

# 4. Linear Algebra

# Background

一桶油连桶在内重16kg，用去一半油后连桶重9kg，那么桶重多少kg？

解：

半桶油重量：  
 $16 - 9 = 7\text{kg}$

桶重：  
 $9 - 7 = 2\text{kg}$

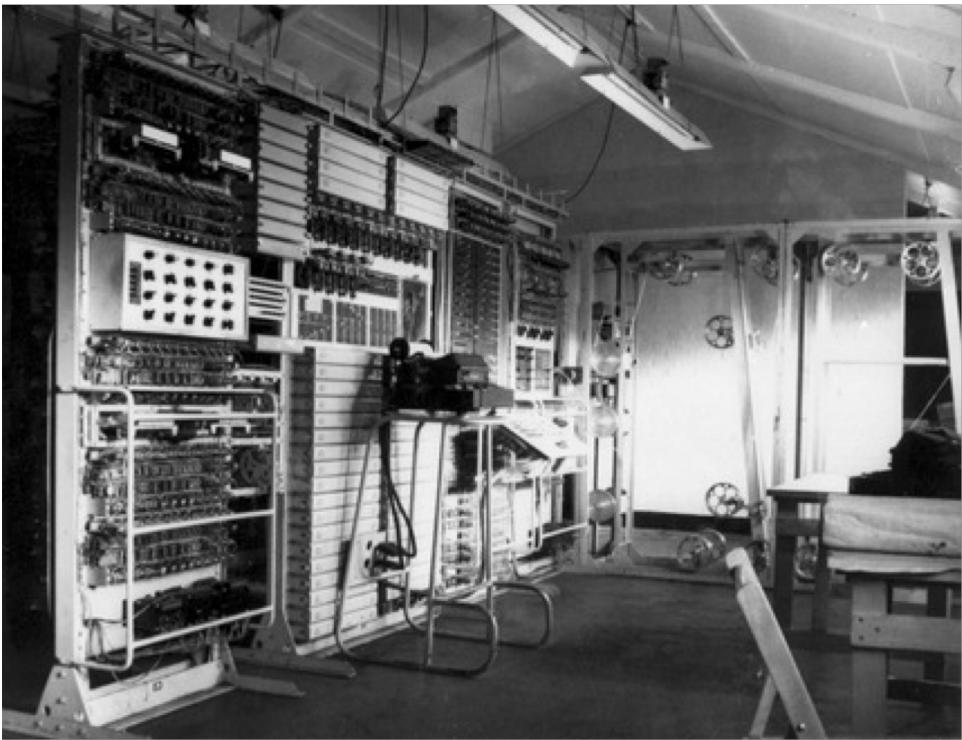
方程组  
设半桶油x，桶重y  
 $\begin{cases} 2x+y=16 & ① \\ x+y=9 & ② \end{cases}$   
 $② \times 2 - ①$   
则  $2y - y = 2 \times 9 - 16$   
 $y = 18 - 16 = 2\text{kg}$

1. 多元一次方程组的解法  
怎么解多元一次方程组?  
第一招：加减消元。

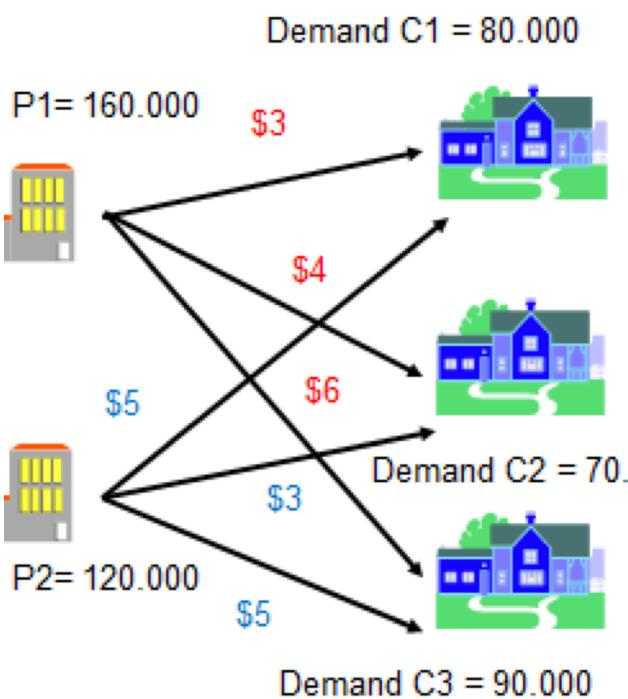
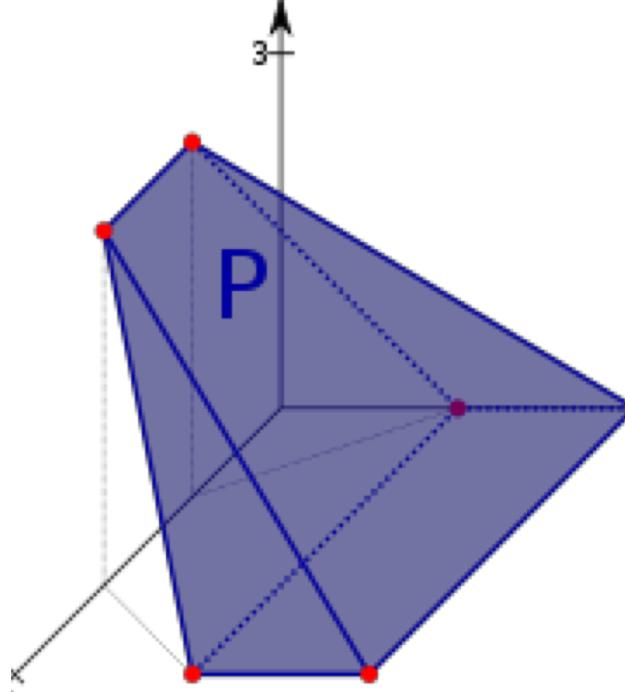
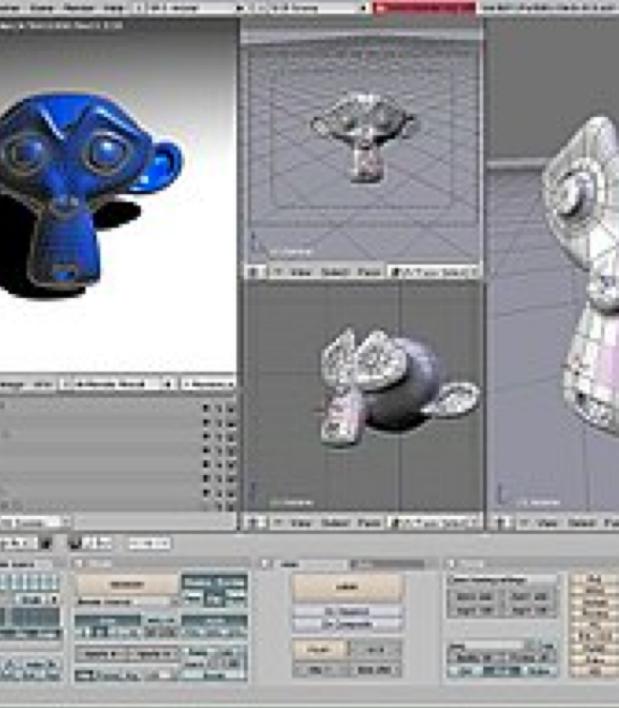
$$\begin{cases} x + 2y = 30 & ① \\ x - 2y = 10 & ② \end{cases}$$

xueersi

# Key Points



$$\left\{ \begin{array}{l} a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n = b_1 \\ a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n = b_2 \\ \dots\dots\dots \\ a_{m1}x_1 + a_{m2}x_2 + \cdots + a_{mn}x_n = b_m \end{array} \right.$$



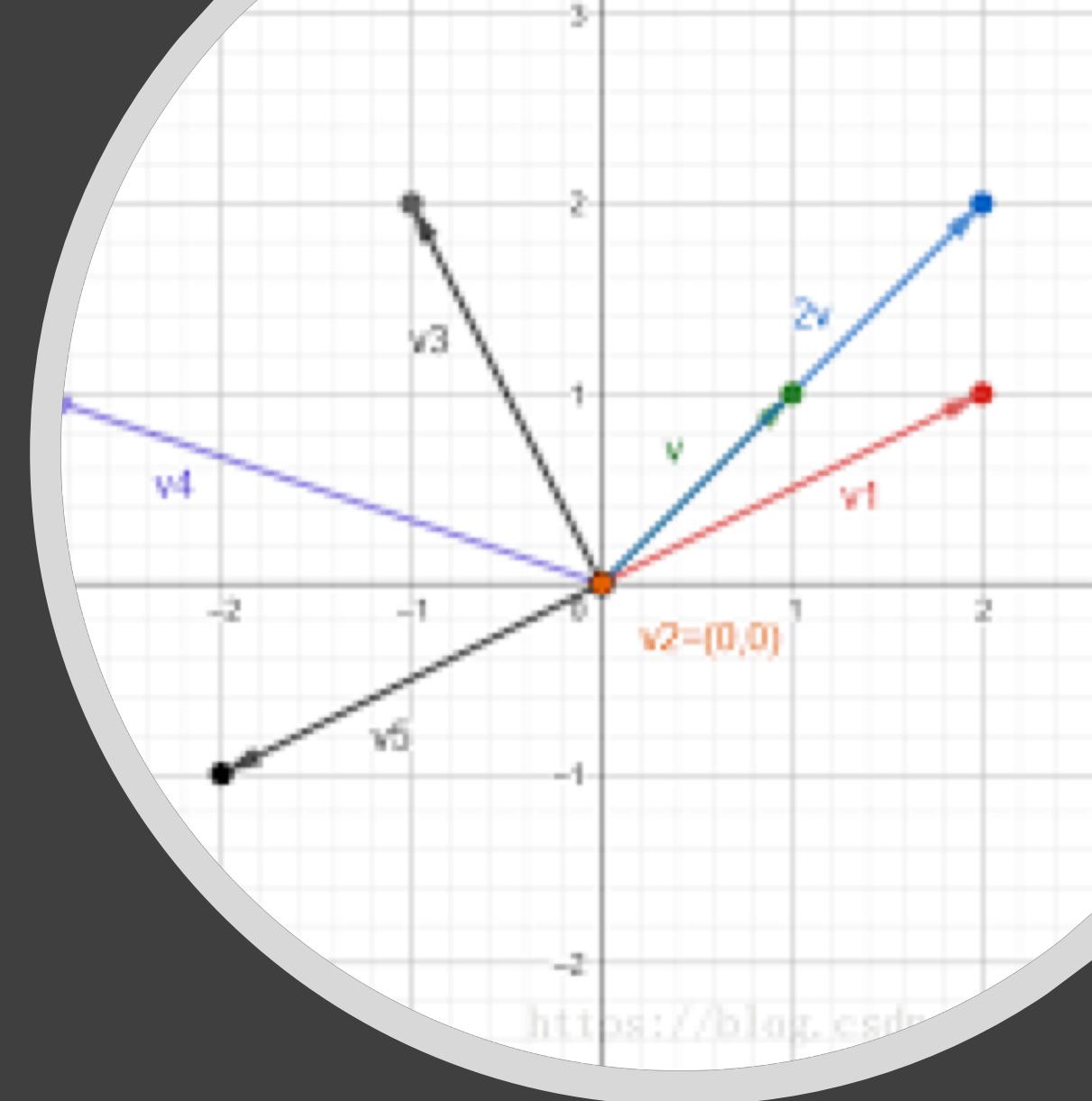
- Linear Algebra Everywhere!

# A Simple Example

- *(in whiteboard)*

# Physical Meaning-I: Dynamic System

# Vector and Matrix Equation

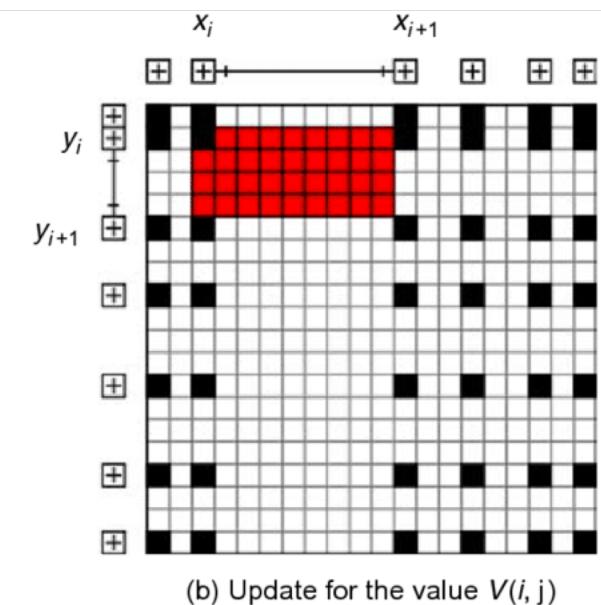
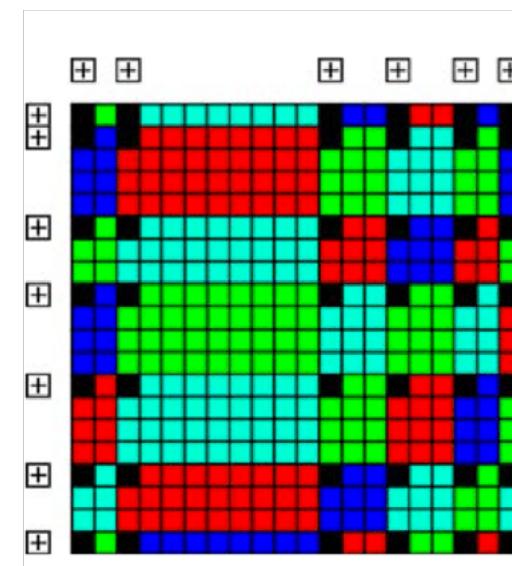
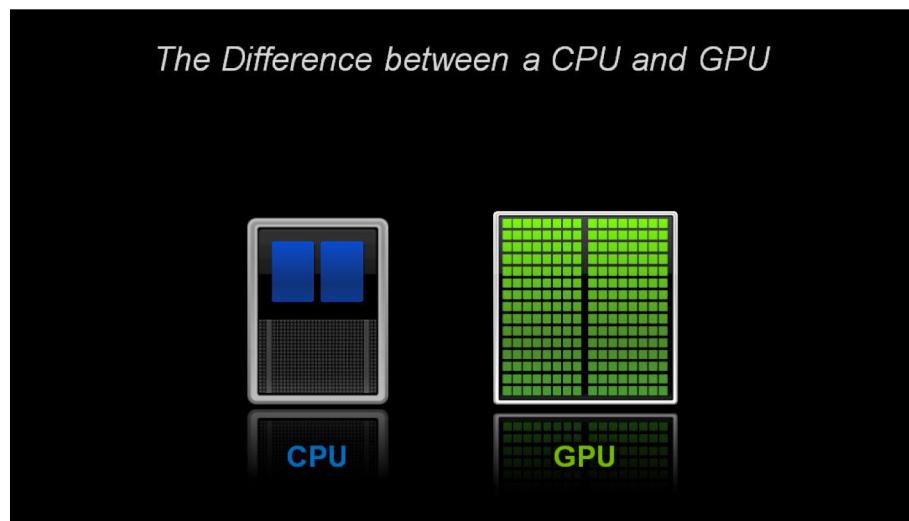


# Vector and Matrix Equation

# Linear correlation

# Matrix and Deep Learning

# Computing and GPU



# Physical Meaning-II: Transform

- *(show in jupyter notebook)*

# 5. Probability



獨贏 Win	位置 Pla	場次 Race	餘 in	分鐘 min	獨贏賠率 Win odds	連贏賠率 Qin odds	2	3	4
1				1 2 1	8 5 3	1	27	140	14
2				2 +	9 9 8	9	24	26	17
3					Totals 3 1 8 10 7 7	10	21	35	100
4					獨贏 Win 14 199 309 4 1 3 11 1 4	11	30	71	45
					位置 Pla 11 660 021 5 4 9 12 2 6	12	58	89	69 168
					連贏 Qin 20 081 631 6 9 3 13 5 4	13	135	225	169 271 597
					三重彩 Tce 3 977 846 7 2 6 14 6 9	14	246	329	238 482 658
					本地賽事 Local Races	8	9	10	11 12

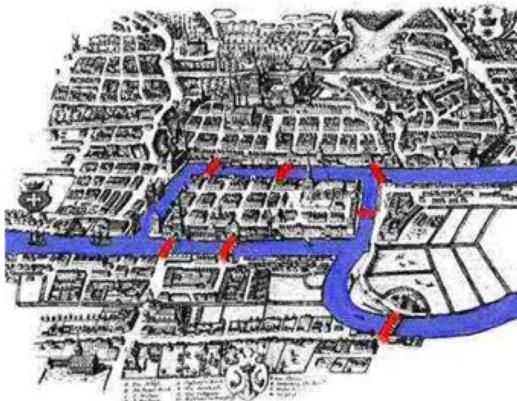
# Probability

*(show in jupyter notebook)*

# Center Limitation Theory

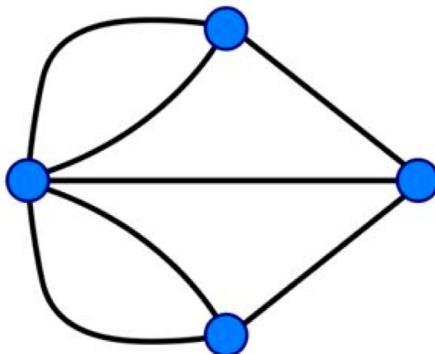
# 7. Graph Theory

# Application of an Euler Path

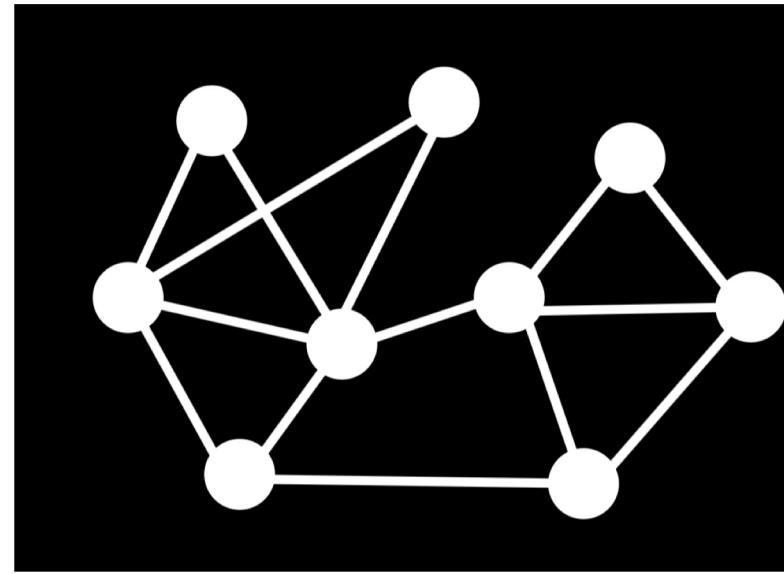
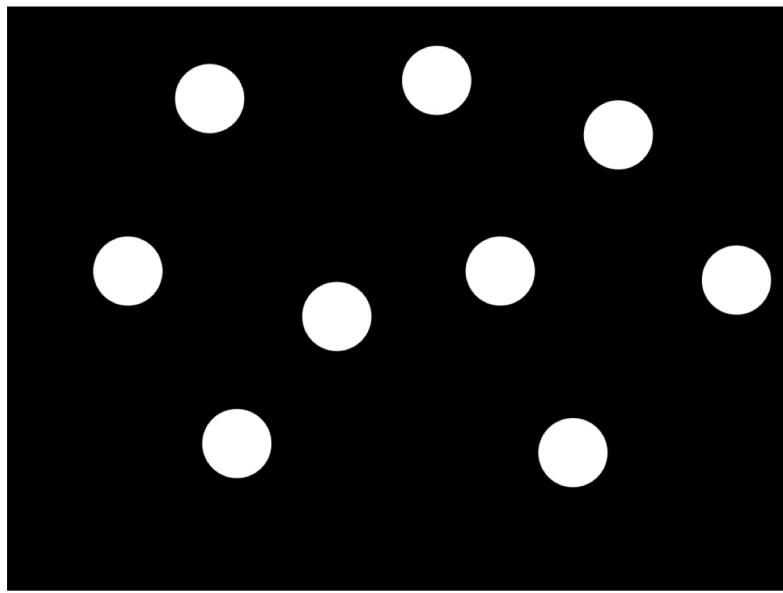


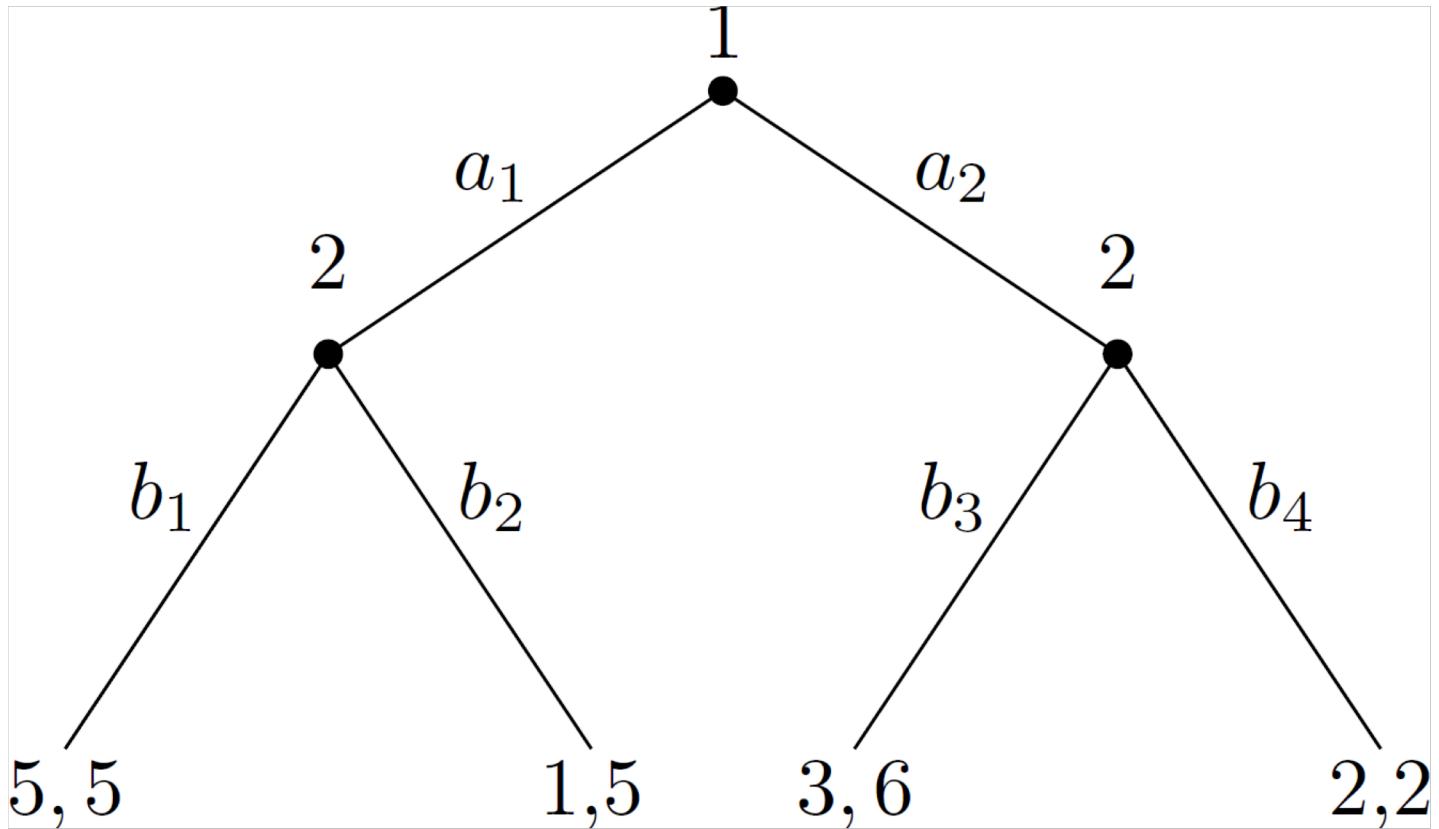
The most famous Euler Circuit was that of the 7 bridges of Königsberg. This was when Euler created the field of graph theory.

This problem is described as follows:  
You must find a walk through the city that crossed each bridge once and only once.  
The islands could not be reached by any route other than bridges, and each bridge must be crossed completely every time.



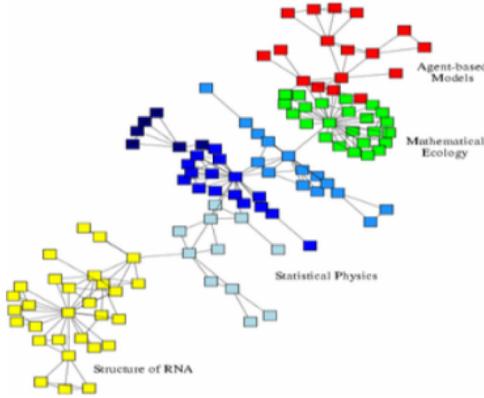
Euler simplified the problem into this graphical representation. This graph makes it clear that all 4 vertices have odd degrees. This makes it impossible for an Euler path to be created.



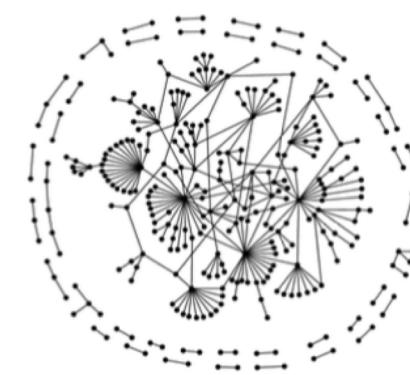




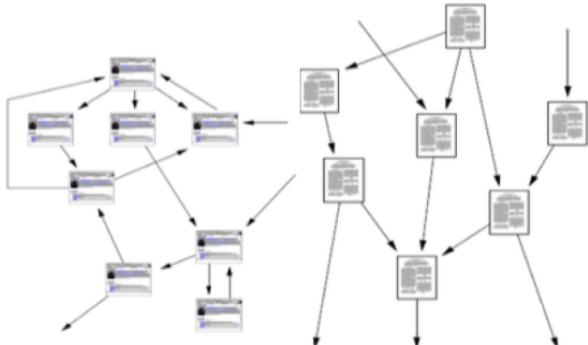
Social networks



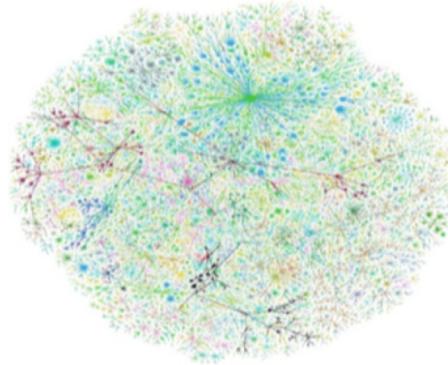
Economic networks



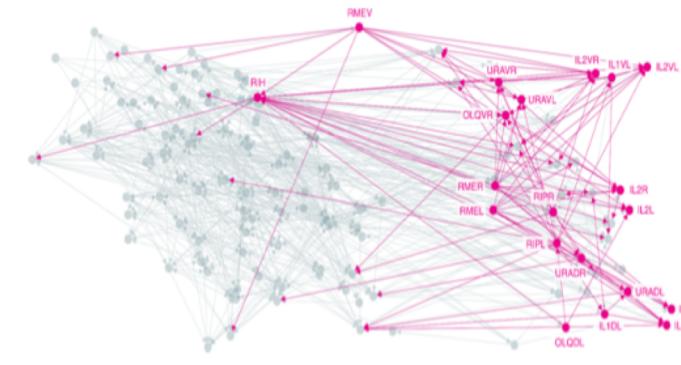
Communication graphs



Information networks:  
Web & citations



Internet

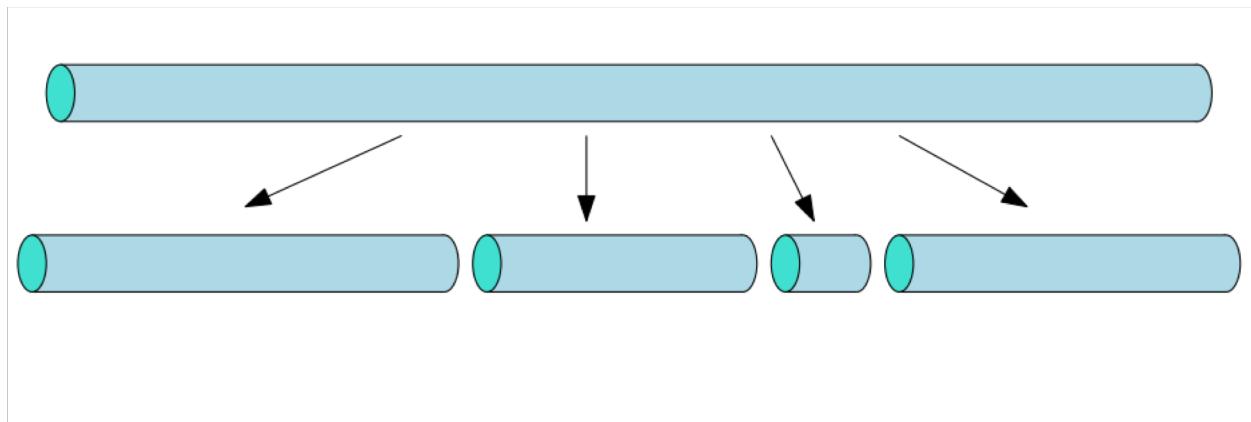


Networks of neurons

# 8. Dynamic Programming

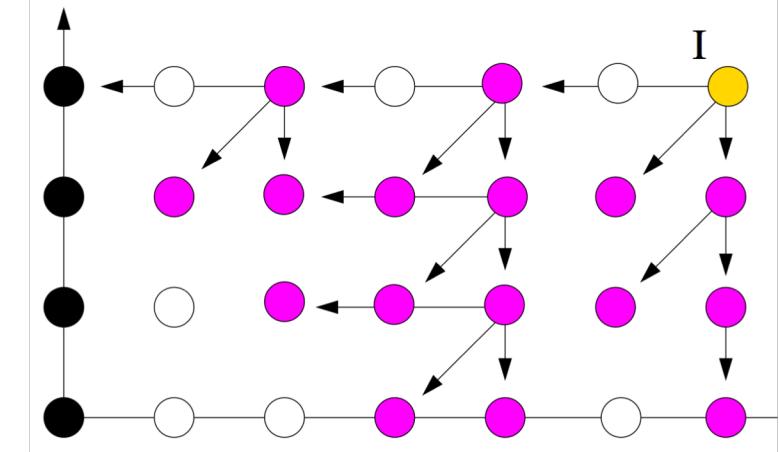
# Fibonaccian

# Cut Problems



length $i$	1	2	3	4	5	6	7	8	9	10
price $p_i$	1	5	8	9	10	17	17	20	24	30

# Dynamic Programming and Reinforcement Learning



# Review

- 1. Binary Number
- 2. Number Representation in computer system
- 3. Categorical and Numerical
- 4. Calculus
- 5. Linear Algebra
- 6. Probability
- 7. Graph Theory
- 8. Dynamic Programming

# References

- Github Reference