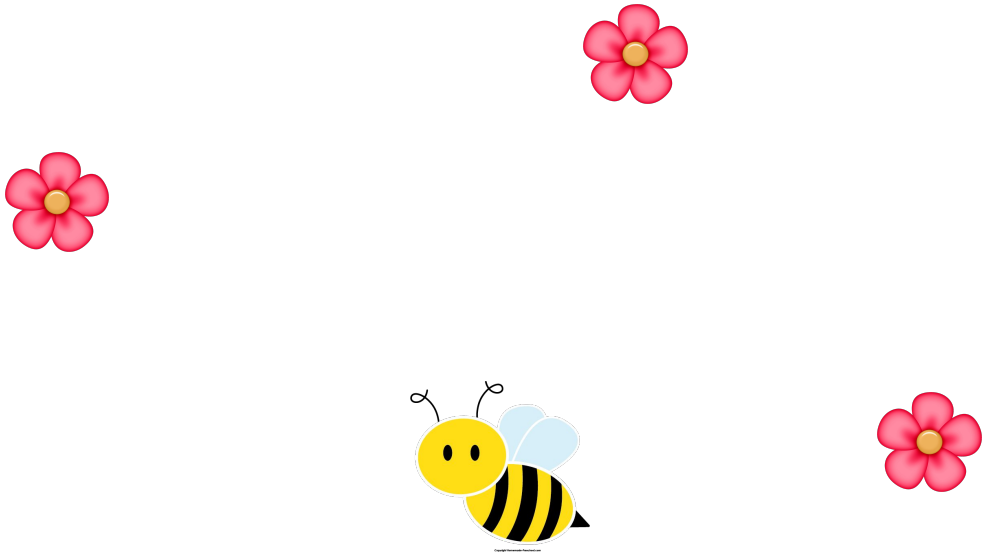
# A BIT




Imagine one bit of information

*A bit isn't actually a physical, circle object but it's easier to visualize it this way*

# Travelling Salesperson problem (Bees)



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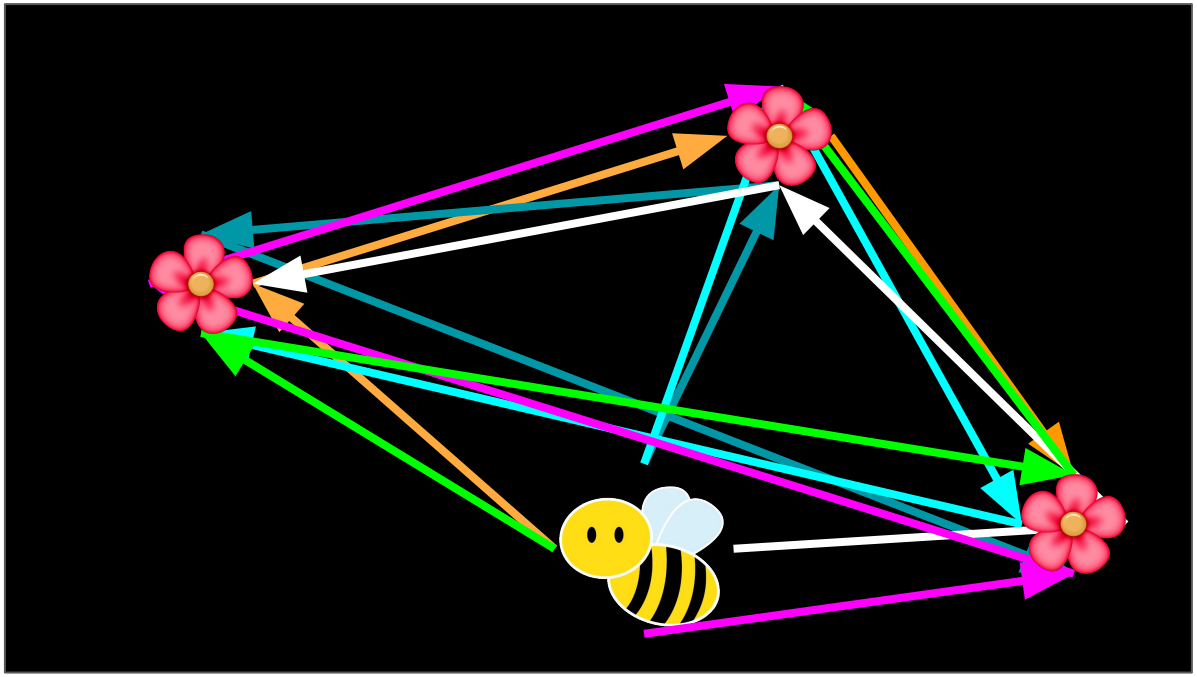

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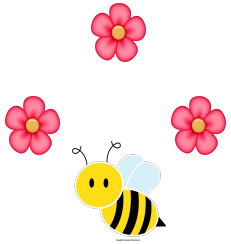
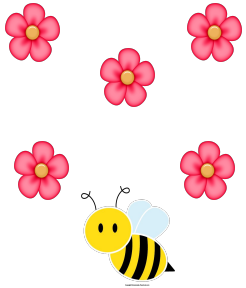
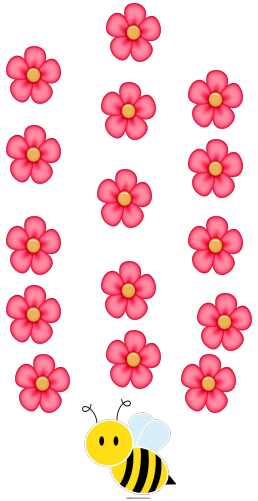


6

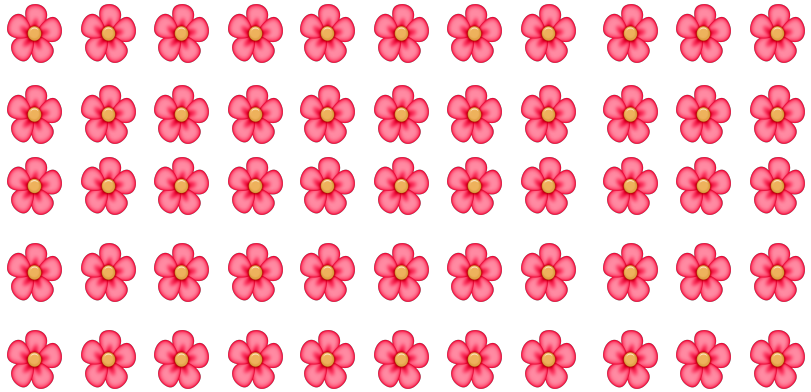


120



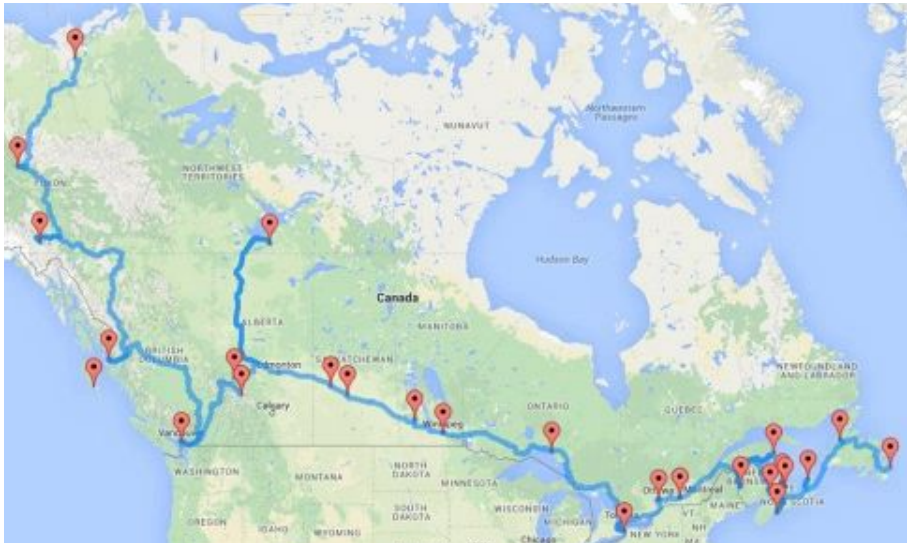
1,307,674,368,000
(read: 1.3 trillion)

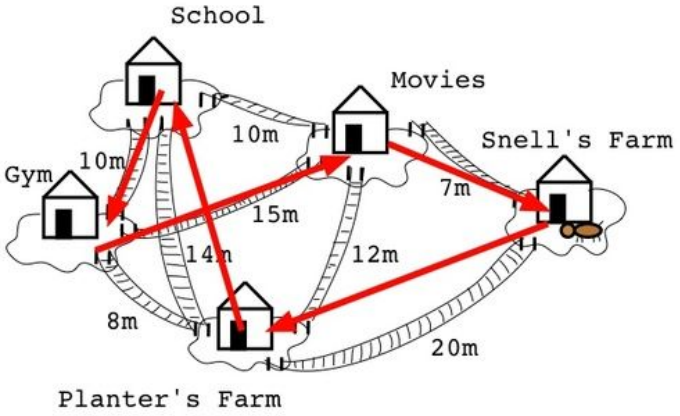
# Travelling Salesperson problem (Bees)



Bees visit about 50-100 flowers per collection trip, and can pollinate up to 5,000 flowers a day!

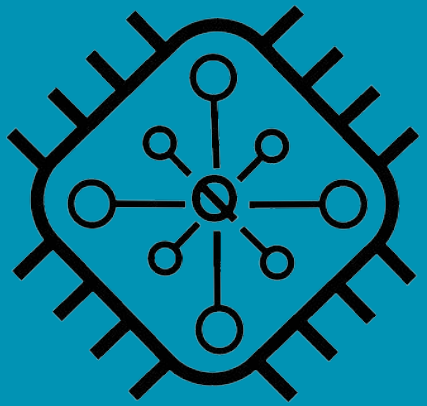
# Travelling Salesperson problem - Resource Management

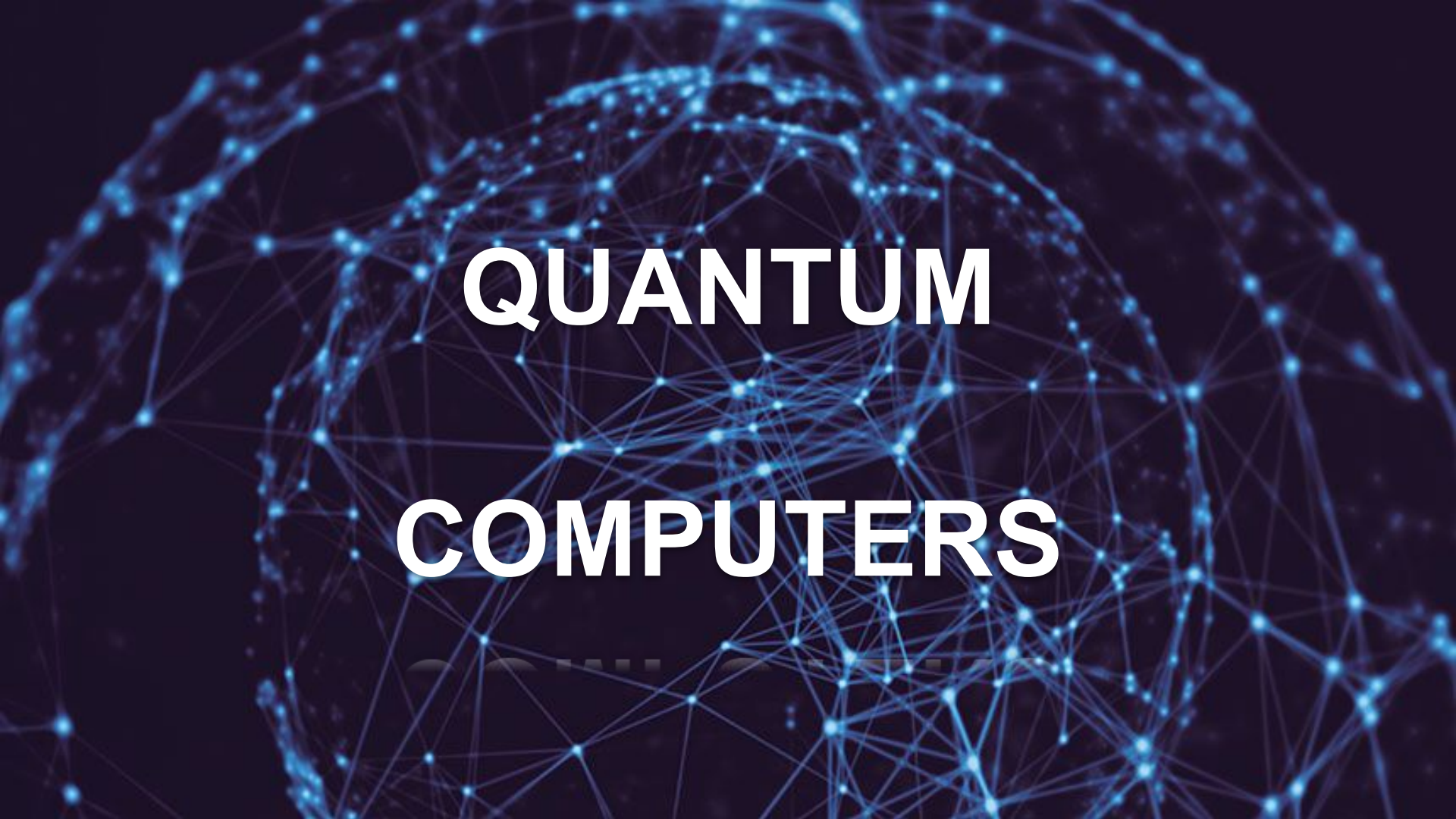


# Classical Computers compare every route

# A new type of ‘Computers’




QUANTUM
COMPUTERS

# Classical vs Quantum Computers

**“Classical” Computers**

1 or 0

**“Quantum” Computers**

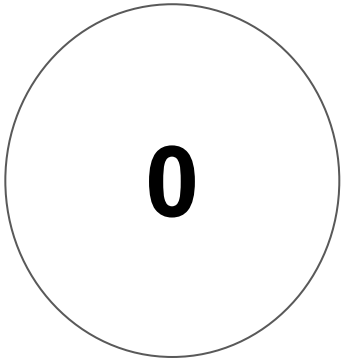
1 0

?

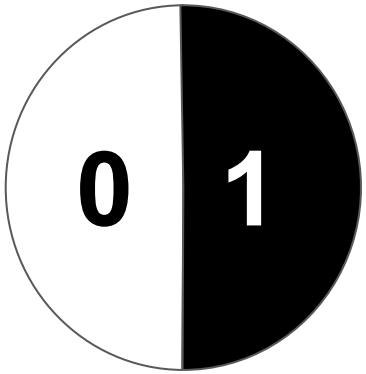
# Picture a Coin Flip

**Is the coin ‘Heads’ or ‘Tails’ while it’s in the air, mid-flip?**

CLASSICAL BIT




QUANTUM BIT

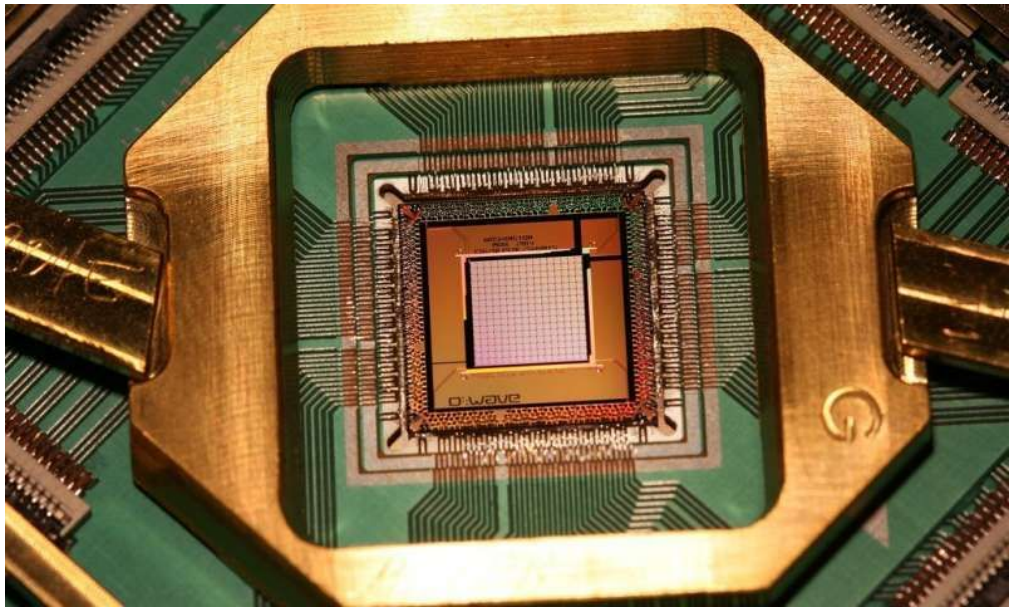


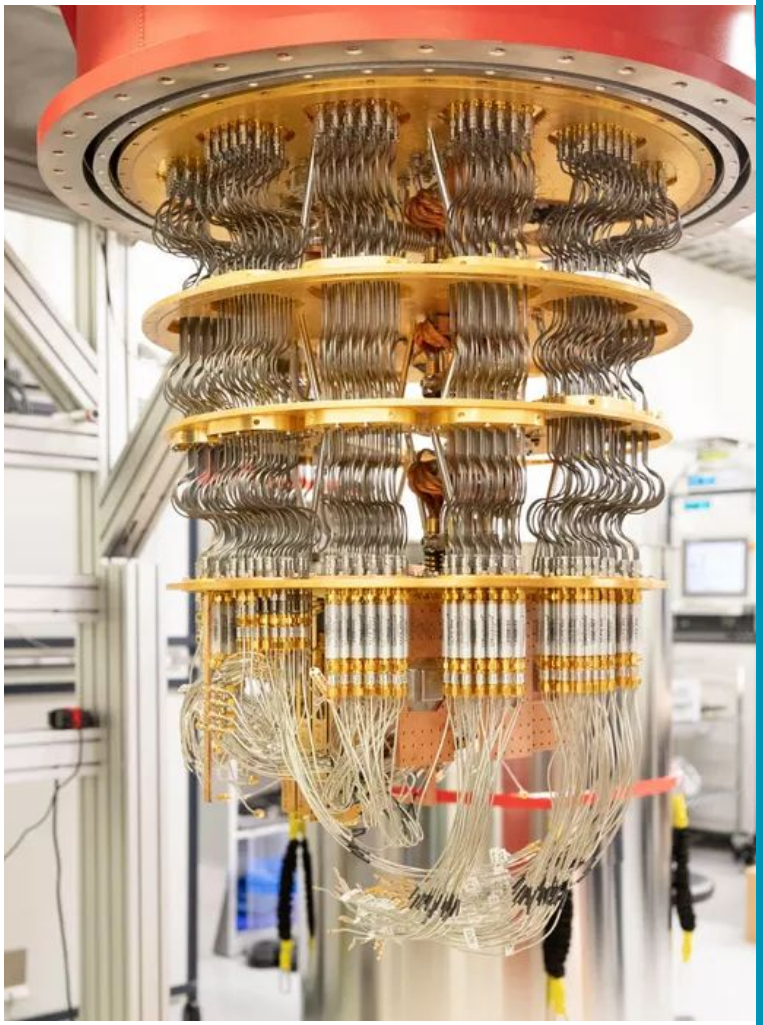

A QUANTUM BIT IS CALLED
A ‘Qubit’

# QUANTUM COMPUTERS

**Cooling**

**MicroChip**



# What are they?

New way of computing

Excellent for large problems that would take classical (normal) computers way too long to solve

There are different types of quantum computers, that work in different ways - suited to solving different problems

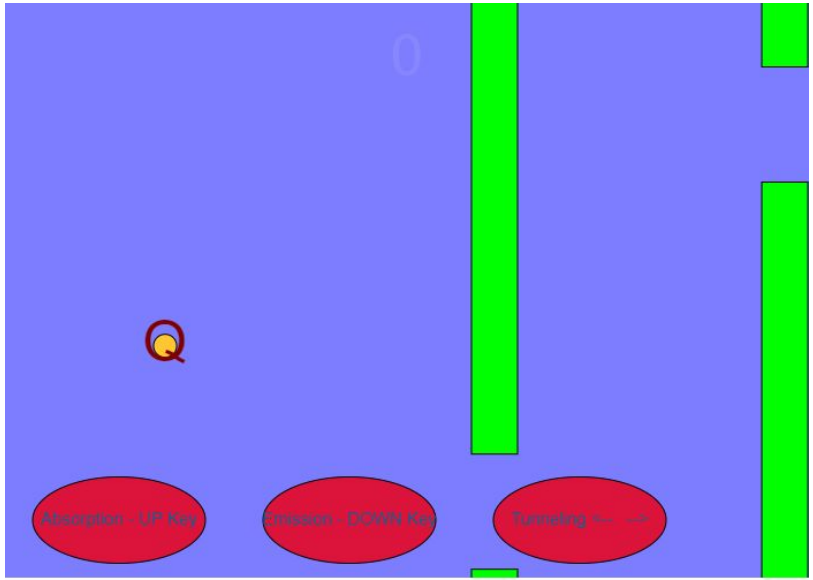
Can be quite expensive, and not very useful for solving smaller problems that can be quickly done by hand or classical computer

**Quantum Computers use something called *Quantum Mechanics*.**

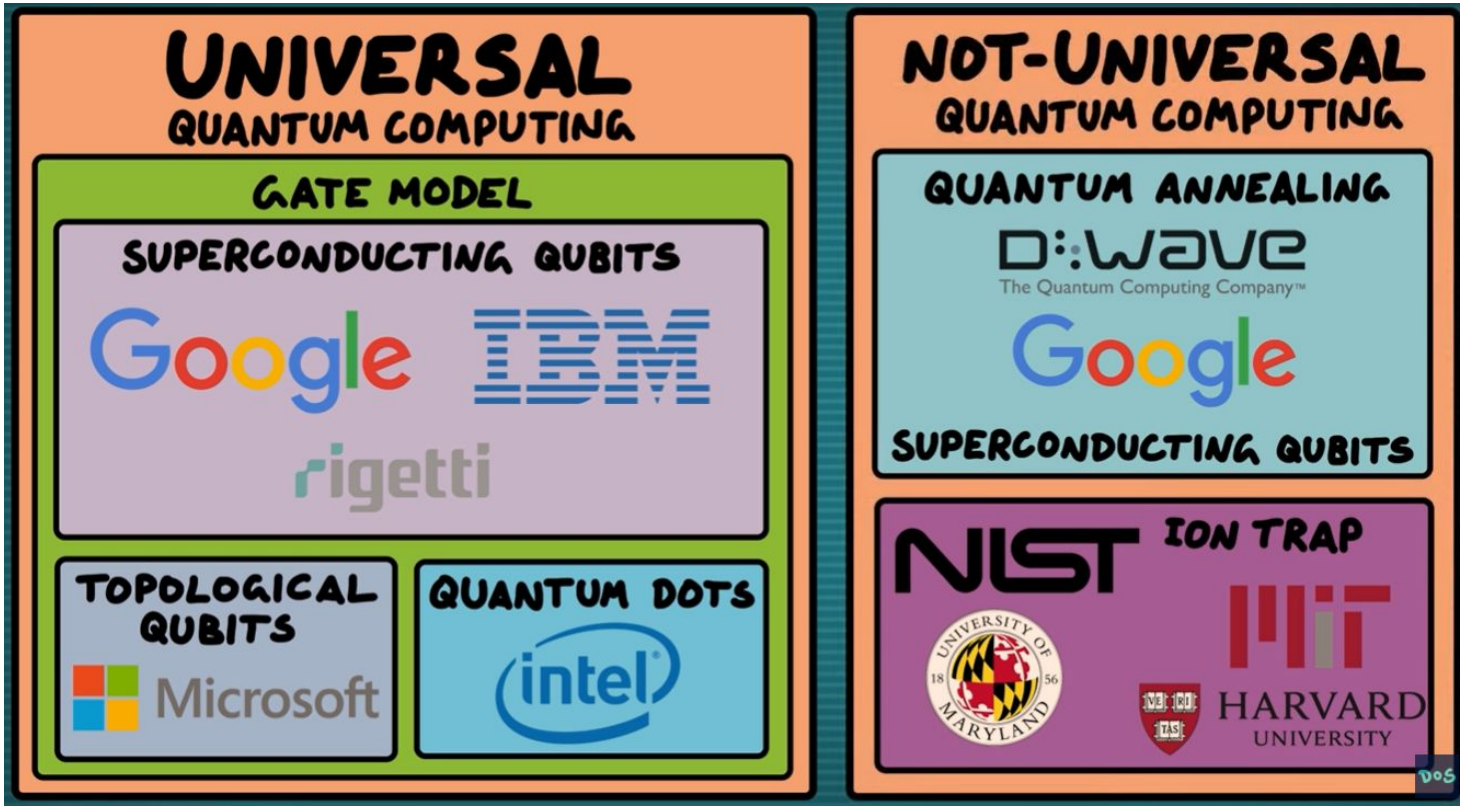
**Quantum Mechanics is the study of things at a very, very small scale**

# Qubit Jump

**https://www.openprocessing.org/sketch/815868**



# TYPES OF QUANTUM COMPUTERS




*DomainOfScience, Dominic Walliman, 2018*

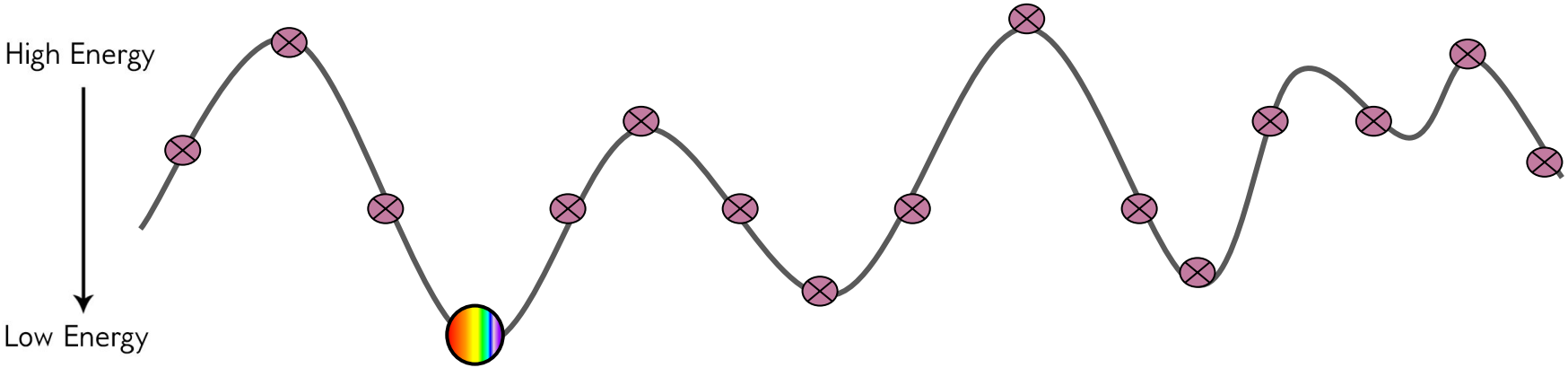
**Ion Trap is actually Universal**

# QUANTUM ANNEALING

# A QUANTUM LIFE BOARD GAME

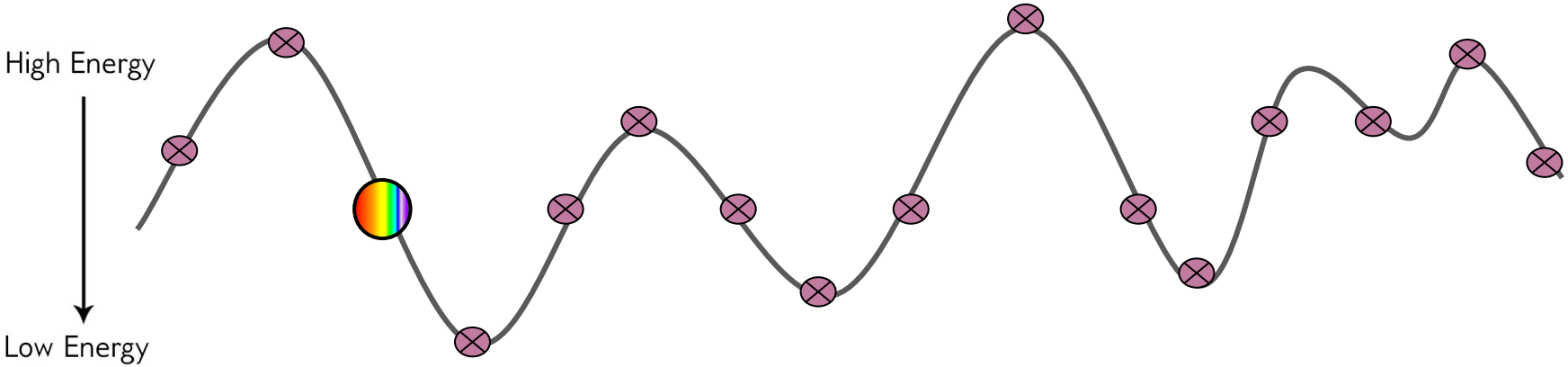

# The Setup

We can set up our problem as a landscape of energy, or an *eigenspace*. Different problems will have different energy landscapes, but the general approach is the same!



# The Setup

Energy levels are *quantized*. So we're going to ask that your QPU only moves in steps or 'pegs'



# The Setup

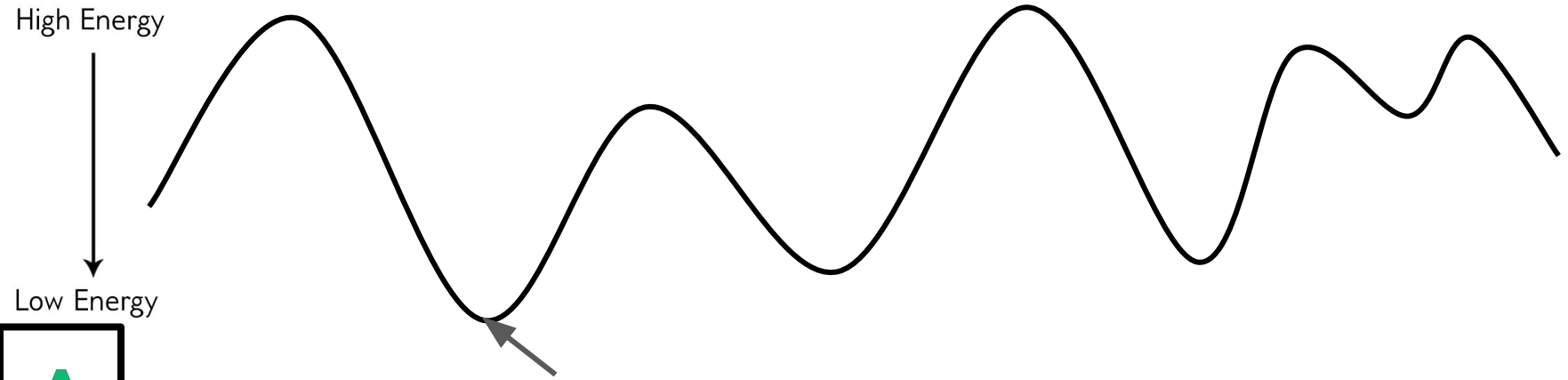
There are two teams:

**Team Anneal** and **Team Collapse**

# The Setup

**Team Anneal**: You are a Quantum Computer, or *Quantum Processor Unit (QPU)*

Your goal is to remain in the lowest energy state, or *global minimum*

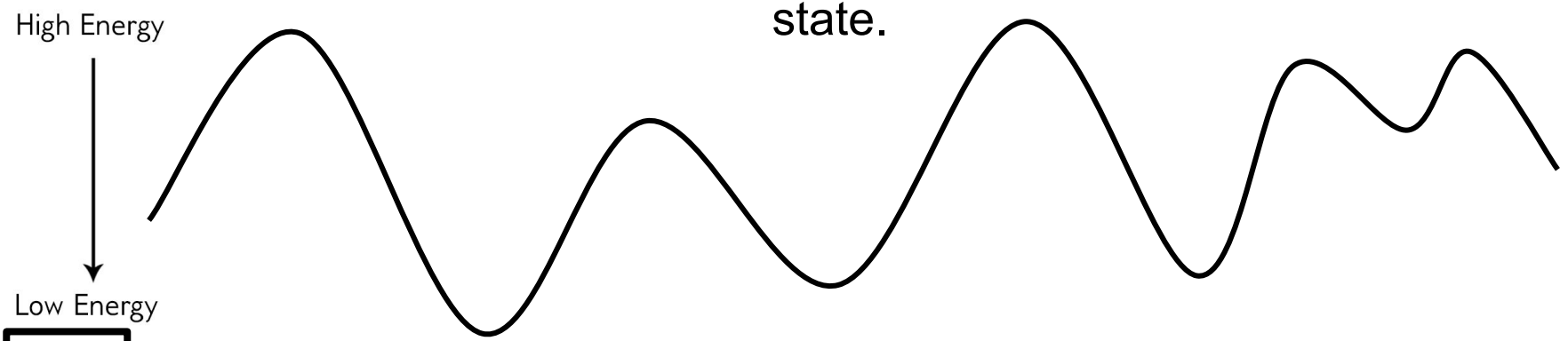



You want your QPU to stay at the global minimum by the end of the game!

# The Setup

**Team Collapse**: You play the role of noise in the system. Your gameplay represents some challenges in quantum annealing.

Prevent the QPUs on Team Anneal from remaining in the lowest energy state.



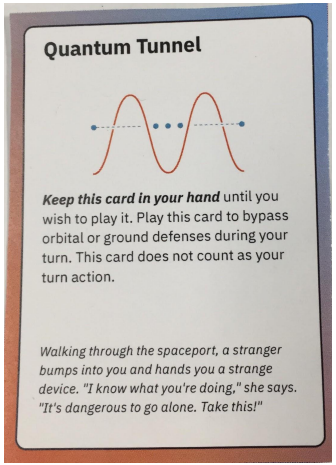

You want to kick the QPUs out of the global minimum by the end of the game!

# Cards

You can only move using the cards available

Each card has a different effect on the game

Some cards affect you , some affect your opponent, and some affect the energy landscape

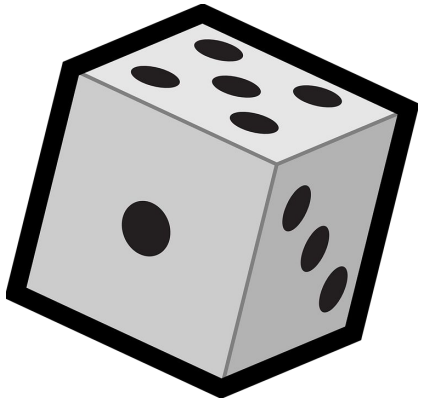


# Probability and the Die

Players will use a 6 sided die to represent the ‘probability’ concepts of Quantum Mechanics

There are no turns in the game! You play your cards and move your QPU!

Some cards will ask you to roll the die, to determine the effect your card has on the game!



# Time Limit

There is a time limit. Let's start with a 4 minute timer for the first round, then 2 minute timers for later rounds! You'll notice that the 'quicker' the anneal, the harder it is to end in the lowest energy state. This is similar in quantum annealing.

When the timer goes off, the game is over! Points are awarded by the number of energy levels between the QPU and the lowest energy state or peg (the trough).

Points for Team Collapse and Team Anneal work in reverse

# Points

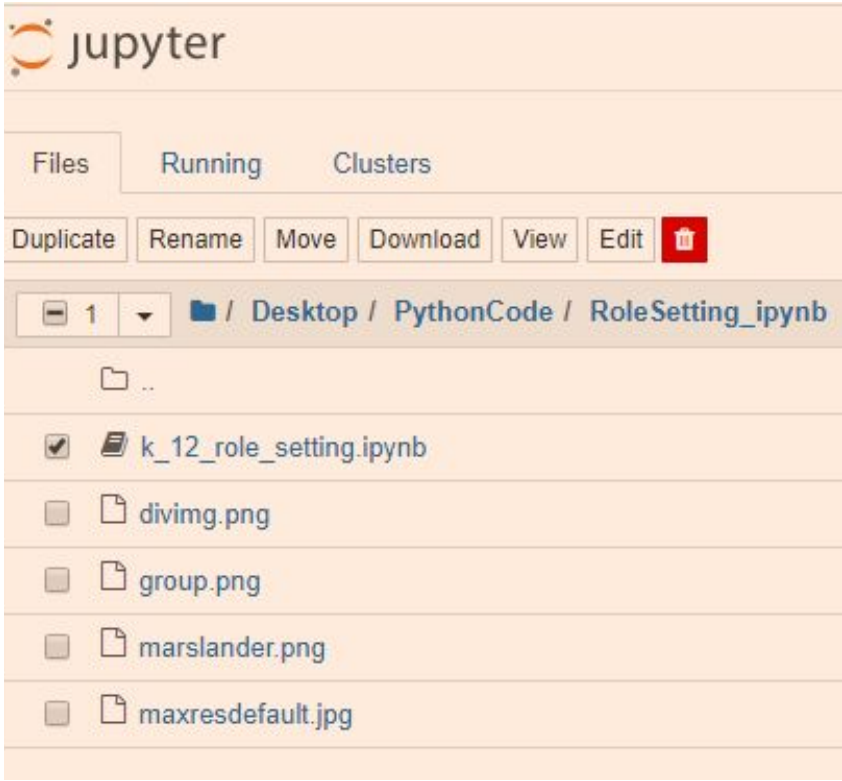
**# of Energy Levels b/ween the QPU and the global minima:**

| A | C |
| --- | --- |
| 0 - 10 pts | 0 - 0 pts |
| 1/2 - 9/8 pts | 1/2 - 4/5 pts |
| 3/4 - 7/6 pts | 3/4 - 6/7 pts |
| 4/5 - 5/4 pts | 4/5 - 8/9 pts |
| 5+ - 0 pts | 5+ - 10 pts |

Navigate to Jupyter Notebook from the search bar!

On the web page, navigate to Desktop -> Quantum Computing -> RoleSetting_ipynb

Click on ‘k_12_role_setting.ipynb’



# 30 second presentation pitch

# BUDGET: $ 50 / team

# STORE

Plates - 10 $/plate

Pipe Cleaners - 1 free for each team (for the astronaut) - 5$/pipe cleaner

Skewers - 5$/skewer

Tape - 10$ / arm’s length of tape

Coffee filters - 30$/coffee filter

Straws - 5$ / straw

String - 20$ / arm’s length