數學應用漫談

NCU 數學系

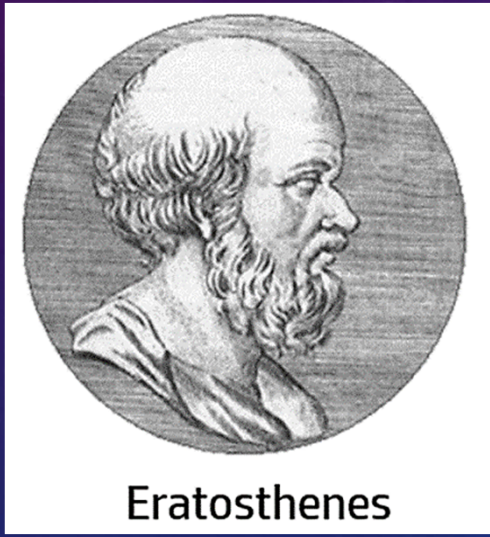
葉鴻國

2016-03-29 學士班

天文與地球

地球的半徑 (Eratosthenes, 240 B.C.) radius = 6371km

- Eratosthenes lived in the city of Alexandria (Egypt).



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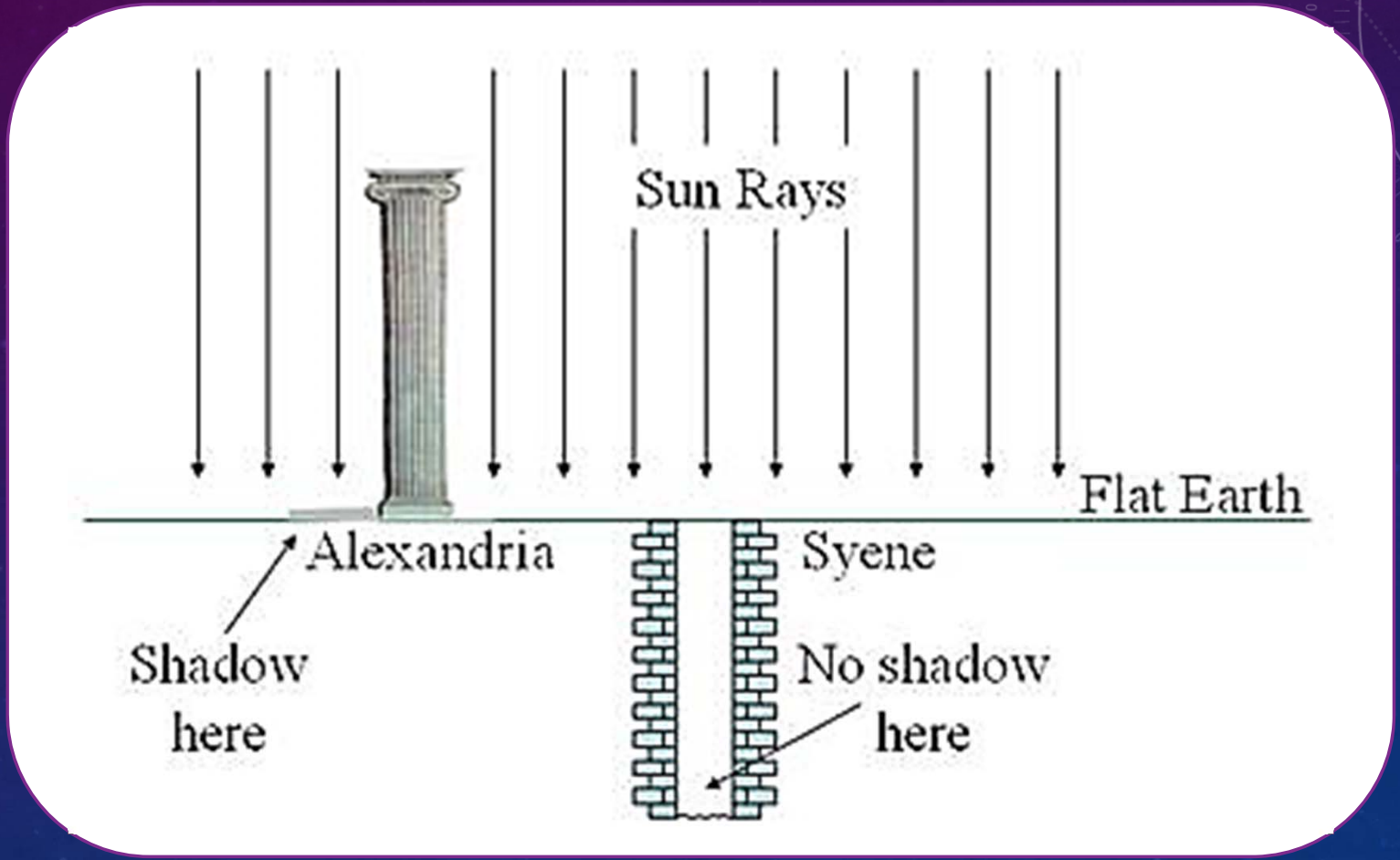

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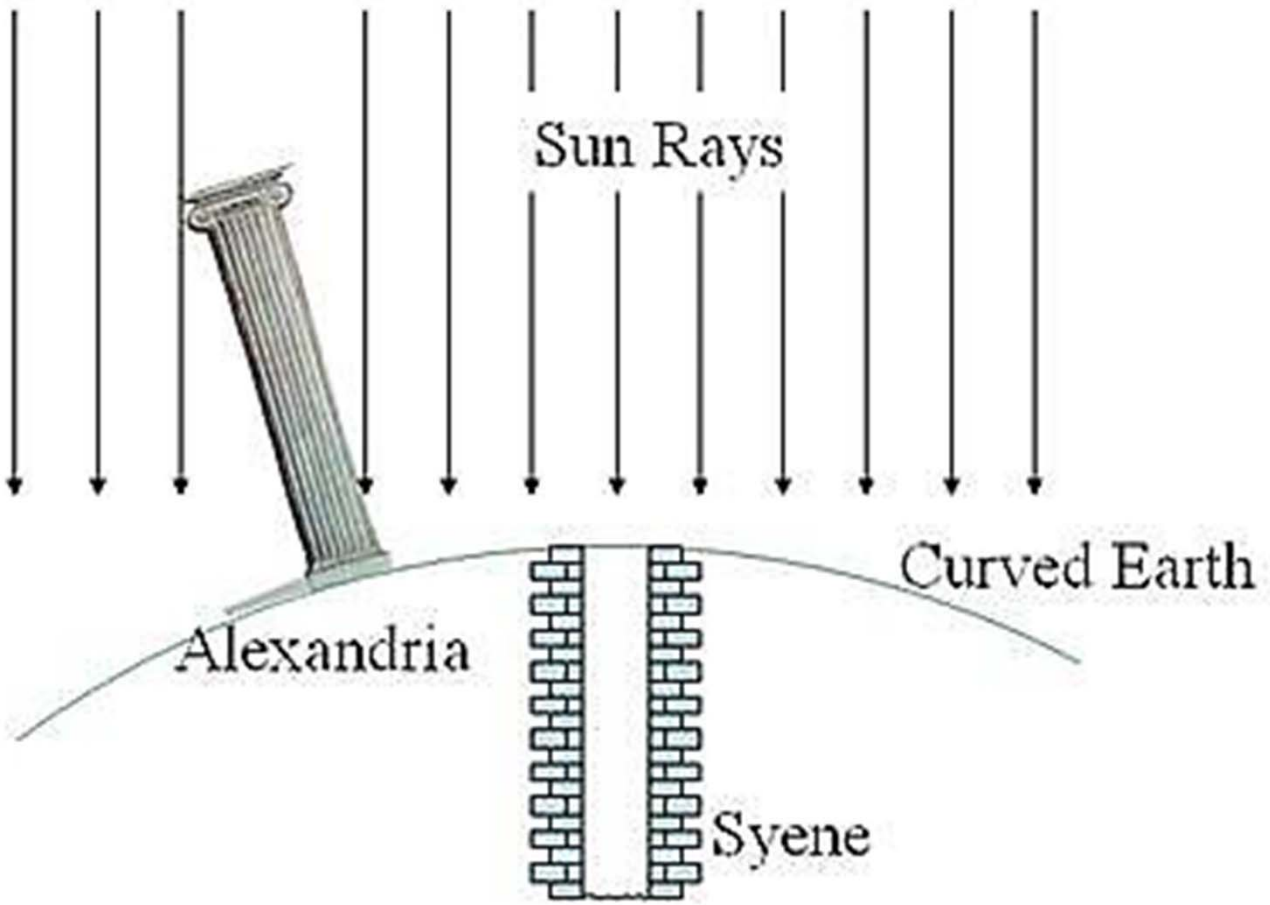

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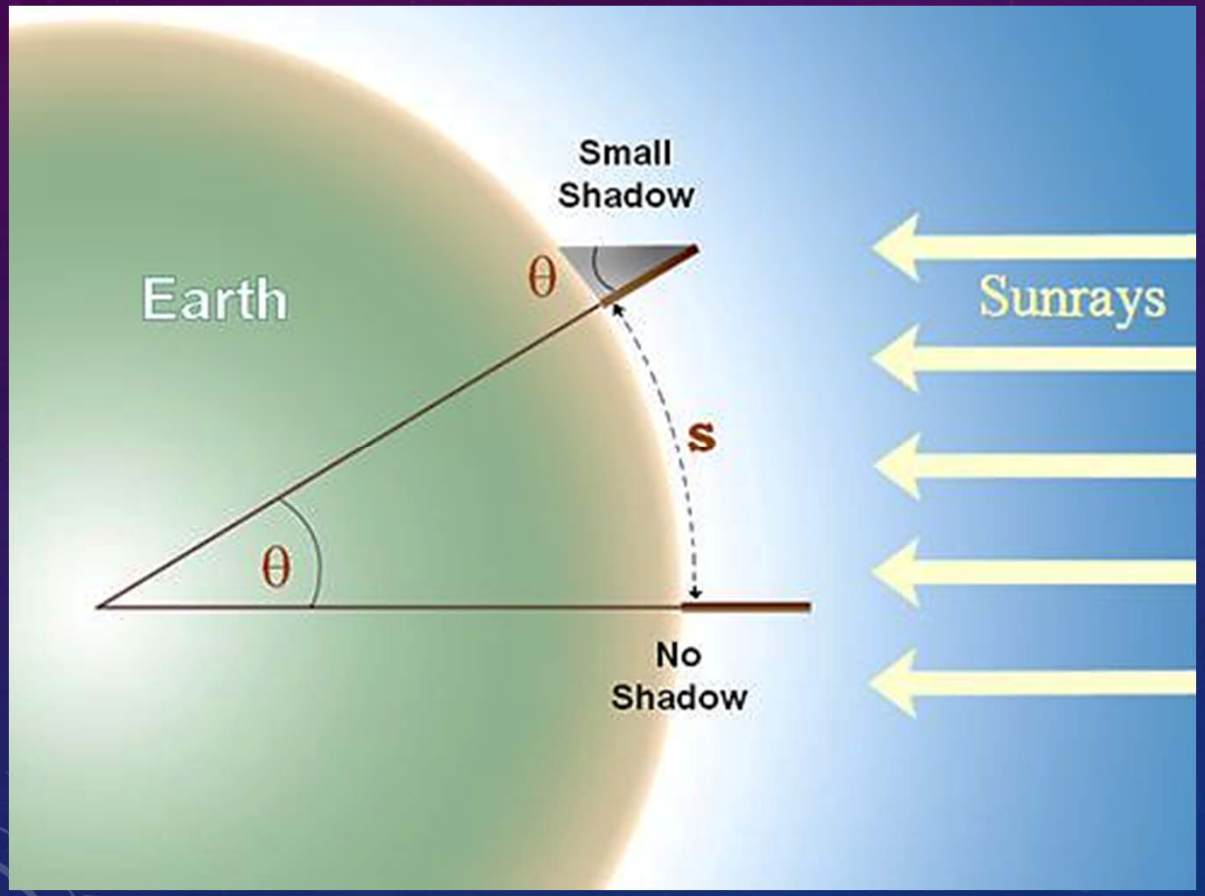


$\theta = 7.2^0$

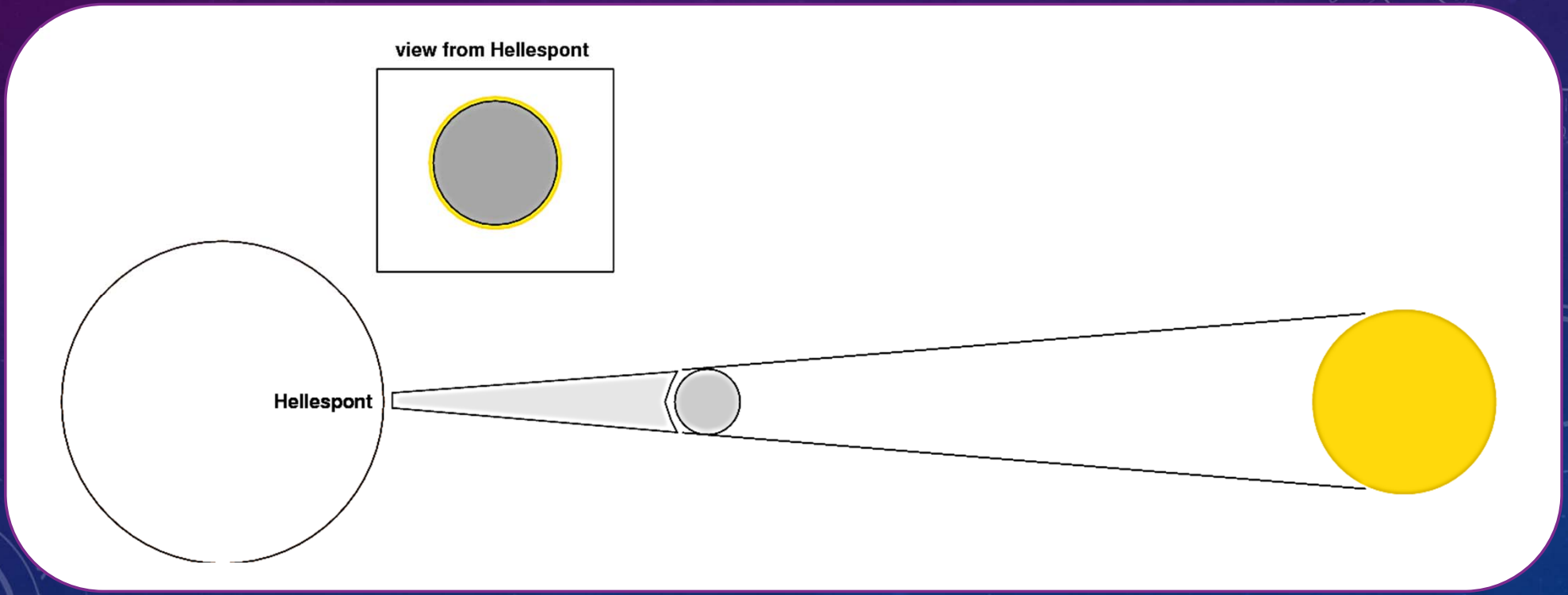
S=800km

(C/S)=(360/7.2)

R=(C/2π)≈6366km

地球到月球的距離(Hipparchus 190 - 120 B.C.) distance≈384400km

- That eclipse was **total** at the **Hellespont,** but only 4/5 of the Sun were covered in Alexandria.



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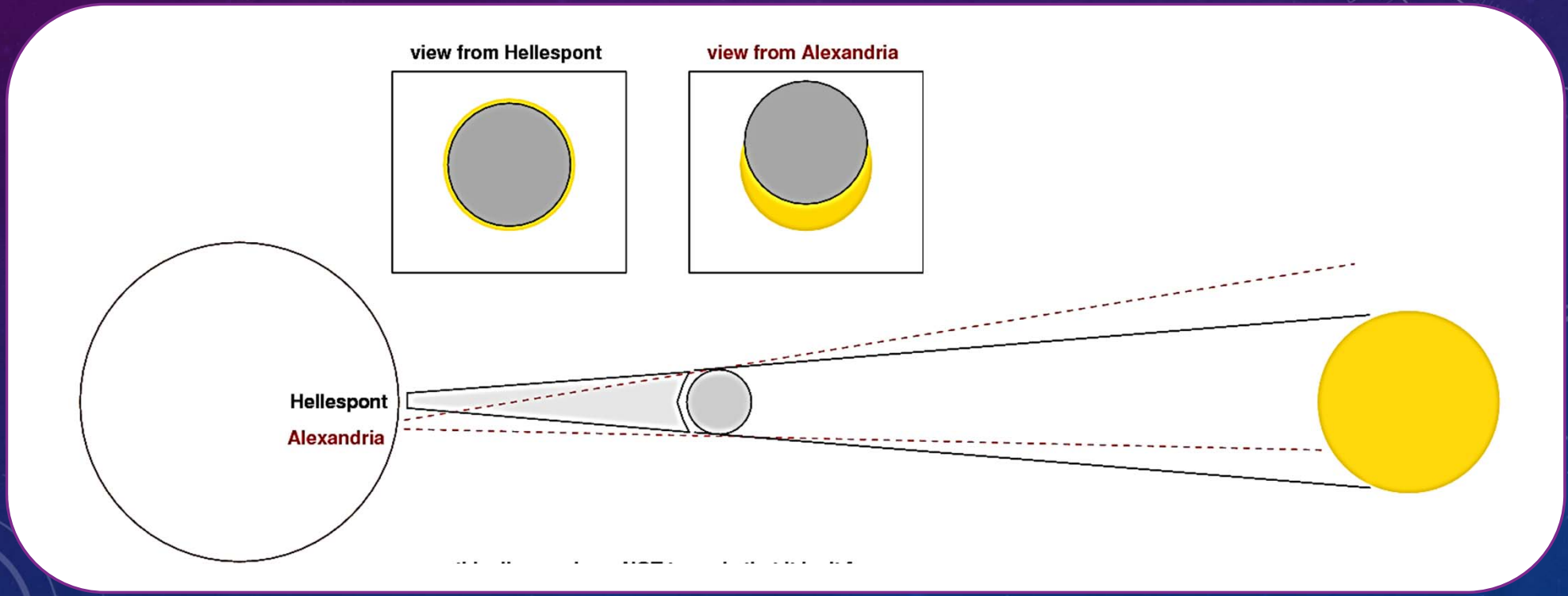
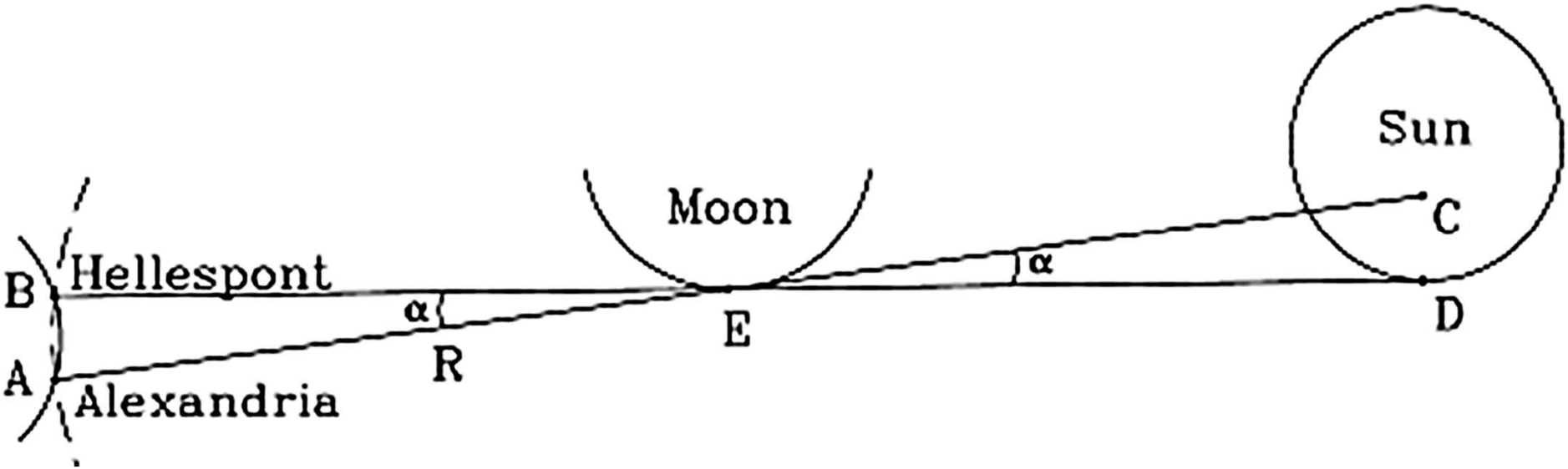


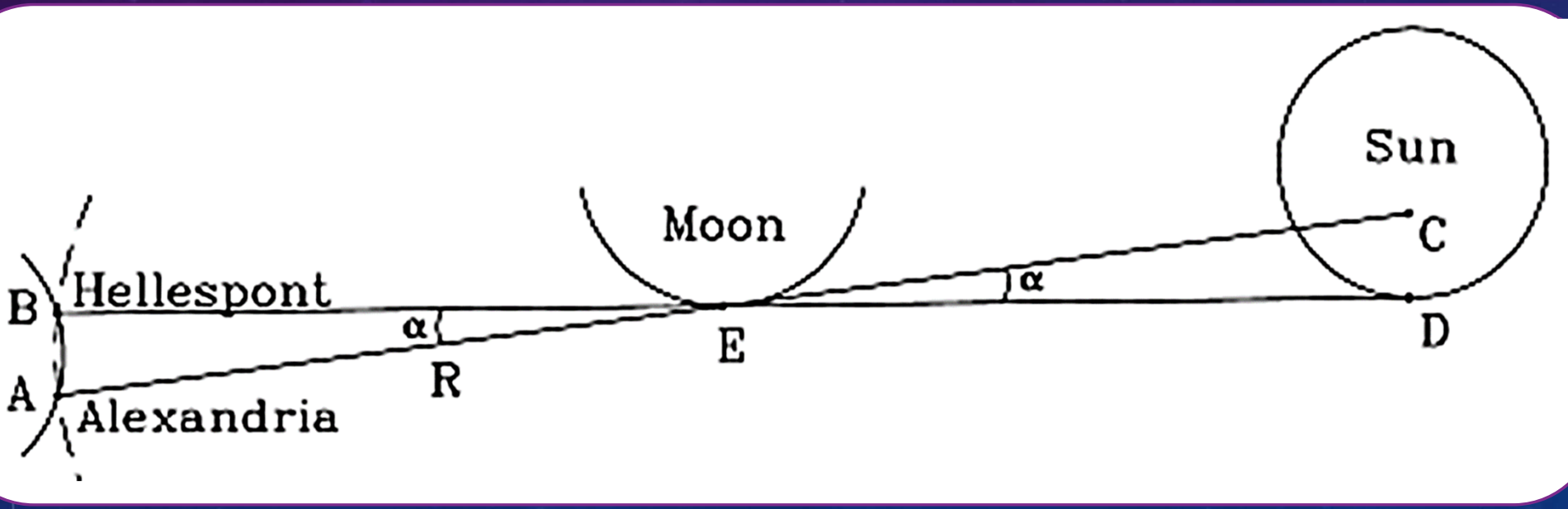
地球到月球的距離(Hipparchus 190 - 120 B.C.) distance≈384400km

- That eclipse was **total** at the **Hellespont,** but only 4/5 of the Sun were covered in Alexandria.
- The Sun itself is so distant that when viewed from anywhere on Earth, it covers practically the same patch of the sky, with a width of about **0.5°**.



地球到月球的距離(Hipparchus 190 - 120 B.C.) distance≈384400km

- 1/5th of the Sun's diameter covers about 0.1° in the sky, so the angle α is about 0.1 degrees.
- The latitude of the Hellespont is about 40° 20, while that of Alexandria is about 31° 20', a difference of 9°.



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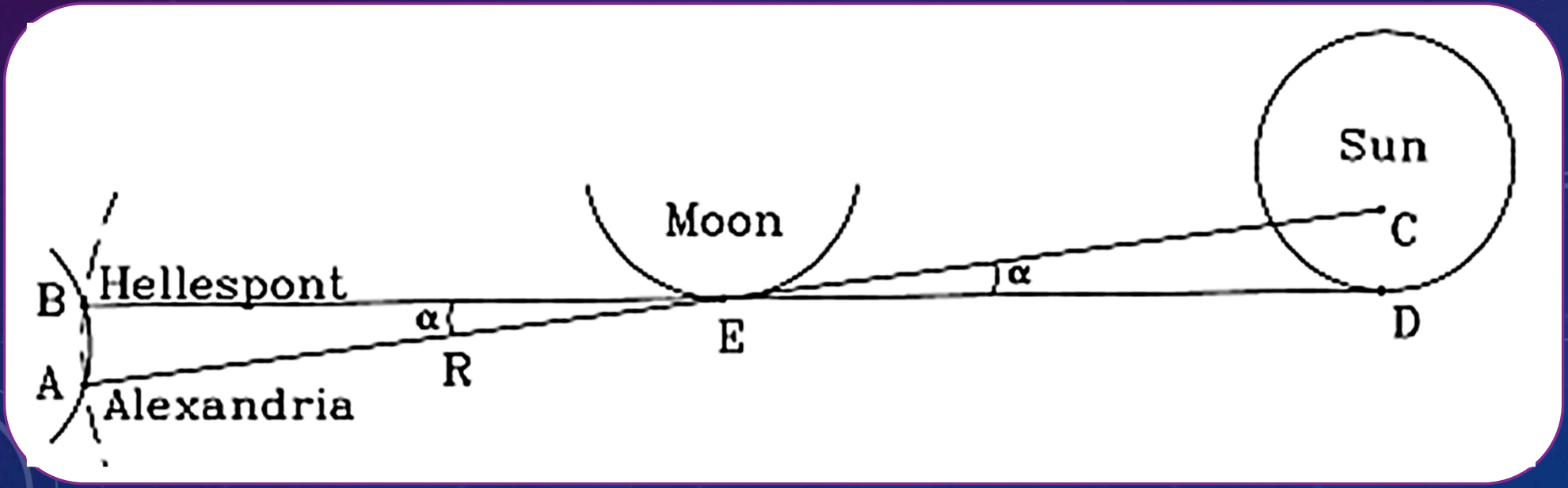
- 1/5th of the Sun's diameter covers about 0.1° in the sky, so the angle α is about 0.1 degrees.
- Let r= Earth radii. $(2\pi R/360)x0.1 = (2\pi r/360)x9$



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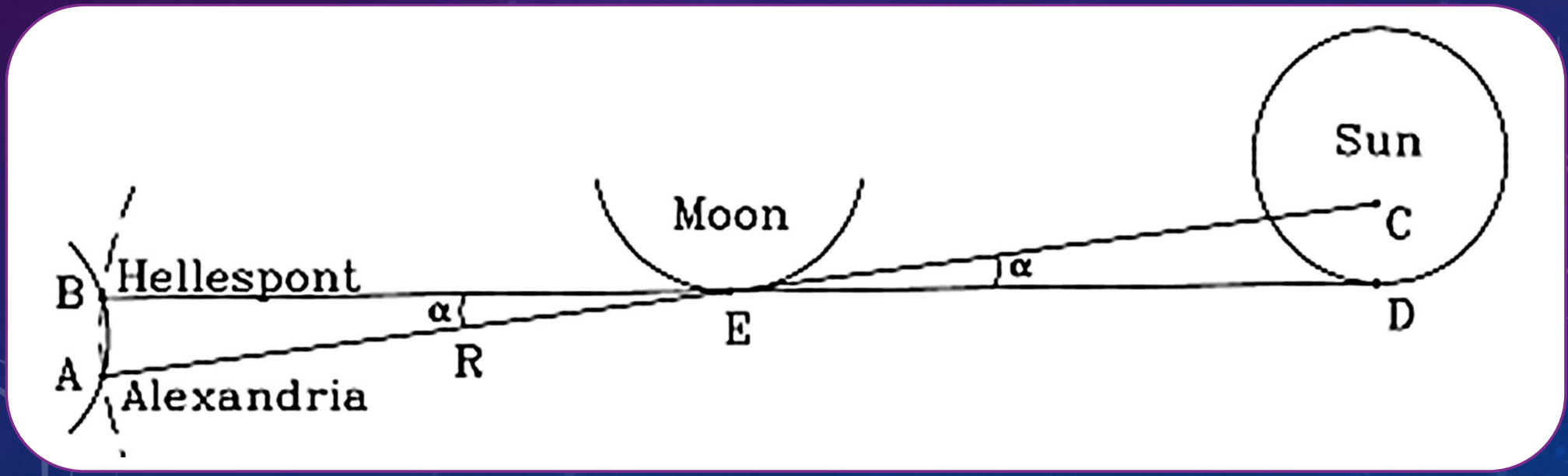
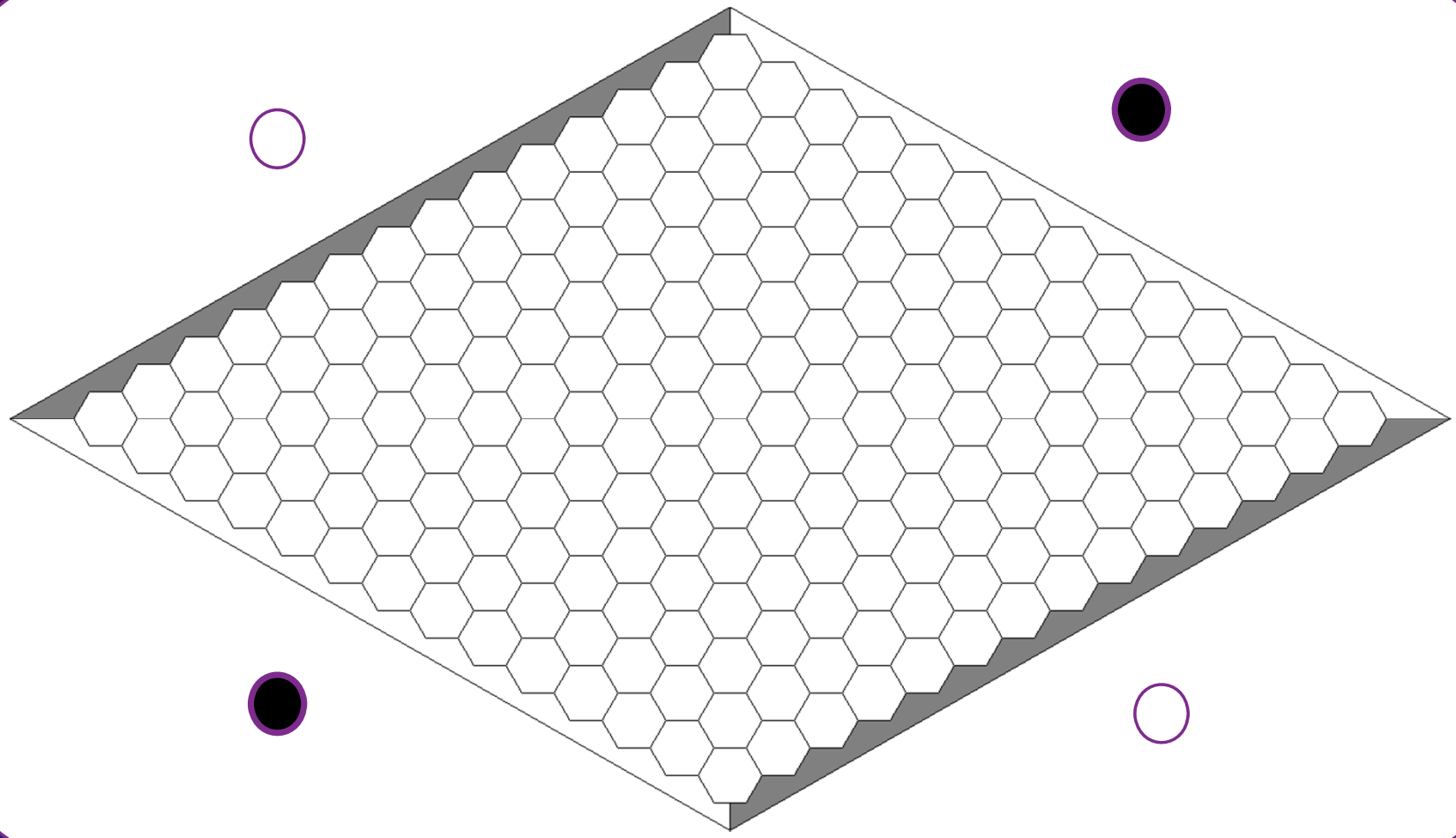
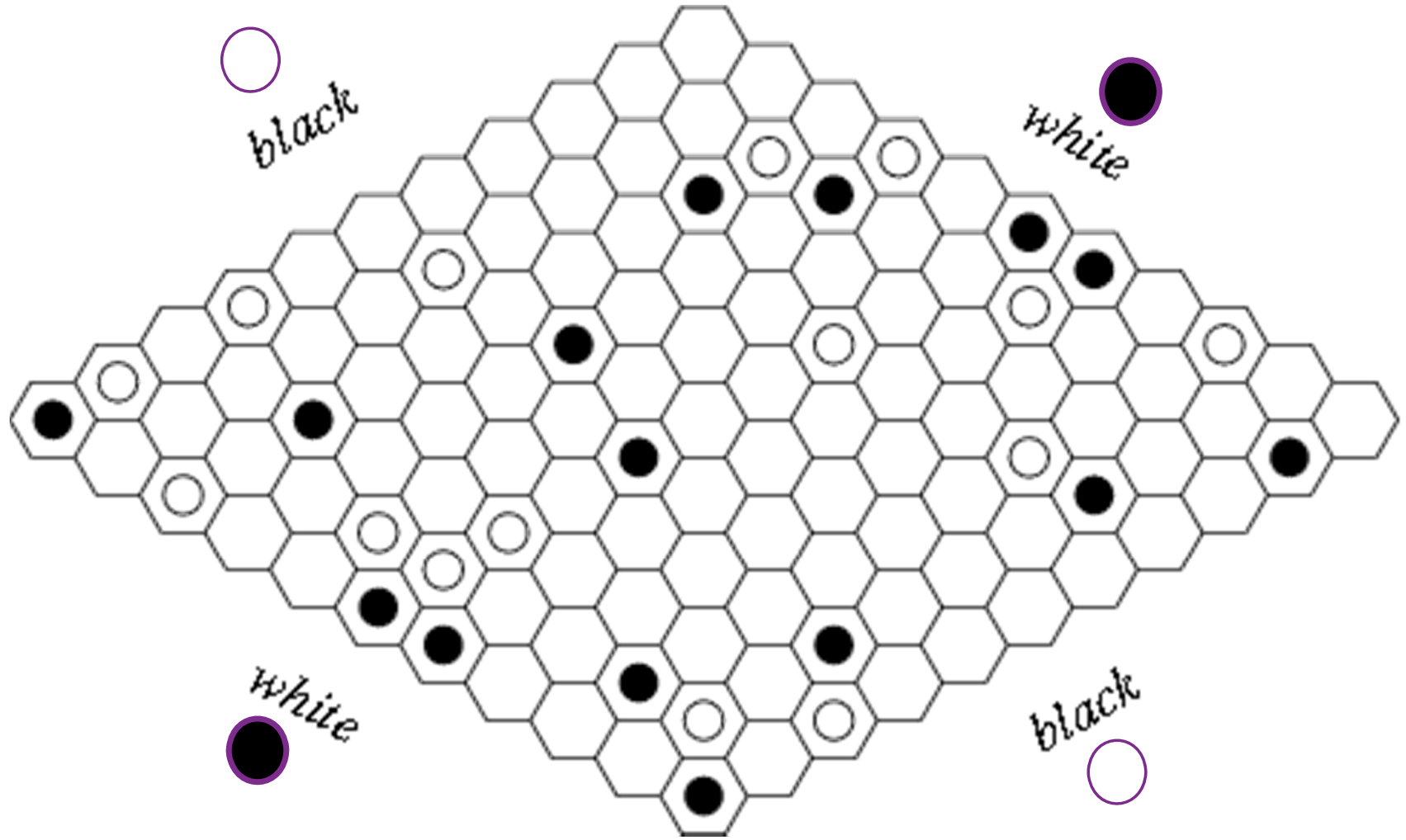
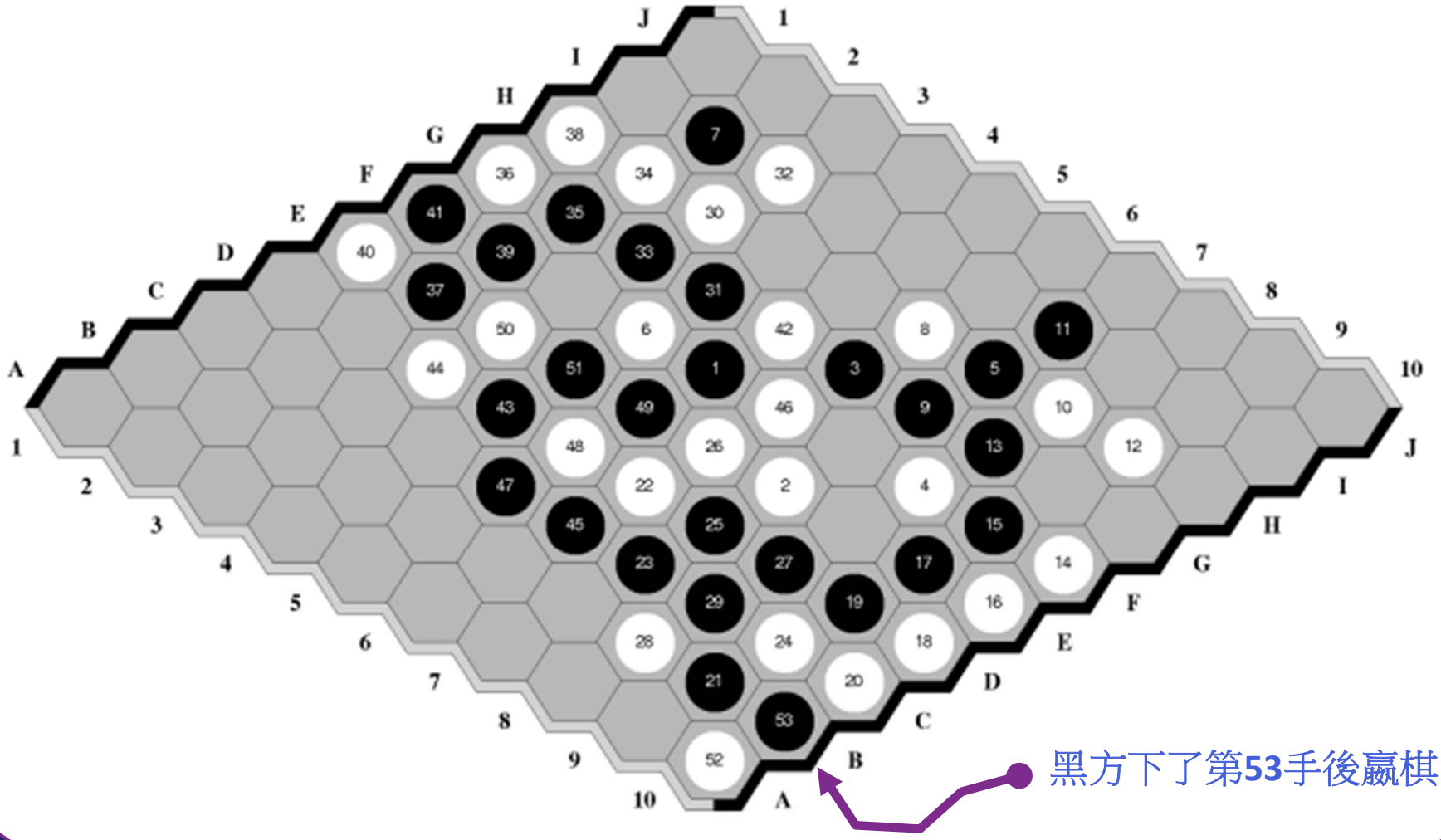
- Let r= Earth radii. $(2\pi R/360)x0.1 = (2\pi r/360)x9$
- Thus **R=90r**, an overstimate of about 50%. (vs about 60 Earth radii)

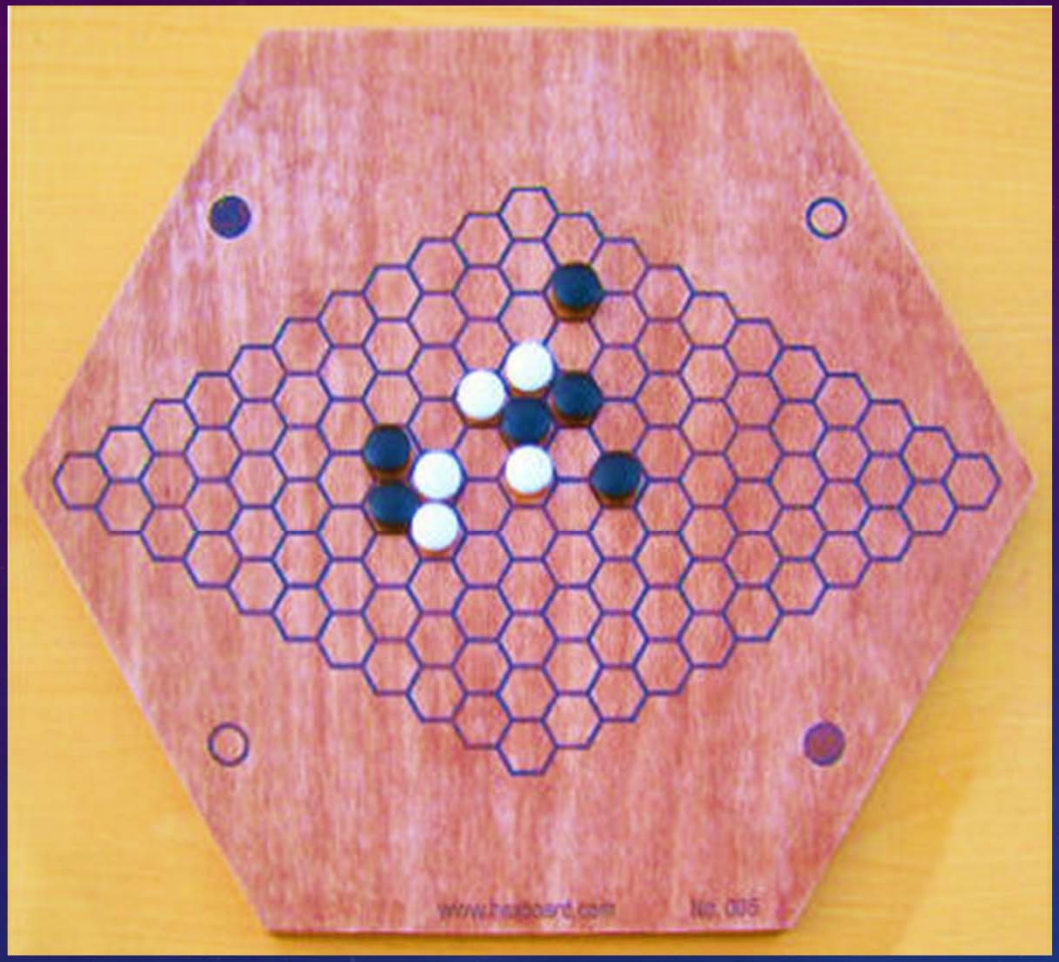


遊戲
HEX GAME




black
white
white
black


黑方下了第53手後贏棋



Source: http://www.hexboard.com/

HEX THEOREM (JOHN NASH, 1948)

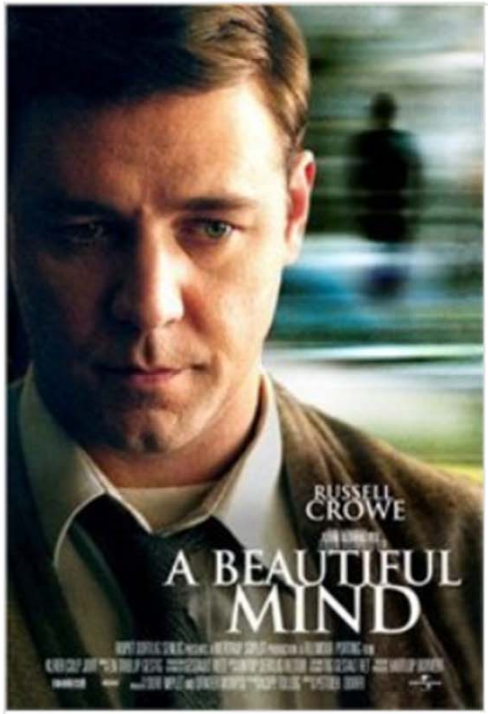
- **Theorem (Hex Theorem)** A game of Hex cannot end in a draw.

HEX THEOREM (JOHN NASH, 1948)

- **Theorem (Hex Theorem)** A game of Hex cannot end in a draw.
- **Theorem** In a game of Hex, the first player always has a winning strategy

JOHN NASH

- John Nash won the 1994 Nobel Prize for his work in non-cooperative game theory, and the Brouwer Theorem is key in proving one of his most celebrated theorems, the existence of Nash Equilibria in games.



Contact the Filmmakers on IMDbPro »

A Beautiful Mind (2001)

Top 5000

PG-13 135 min - Biography | Drama - 8 March 2002 (Taiwan)

8.2

Your rating: ★★★★★★★★★★ -/10

Ratings: **8.2**/10 from 438,759 users Metascore: 72/100
Reviews: 1,138 user | 200 critic | 33 from Metacritic.com

After a brilliant but asocial mathematician accepts secret work in cryptography, his life takes a turn for the nightmarish.

Director: Ron Howard
Writers: Akiva Goldsman, Sylvia Nasar (book)
Stars: Russell Crowe, Ed Harris, Jennifer Connelly | See full cast and crew »

+ Watchlist | Share...

Top 250 #160 | **Won 4 Oscars.** Another 30 wins & 54 nominations. See more awards »

Quick Links

1.布勞威爾(Brouwer)是一位荷蘭數學家和哲學家。他是數學直覺主義流派的創始人，也在拓撲學，集合論，測度論和複分析領域有很多貢獻。

2.出生： 1881 年 2 月 27 日

3.逝世： 1966 年 12 月 2 日，荷蘭

Source: 維基百科

L. E. J. Brouwer

BROUWER FIXED POINT THEOREM

Theorem Let f be a continuous function from the unit square I^2 into itself. Then there exists a point x in I^2 such that f(x) = x.

MAIN RESULT

Theorem

Brouwer's Fixed Point Theorem

is equivalent to

Hex Theorem

Theorem (Hex Theorem) A game of Hex cannot end in a draw.

機率問題
MONTY HALL PROBLEM

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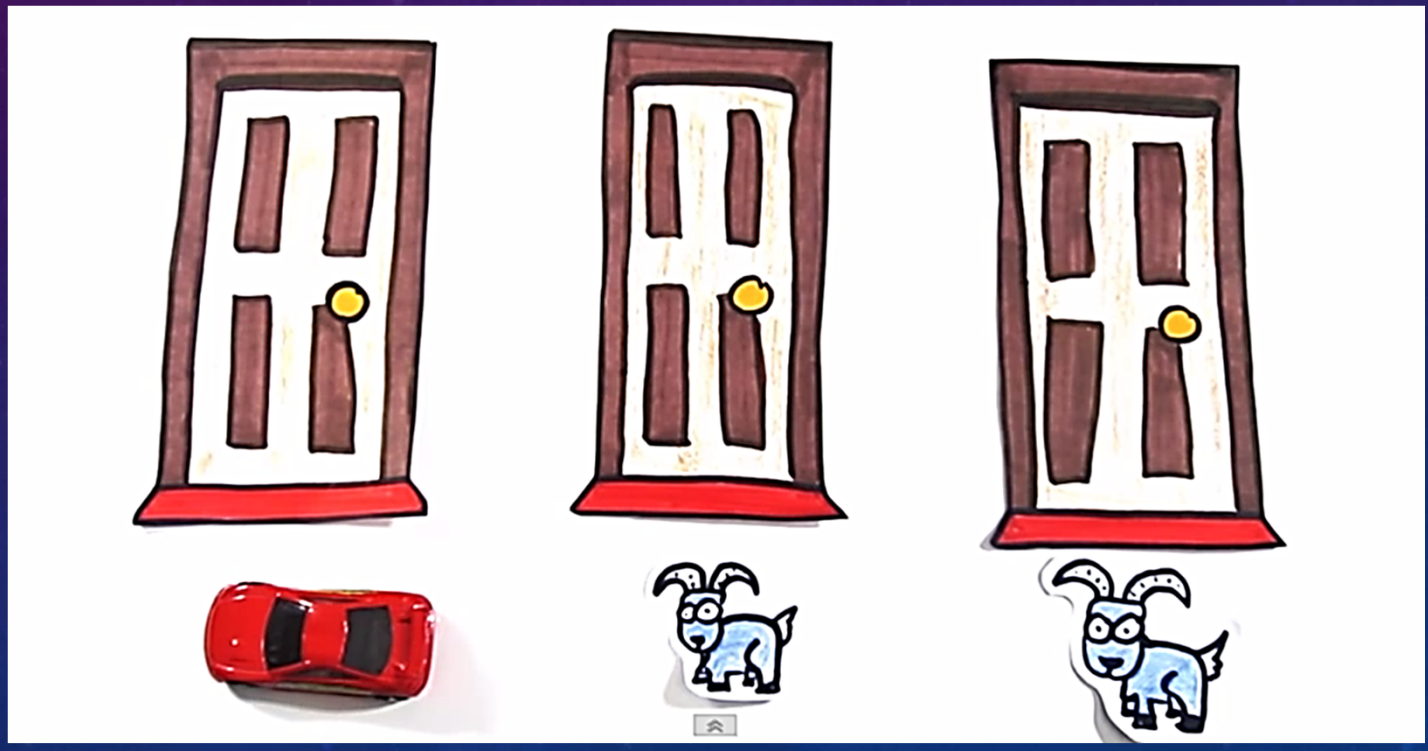
- 蒙提霍爾問題是一個源自博弈論的數學遊戲問題，大致出自美國的電視遊戲節目Let's Make a Deal。問題的名字來自該節目的主持人蒙提·霍爾（Monty Hall）。



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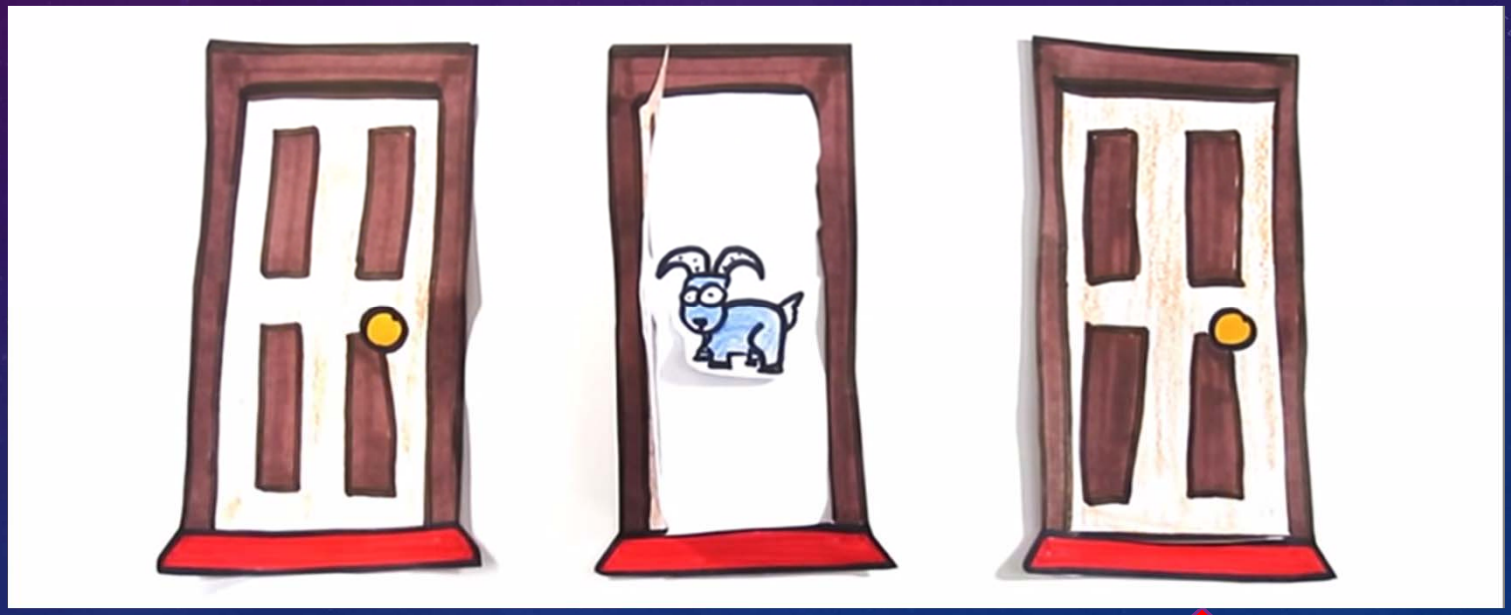

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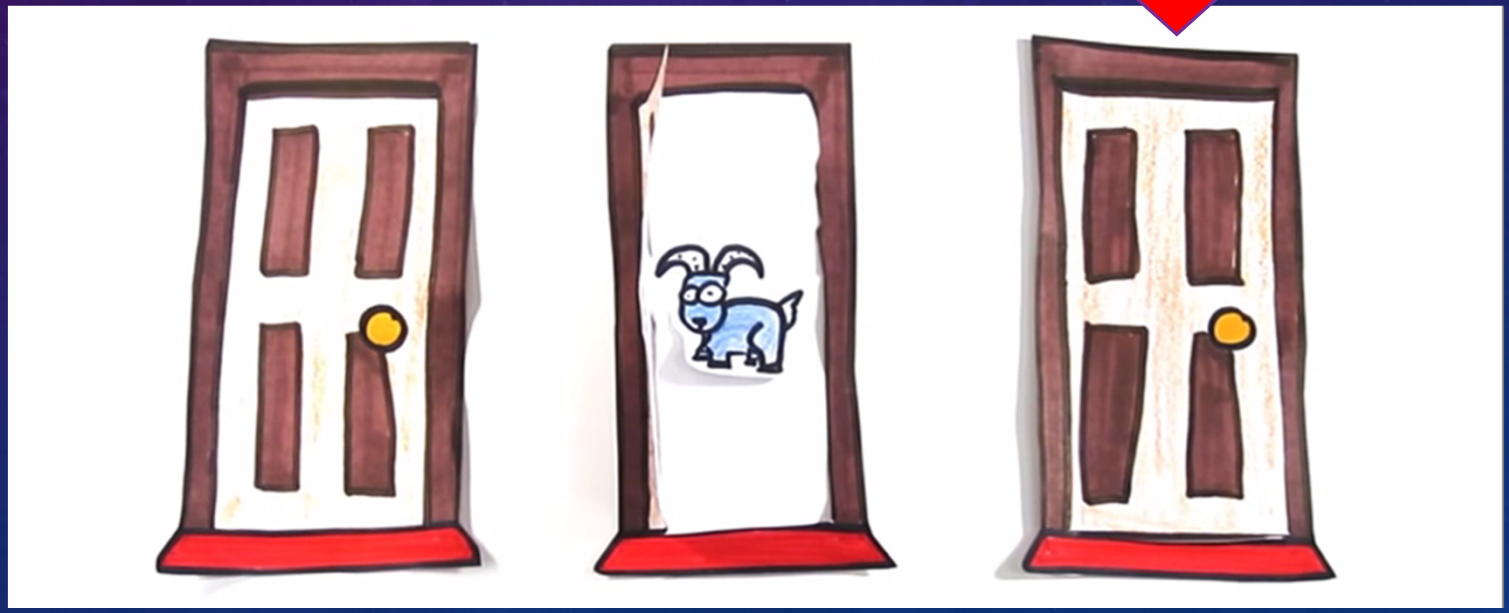
- 參賽者會被問是否保持他的原來選擇，還是轉而選擇剩下的那一道門。
- 轉換選擇可以增加參賽者的機會嗎？

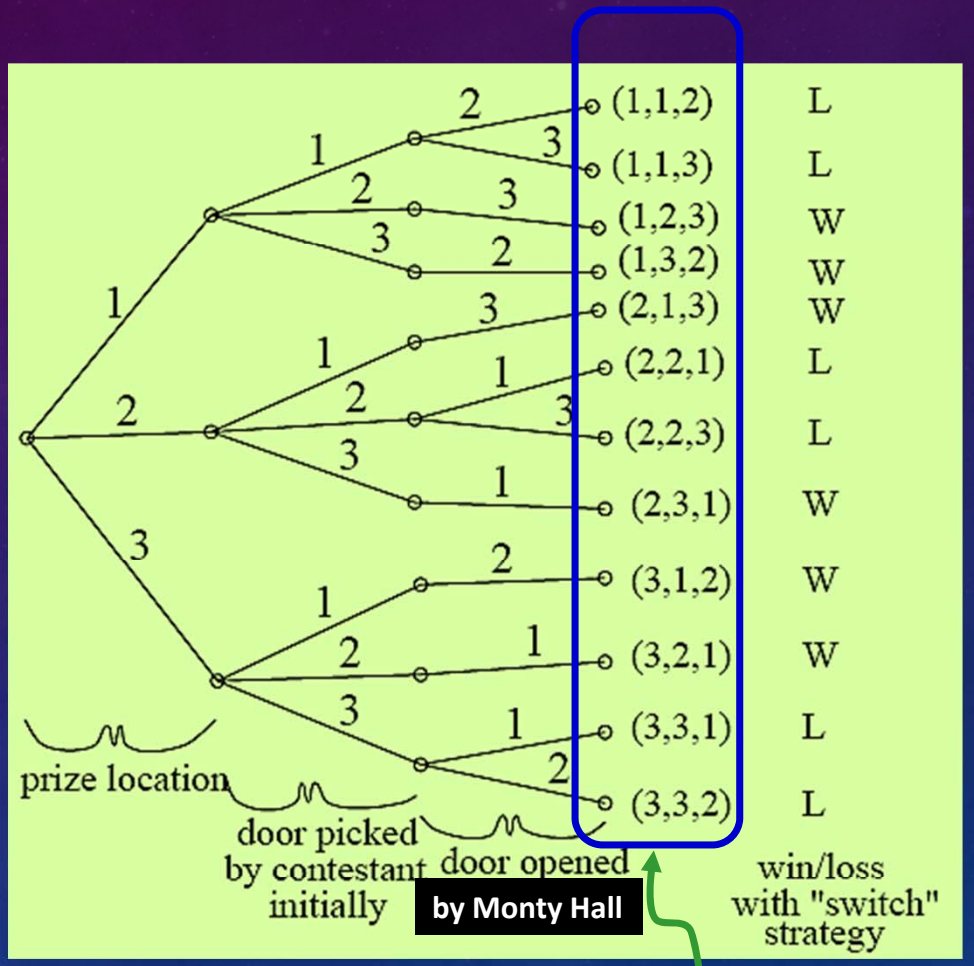


(x,y,z)

X=The number of the door concealing the prize

Y=The number of the door initially chosen by the contestant

Z=The number of the door Monty Hall opens to reveal a goat

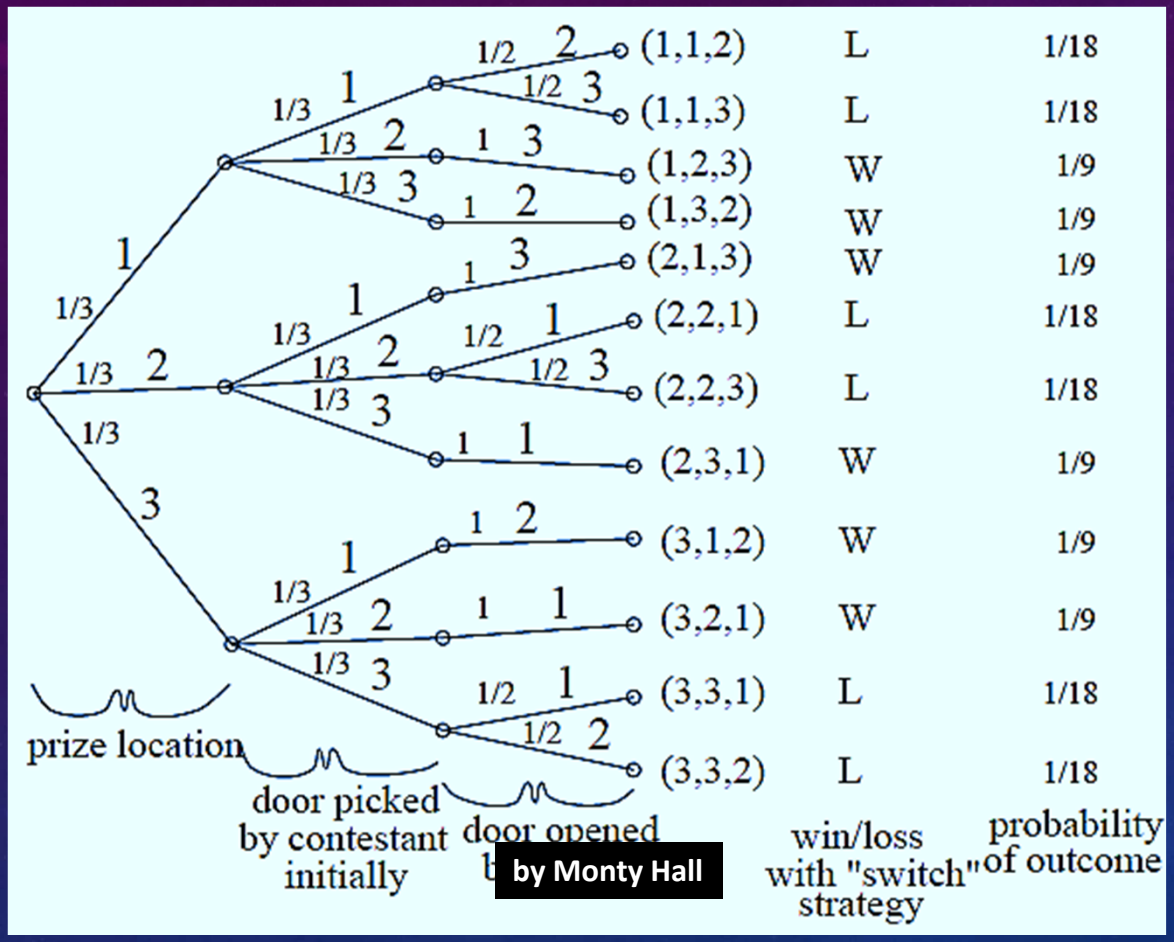


sample space S

S_w := the event that the contestant wins with the "*switch*" strategy

= {(1,2,3), (1,3,2), (2,1,3), (2,3,1), (3,1,2), (3,2,1)}

Claim $\Pr(S_w)=2/3$

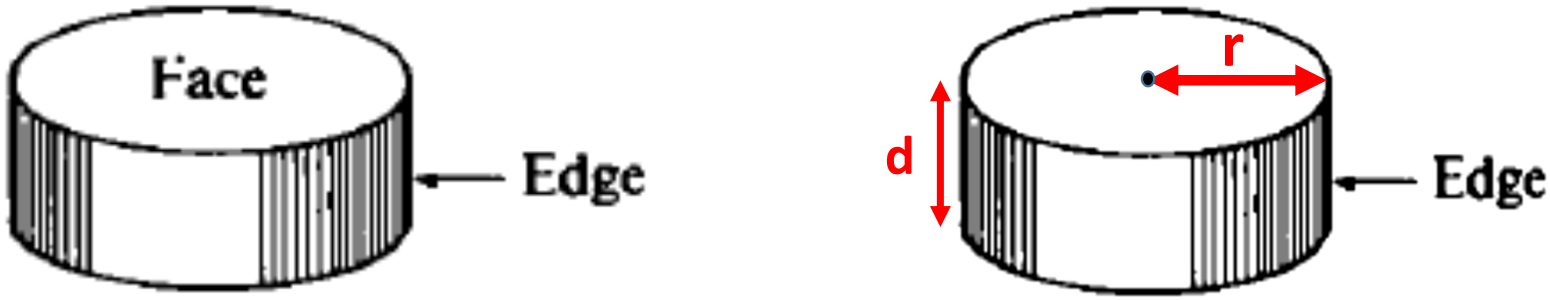


機率問題

THICK COIN PROBLEM

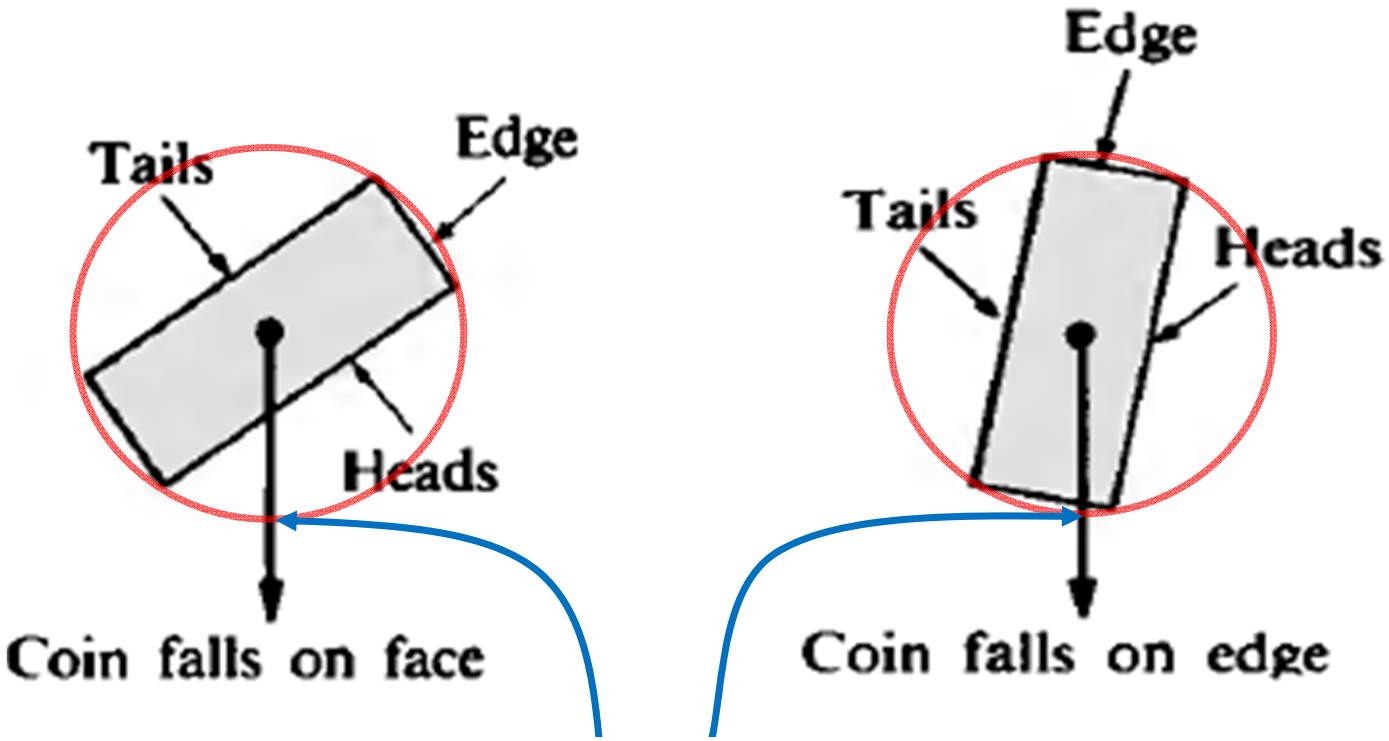
Thick Coin Problem

- **Problem. How thick should a coin be to have a 1/3 chance of landing on edge?**



當初次聽到這個問題, 已故大數學家馮紐曼 (John von Neumann)當著許多想了半天的人之面, 僅在腦中轉了 20 秒就解決了,得到一個小數點三位的答案.

Simplifying Conditions

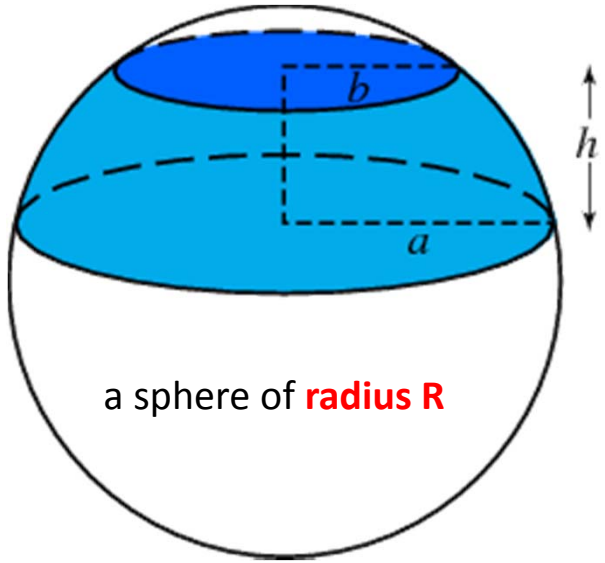


A random point on the surface of the sphere

A Theorem in Geometry

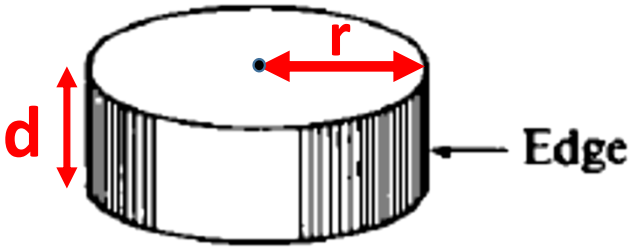
Theorem The surface area **S** of the zone depends only on the height of the zone.

S=2πRh

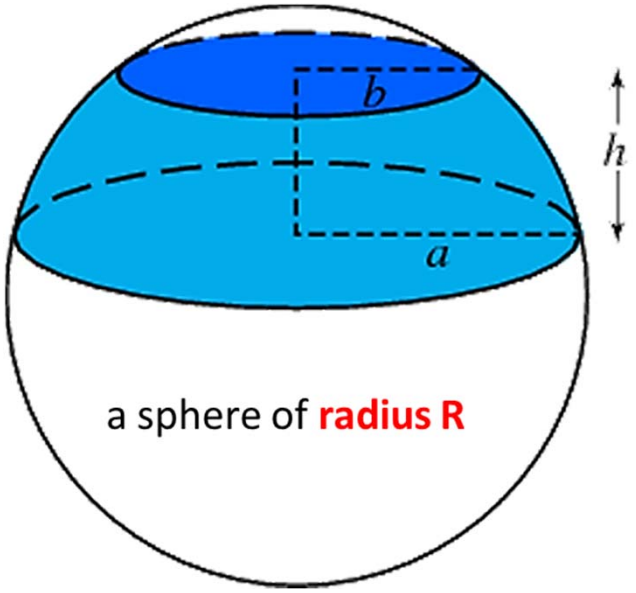


Source: http://mathworld.wolfram.com/Zone.html

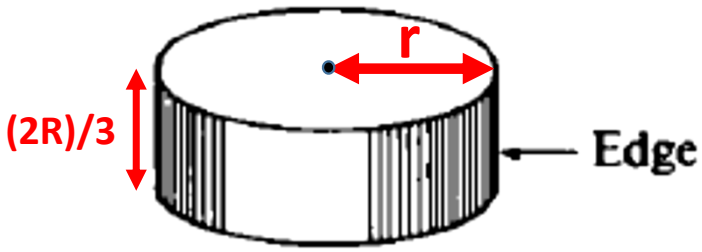
Answer: relation between d and R

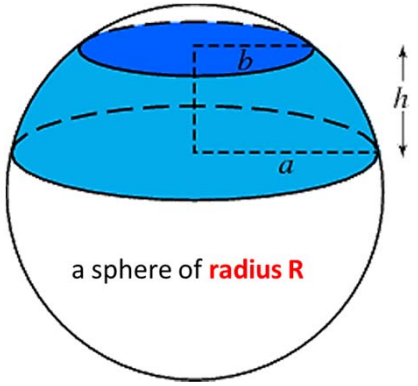


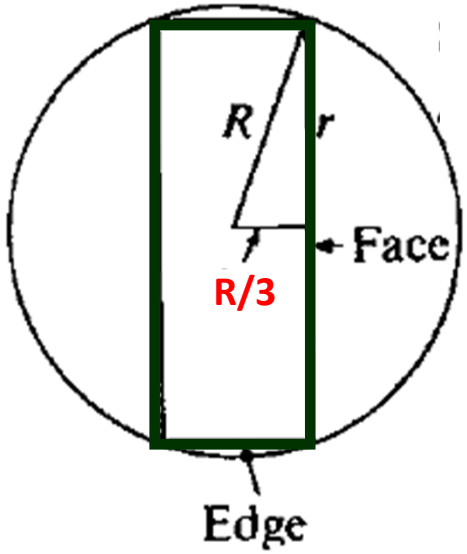
d/(2R)=1/3



Answer: relation between r and R





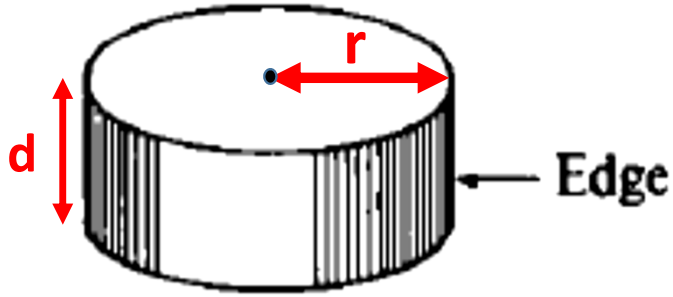


$$\frac{1}{3}R = \frac{\sqrt{2}}{4}r$$

Thickness-diameter ratio

$= d/(2r) = \frac{\sqrt{2}}{4}$

=0.35355 *Done!*



機率問題

THE SUCCESSIVE WINS PROBLEM

THE SUCCESSIVE WINS PROBLEM

- 為了鼓勵阿尼成為網球高手, 他的父親立了一個辦法, 倘若阿尼能於和他及網球俱樂部冠軍交替的三局比賽中連續勝兩局, 就送給阿尼一個獎品, 至於順序為父---冠---父, 或冠---父---冠, 隨阿尼選擇, 已知冠軍的技術比阿尼父親高明, 試問阿尼應如何抉擇?

- **Source: Problem #2 of F. Mosteller's book "Fifty Challenging Problems in Probability with Solutions", 1987.**

SOLUTION

- f:=為擊敗父親的機率,
- c:=為擊敗冠軍的機率,

先與父親交手

F	C	F	機　率
W	W	W	fcf
W	W	L	$fc(1-f)$
L	W	W	$(1-f)cf$
總和			$fc(2-f)$

先與冠軍交手

C	F	C	機　率
W	W	W	cfc
W	W	L	$cf(1-c)$
L	W	W	$(1-c)fc$
總和			$fc(2-c)$

- 因為阿尼擊敗父親的機率比擊敗冠軍的機率大, 即f大於 c. 因此阿尼應選擇:冠---父---冠的順序來挑戰.

密碼學

ZERO KNOWLEDGE PROOF

Two problems

巴布 色盲 愛麗斯 兩件襯衫

1. Bob, who is color blind, goes shopping with his wife Alice. Alice finds two shirts and asks Bob which shirt Bob likes better. The shirts look identical to Bob but Alice says they look different. How can Alice convince Bob that the shirts are indeed different? (Based on a true story) On the other hand, Alice do not want Bob to learn which is red and which is green.

3個職員 平均薪資

2. How do 3 office workers compute the average of their salaries without anyone revealing anything additional about their individual salaries?

個別薪資

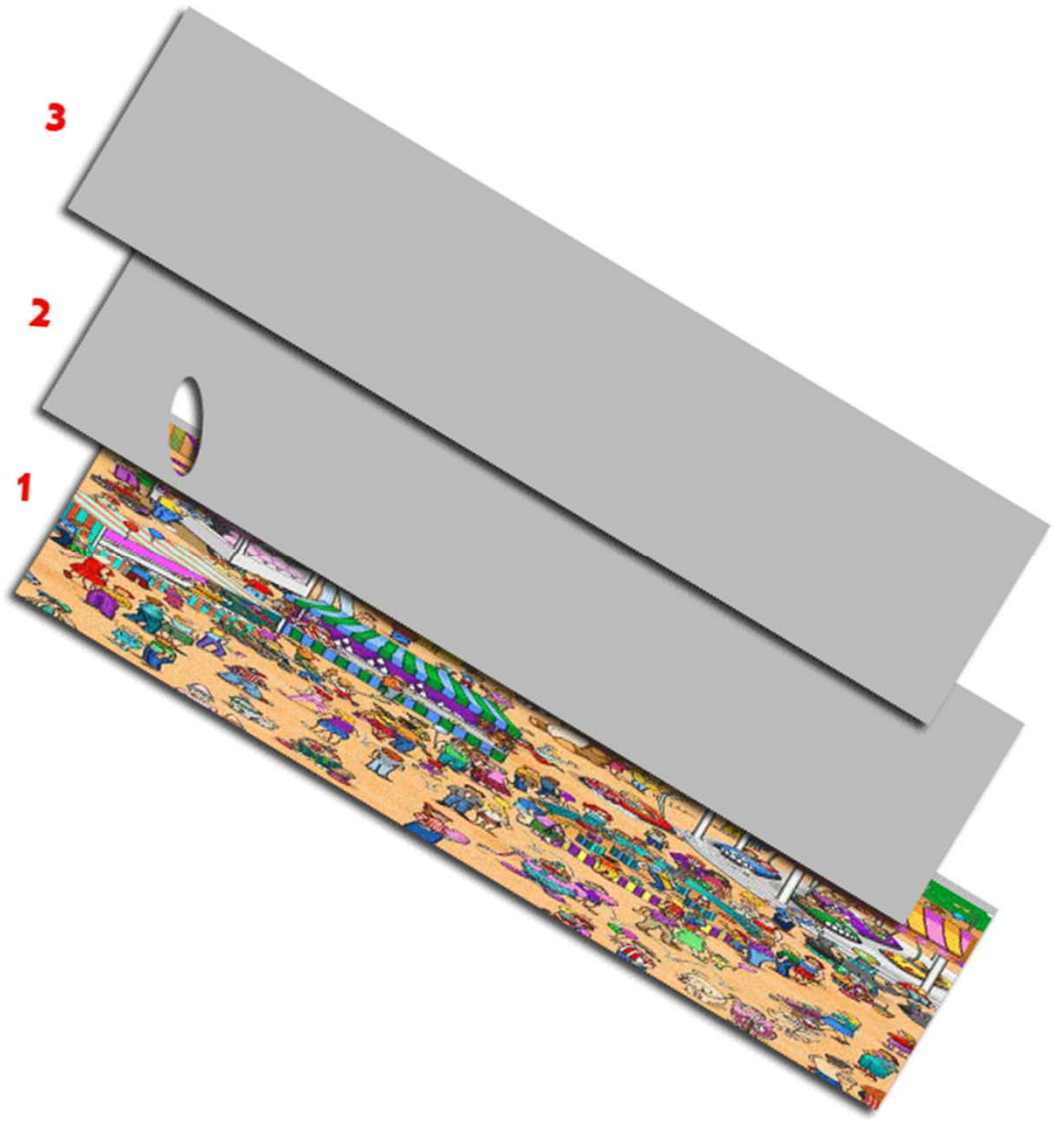
Where's Wally?

威利在那裡?


COTTON CANDY

怎麼說服別人

- **How** can I prove to you that I know where 威利 is without revealing his location**?**


3
2
1

被說服者的選項

- You then choose a number: 1 or 2.
- **If you choose 1**, ***I remove both pieces of paper***, revealing to you the entire *image*.


COTTON CANDY

被說服者的選項

- You then choose a number: 1 or 2.
- **If you choose 1**, ***I remove both pieces of paper***, revealing to you the entire *image*.
- **If you choose 2**, ***I remove only the top piece of paper***, revealing to you that I know where **Wally** is, as such:

What we got is this:

- **If I know** where **Wally** is, I can deliver a correct answer that you can verify 100% of the time.
- **If I am lying** and I do not know where **Wally** is, YOU will bust me with a probability of at least 1/2.

Sudoku

數獨

Sudoku

I can’t solve it.

I know solution.

	9			8		4		
		2		4	1			5
3							6	
	1							
7	6			2			1	9
							8	
	2							8
5			2	9		3		
		4		5			2	

Sudoku

I can’t solve it.

I know solution.

	9			8		4		
		2		4	1			5
3							6	
	1							
7	6			2			1	9
							8	
	2							8
5			2	9		3		
		4		5			2	

1	9	7	6	8	5	4	3	2
6	8	2	3	4	1	7	9	5
3	4	5	9	7	2	8	6	1
4	1	8	5	6	9	2	7	3
7	6	3	8	2	4	5	1	9
2	5	9	7	1	3	6	8	4
9	2	6	4	3	7	1	5	8
5	7	1	2	9	8	3	4	6
8	3	4	1	5	6	9	2	7

Sudoku

I can't solve it.

I know solution.

1	9	7	6	8	5	4	3	2
6	8	2	3	4	1	7	9	5
3	4	5	9	7	2	8	6	1
4	1	8	5	6	9	2	7	3
7	6	3	8	2	4	5	1	9
2	5	9	7	1	3	6	8	4
9	2	6	4	3	7	1	5	8
5	7	1	2	9	8	3	4	6
8	3	4	1	5	6	9	2	7

2	3	1	9	7	4	5	6	8
9	7	8	6	5	2	1	3	4
6	5	4	3	1	8	7	9	2
5	2	7	4	9	3	8	1	6
1	9	6	7	8	5	4	2	3
8	4	3	1	2	6	9	7	5
3	8	9	5	6	1	2	4	7
4	1	2	8	3	7	6	5	9
7	6	5	2	4	9	3	8	1

Alice goes to a different room than Bob and chooses a random permutation σ of {1,…,9}
say σ(1)=2, σ(2)=8, σ(3)=6, σ(4)=5, σ(5)=4, σ(6)=9, σ(7)=1, σ(8)=7 and σ(9)=3.
Alice then permutes the solution using σ as such.

Sudoku

I can't solve it.

I know solution.

∗ **Alice then puts each entry into a lockbox and gives the lockboxes to Bob.**

	9			8		4		
		2		4	1			5
3							6	
	1							
7	6			2			1	9
							8	
	2							8
5			2	9		3		
		4		5			2	

2	3	1	9	7	4	5	6	8
9	7	8	6	5	2	1	3	4
6	5	4	3	1	8	7	9	2
5	2	7	4	9	3	8	1	6
1	9	6	7	8	5	4	2	3
8	4	3	1	2	6	9	7	5
3	8	9	5	6	1	2	4	7
4	1	2	8	3	7	6	5	9
7	6	5	2	4	9	3	8	1

Sudoku

I can't solve it.

∗ **Alice then puts each entry into a lockbox and gives the lockboxes to Bob.**

	9			8		4		
		2		4	1			5
3							6	
	1							
7	6			2			1	9
							8	
	2							8
5			2	9		3		
		4		5			2	

I know solution.

Bob can make one of 28 choices.

1. Choose one of the rows.
2. Choose one of the columns.
3. Choose one of the sub-boxes.
4. See the permuted version of the original puzzle.

Sudoku

I can't solve it.

∗ **Alice then puts each entry into a lockbox and gives the lockboxes to Bob.**

	9			8		4		
		2		4	1			5
3							6	
	1							
7	6			2			1	9
							8	
	2							8
5			2	9		3		
		4		5			2	

5	2	7	4	9	3	8	1	6

I know solution.

4th Row

Sudoku

I can’t solve it.

	9			8		4		
		2		4	1			5
3							6	
	1							
7	6			2			1	9
							8	
	2							8
5			2	9		3		
		4		5			2	

5	2	7						
1	9	6						
8	4	3						

I know solution.

Left Center Box

Sudoku

I can't solve it.

	9			8		4		
		2		4	1			5
3							6	
	1							
7	6			2			1	9
							8	
	2							8
5			2	9		3		
		4		5			2	

I know solution.

Original

Why should Bob now be convinced that a solution exists?
If there was no solution, Alice could not find a permutation that causes Victor to accept for all of his 28 choices for the permuted puzzle is just the original puzzle in disguise.
If Bob makes his choice at random then he will catch a cheating Alice with probability at least 1/28.
That still gives Alice a possible 27/28 chance of cheating.
So repeat the protocol 150 times, each time Alice throws away the unused lock boxes and chooses a new permutation.
Alice's chance of cheating in every round is at most $(27/28)^{150} < 0.5\%$.

如何透過電話打牌

Mental Poker

Adi Shamir, Ronald L. Rivest and Leonard M. Adleman

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

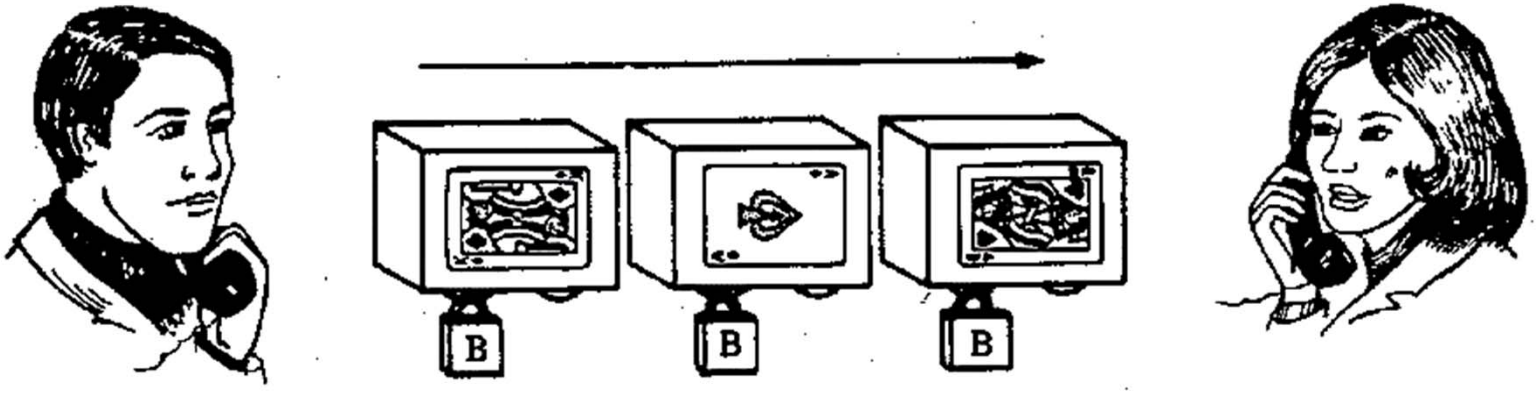
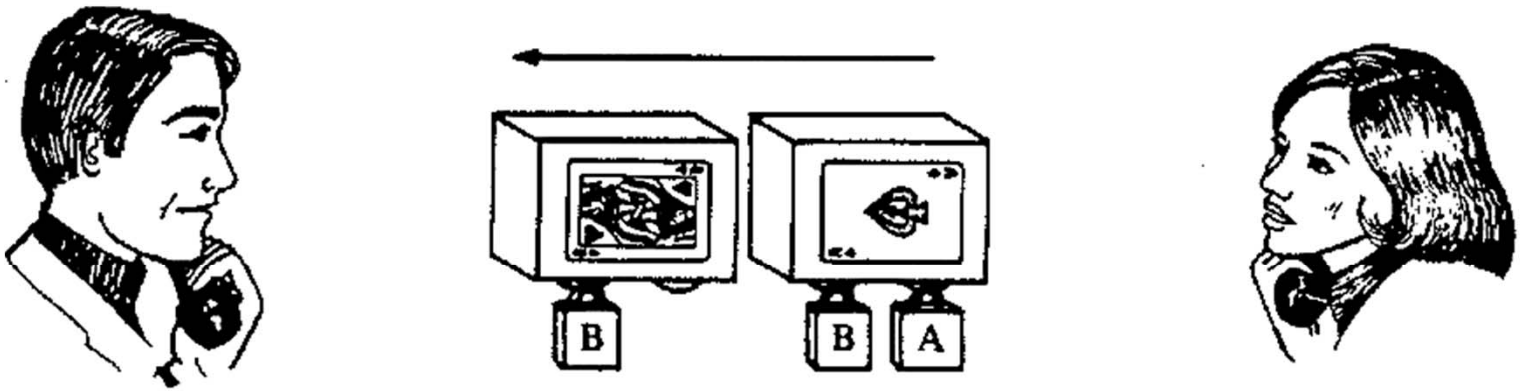
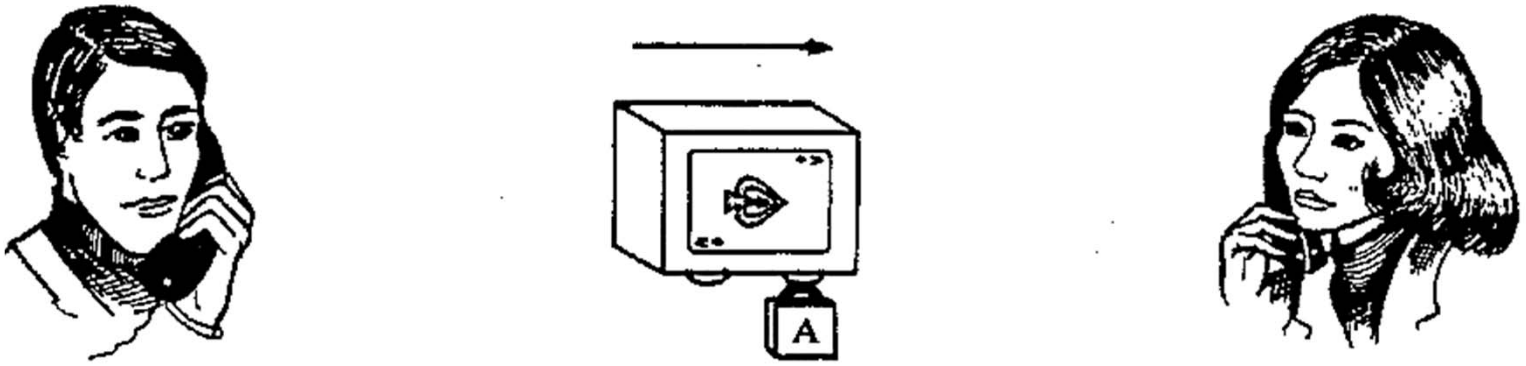


FIGURE 1

Bob encrypts the cards and sends them to Alice in scrambled order.



Alice chooses one for Bob, and encrypts another for herself, and sends them both to Bob.



Bob decrypts both cards, and returns Alice's encrypted card to her.

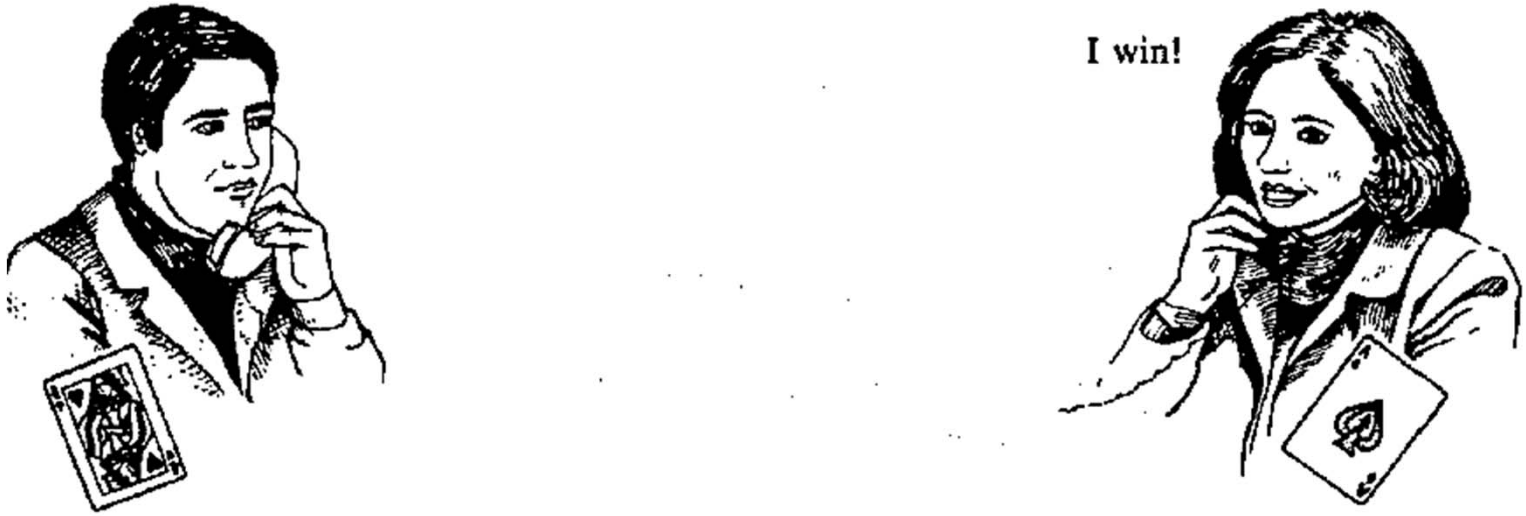
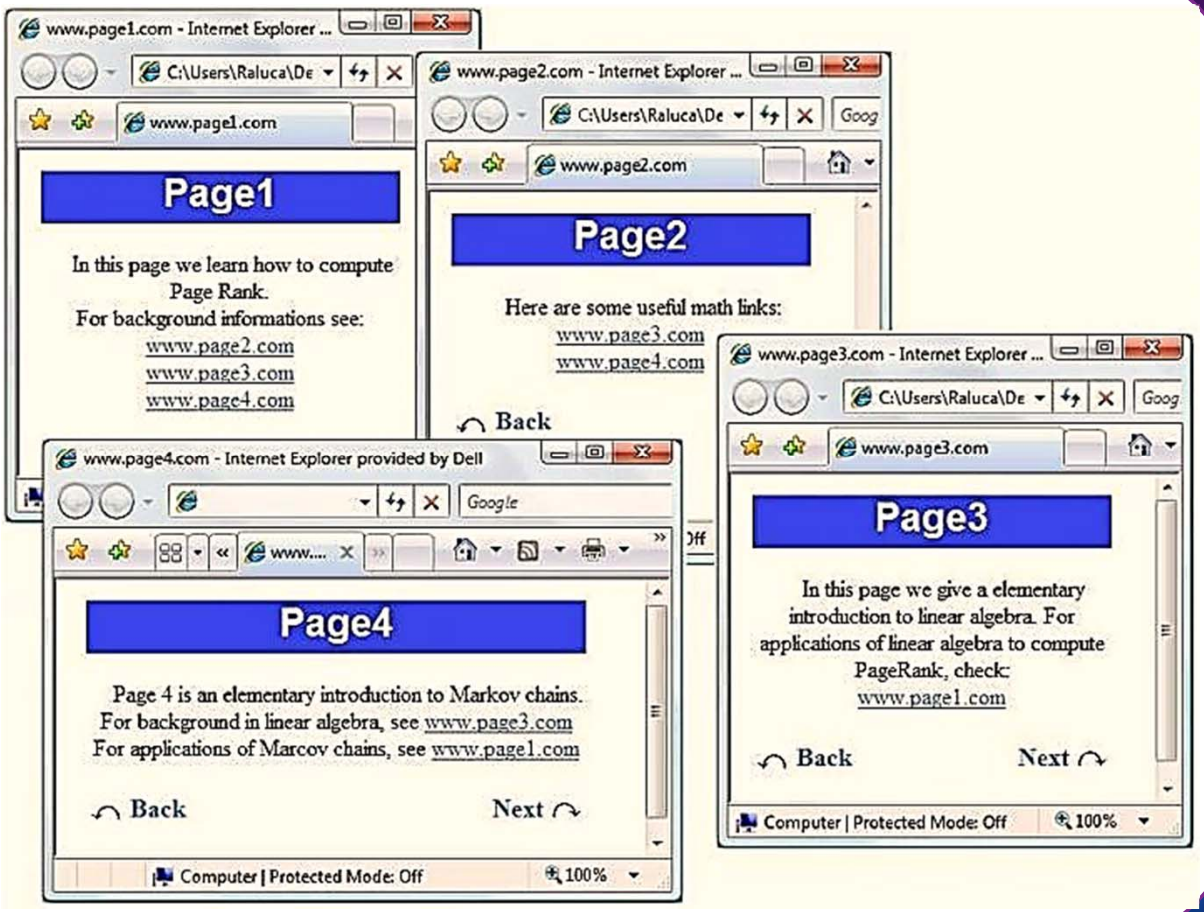
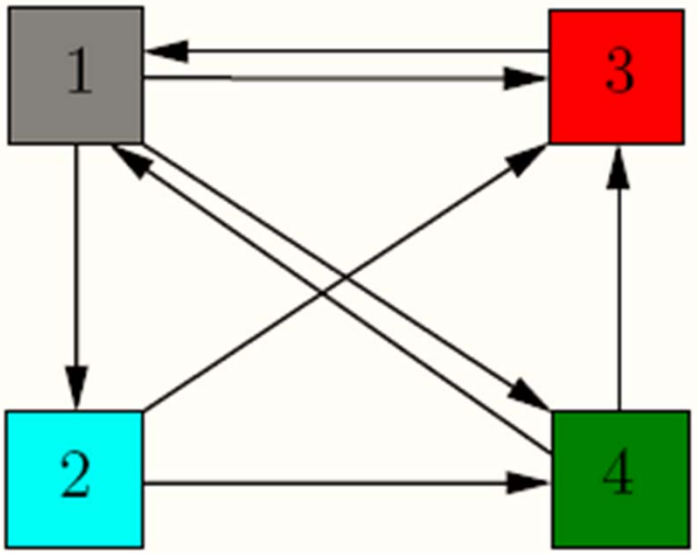


FIGURE 2
Alice decrypts her card, and then they compare cards to see who has won.

網頁搜尋
GOOGLE SEARCH ENGINE

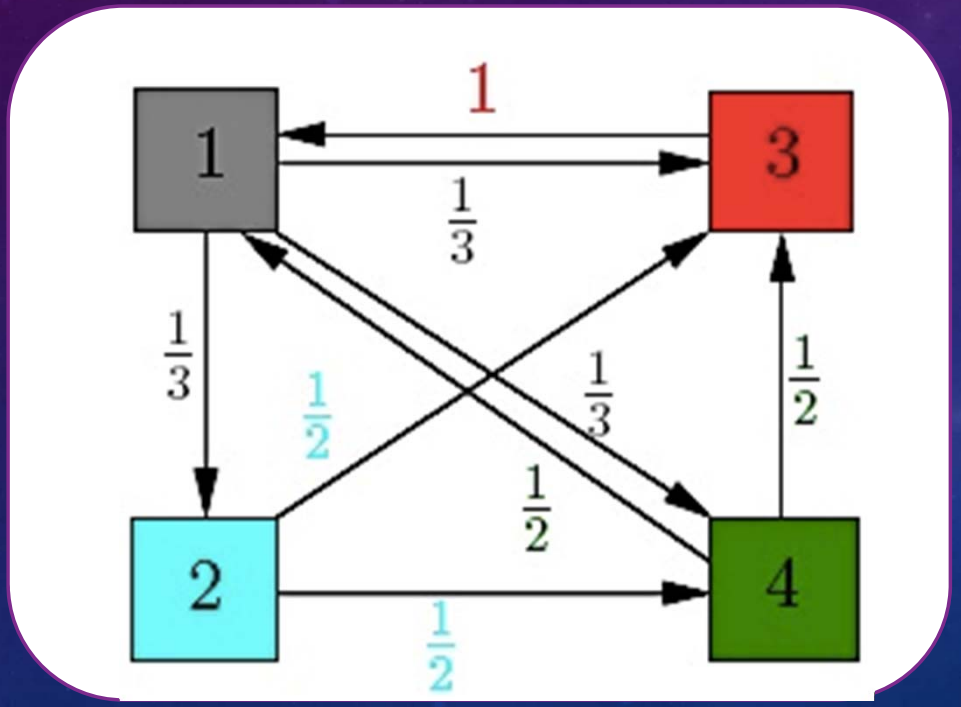
THE WEB GRAPH





Transition matrix

- Web page transfer evenly its importance to the web pages that it links to. If a node has *k* outgoing edges, it will pass on 1/k of its importance to each of the nodes that it links to.

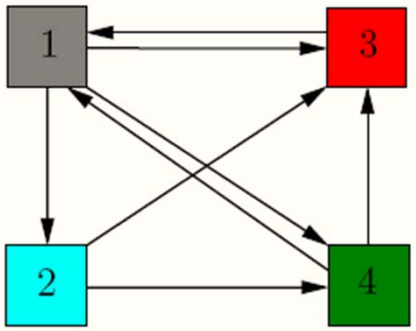


$$\begin{bmatrix} 0 & 0 & 1 & \frac{1}{2} \\ \frac{1}{3} & 0 & 0 & 0 \\ \frac{1}{3} & \frac{1}{2} & 0 & \frac{1}{2} \\ \frac{1}{3} & \frac{1}{2} & 0 & 0 \end{bmatrix}$$

PageRank vector of a web graph

- v = initial rank vector. Suppose that the importance is uniformly distributed among the 4 nodes, each getting ¼.

G =



A =

$$\begin{bmatrix} 0 & 0 & 1 & \frac{1}{2} \\ \frac{1}{3} & 0 & 0 & 0 \\ \frac{1}{3} & \frac{1}{2} & 0 & \frac{1}{2} \\ \frac{1}{3} & \frac{1}{2} & 0 & 0 \end{bmatrix}$$

$$v = \begin{pmatrix} 0.25 \\ 0.25 \\ 0.25 \\ 0.25 \end{pmatrix}, \quad Av = \begin{pmatrix} 0.37 \\ 0.08 \\ 0.33 \\ 0.20 \end{pmatrix}, \quad A^2 v = A(Av) = A \begin{pmatrix} 0.37 \\ 0.08 \\ 0.33 \\ 0.20 \end{pmatrix} = \begin{pmatrix} 0.43 \\ 0.12 \\ 0.27 \\ 0.16 \end{pmatrix}$$

$$A^3 v = \begin{pmatrix} 0.35 \\ 0.14 \\ 0.29 \\ 0.20 \end{pmatrix}, \quad A^4 v = \begin{pmatrix} 0.39 \\ 0.11 \\ 0.29 \\ 0.19 \end{pmatrix}, \quad A^5 v = \begin{pmatrix} 0.39 \\ 0.13 \\ 0.28 \\ 0.19 \end{pmatrix}$$

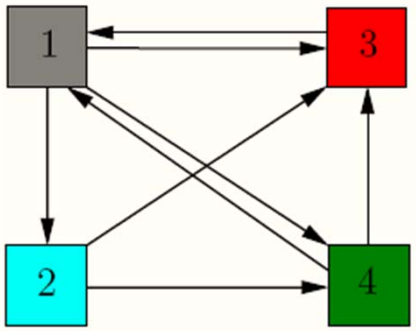
$$A^6 v = \begin{pmatrix} 0.38 \\ 0.13 \\ 0.29 \\ 0.19 \end{pmatrix}, \quad A^7 v = \begin{pmatrix} 0.38 \\ 0.12 \\ 0.29 \\ 0.19 \end{pmatrix}, \quad A^8 v = \begin{bmatrix} 0.38710 \\ 0.12903 \\ 0.29032 \\ 0.19355 \end{bmatrix}$$

PageRank vector of G

Probabilistic point of view

- v = the initial probability distribution. The probability that page i will be visited after k steps is equal to $A^k v$.

G =



A =

$$\begin{bmatrix} 0 & 0 & 1 & \frac{1}{2} \\ \frac{1}{3} & 0 & 0 & 0 \\ \frac{1}{3} & \frac{1}{2} & 0 & \frac{1}{2} \\ \frac{1}{3} & \frac{1}{2} & 0 & 0 \end{bmatrix}$$

$$v = \begin{pmatrix} 0.25 \\ 0.25 \\ 0.25 \\ 0.25 \end{pmatrix}, \quad Av = \begin{pmatrix} 0.37 \\ 0.08 \\ 0.33 \\ 0.20 \end{pmatrix}, \quad A^2 v = A(Av) = A \begin{pmatrix} 0.37 \\ 0.08 \\ 0.33 \\ 0.20 \end{pmatrix} = \begin{pmatrix} 0.43 \\ 0.12 \\ 0.27 \\ 0.16 \end{pmatrix}$$

$$A^3 v = \begin{pmatrix} 0.35 \\ 0.14 \\ 0.29 \\ 0.20 \end{pmatrix}, \quad A^4 v = \begin{pmatrix} 0.39 \\ 0.11 \\ 0.29 \\ 0.19 \end{pmatrix}, \quad A^5 v = \begin{pmatrix} 0.39 \\ 0.13 \\ 0.28 \\ 0.19 \end{pmatrix}$$

$$A^6 v = \begin{pmatrix} 0.38 \\ 0.13 \\ 0.29 \\ 0.19 \end{pmatrix}, \quad A^7 v = \begin{pmatrix} 0.38 \\ 0.12 \\ 0.29 \\ 0.19 \end{pmatrix}, \quad A^8 v = \begin{bmatrix} 0.38710 \\ 0.12903 \\ 0.29032 \\ 0.19355 \end{bmatrix}$$

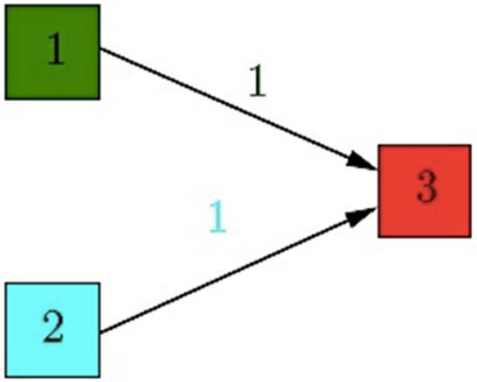
The stationary distribution of A

$$A^8 v = \begin{bmatrix} 0.38672 \\ 0.12992 \\ 0.28979 \\ 0.19358 \end{bmatrix}$$

$$A^{20} v \approx \begin{bmatrix} 0.38710 \\ 0.12903 \\ 0.29032 \\ 0.19355 \end{bmatrix}$$

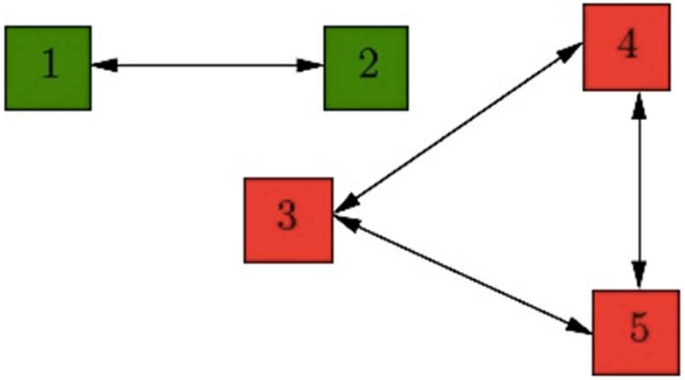
PageRank vector of G

HOUSTON, WE HAVE A PROBLEM



$$v_0 = \begin{bmatrix} \frac{1}{3} \\ \frac{1}{3} \\ \frac{1}{3} \end{bmatrix}, \quad v_1 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 1 & 0 \end{bmatrix} \cdot \begin{bmatrix} \frac{1}{3} \\ \frac{1}{3} \\ \frac{1}{3} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ \frac{2}{3} \end{bmatrix}$$

$$v_2 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 1 & 0 \end{bmatrix} \cdot \begin{bmatrix} 0 \\ 0 \\ \frac{2}{3} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$



$$A = \left[\begin{array}{cc|ccc} 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & \frac{1}{2} & \frac{1}{2} \\ 0 & 0 & \frac{1}{2} & 0 & \frac{1}{2} \\ 0 & 0 & \frac{1}{2} & \frac{1}{2} & 0 \end{array}\right] \quad v = \begin{bmatrix} 1 \\ 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}, \quad u = \begin{bmatrix} 0 \\ 0 \\ 1 \\ 1 \\ 1 \end{bmatrix}$$

Thm (Power Method Convergence Theorem)

Let A be an $n \times n$ positive column-stochastic matrix.

Let $\bar{\pi}$ be the unique vector satisfying $\bar{\pi} \geq 0$, $A\bar{\pi} = \bar{\pi}$ and $\sum_{i=1}^{n} \bar{\pi}_i = 1$. Then $\lim_{t \to \infty} A^t \begin{bmatrix} 1/n \\ \vdots \\ 1/n \end{bmatrix} = \bar{\pi}$.

pf. This theorem follows from Thm B immediately!

Google matrix

- Page Rank matrix also known as Google matrix.
- The Google matrix was described by Sergey Brin and Larry Page in 1998

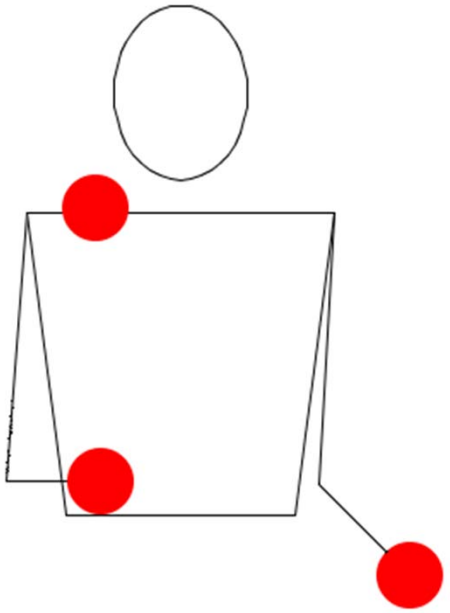
Google matrix

- Let G be a web graph on *n* nodes with transition matrix A.
- **In 1998, Sergey Brin and Larry Page defined the Google matrix of G with damping factor 0< *p* < *1* (a typical value is 0.15) is**

$$M=(1-p)A + p(1/n)J$$

- **Fact M is a positive column-stochastic matrix.**
- *M* models the random surfer model as follows: from a page *i* the surfer will follow the outgoing links and move on to one of the neighbors of *i*. A smaller, but positive probability, the surfer will dump the current page and choose arbitrarily a different page from the web and "teleport" there.
- The damping factor *p* reflects the probability that the surfer quits the current page and "teleports" to a new one.

馬戲團
JUGGLING



Juggling Pattern

- A **juggling pattern** is a permutation *f* of the integers Z

  f: Z→Z such that f(t)≥t for all t.

$$f(x) = \begin{cases} y & \text{if the ball thrown at time } x \text{ is next thrown at time } y \\ x & \text{if there is no throw at time } x. \end{cases}$$

- **Height function** of a juggling pattern

$$df(t) := f(t) - t$$

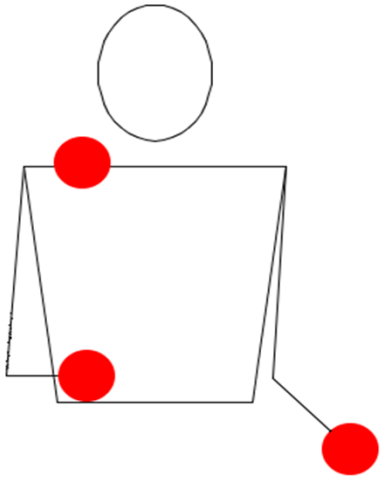
Orbits of 3-ball cascade

- The balls are thrown at times

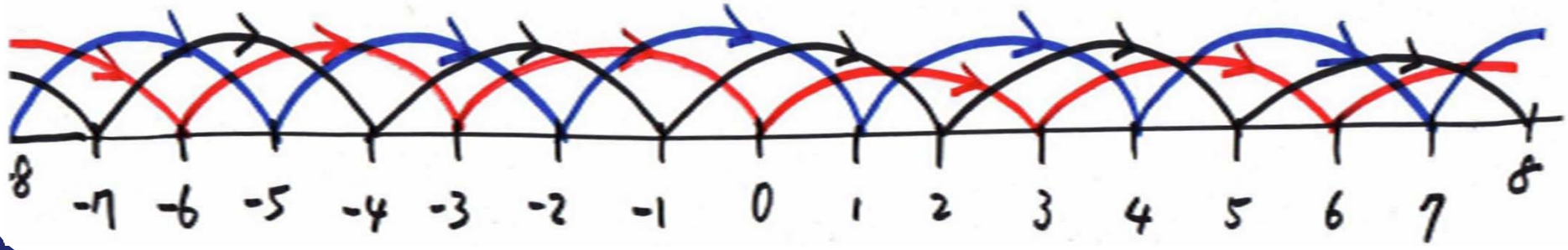
  ball 1: ...., -6,-3,0,3,6,....

  ball 2: ...., -5,-2,1,4,7,....

  ball 3: ...., -4,-1,2,5,8,....

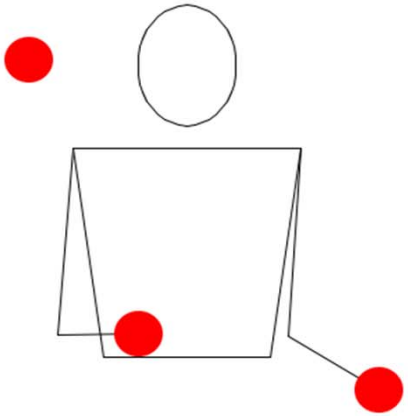


$$f(t) = t + 3$$

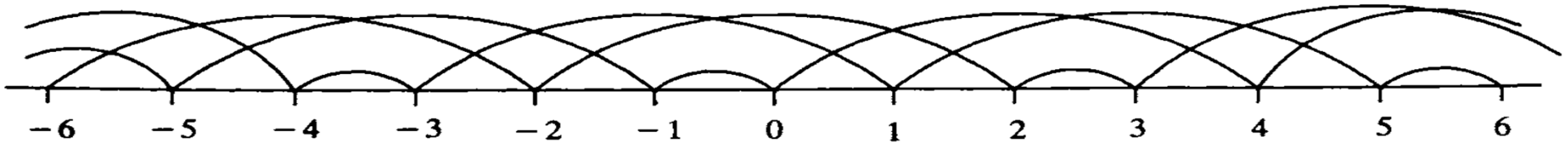


441

- The height function *df* takes on the values 4,4,1 cyclically.



$$f(x) = \begin{cases} x + 4 \text{ if } x \equiv 0, 1 \bmod 3 \\ x + 1 \text{ if } x \equiv 2 \bmod 3 \end{cases}$$



Period-p juggling pattern

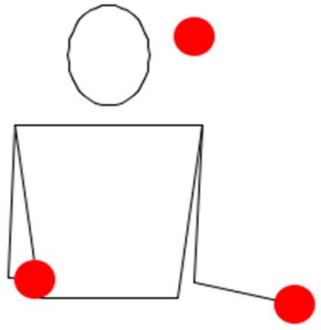
- A period-p juggling pattern

  is a bijection f: Z→Z such that df(t+p)=df(t) for all t.

- Theorem 1 If f is a period-p juggling pattern, then

[df(0)+df(1)+…+df(p-1)] / p = the number of balls

- A period-p juggling pattern can be described by giving df(1)df(2)…df(p).
- 51414 defines a 3-ball period-5 juggling pattern as follow



Key problems

- Which finite sequences correspond to period juggling patterns?
- Question: Does 354 correspond to a juggling period?

- Fact If *f* is a period-n juggling pattern, then we have

$$\{f(t) \bmod n: t=0,1,2,\ldots,n-1\}=\{0,1,2,3,\ldots,n-1\}$$

經濟學

STABLE MATCHING

Stable marriages

A matching is stable if no unmatched man and woman each prefers the other to his or her spouse.

Example

- Arie: Betty Ann Cindy
- Bert: Ann Cindy Betty
- Carl: Ann Cindy Betty
- Ann: Bert Arie Carl
- Betty: Arie Carl Bert
- Cindy: Bert Arie Carl

- Stable matching: (Arie,Betty), (Bert,Ann), (Carl,Cindy)
- Matching (Arie,Ann), (Bert,Betty), (Carl, Cindy) is not stable, e.g., Arie and Betty prefer each other above given partner

A Prize Winning Algorithm

- Lloyd Shapley, **Nobel Prize Winner 2012 in economics**
- Obtained the prize for a number of contributions, one being the Gale-Shapley algorithm, discussed today

Result

- Gale/Stanley algorithm: finds always a stable matching
  - Input: list of men, women, and their preference list
  - Output: stable matching

病毒式行銷

VIRAL MARKETING

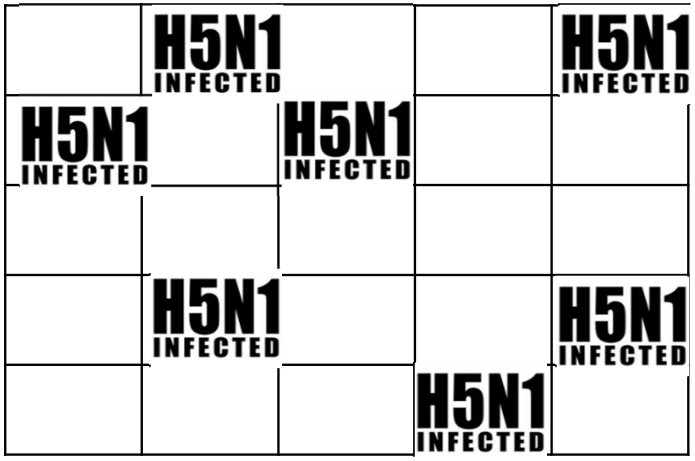
Béla Bollobás: The Spread of Infection on a Square Grid

① An **infection spreads** on a **grid of n by n squares**.

② **At the start**, some squares are infected, and some are healthy.

③ From one generation to the next, a healthy square will become infected **if it has two or more infected neighbors**.

Time Step = 0



Seeds
or
Target Set

Béla Bollobás: The Spread of Infection on a Square Grid

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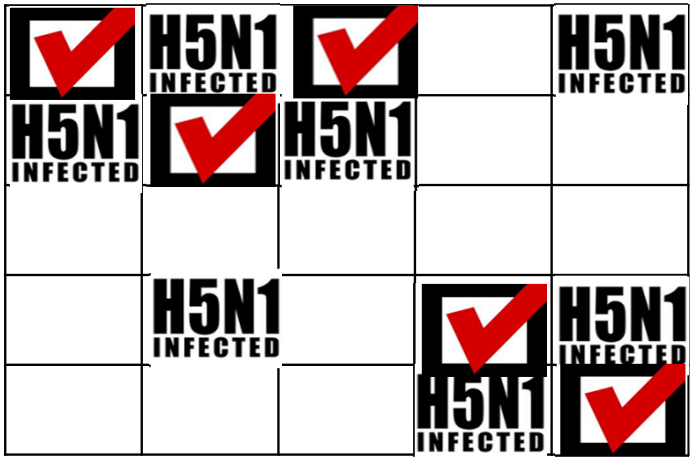
Time Step = 0



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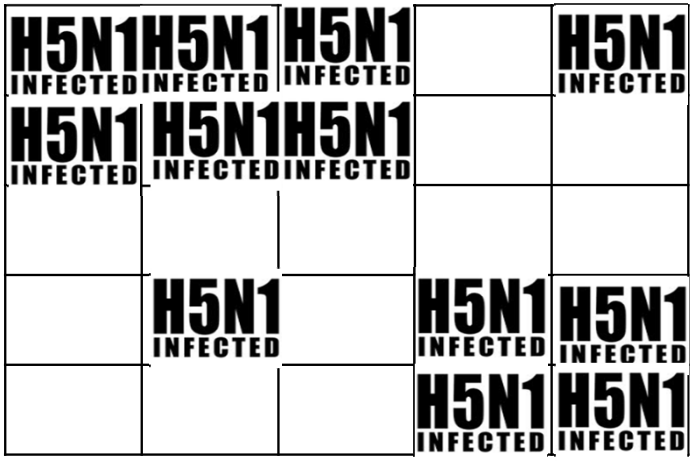
Time Step = 1



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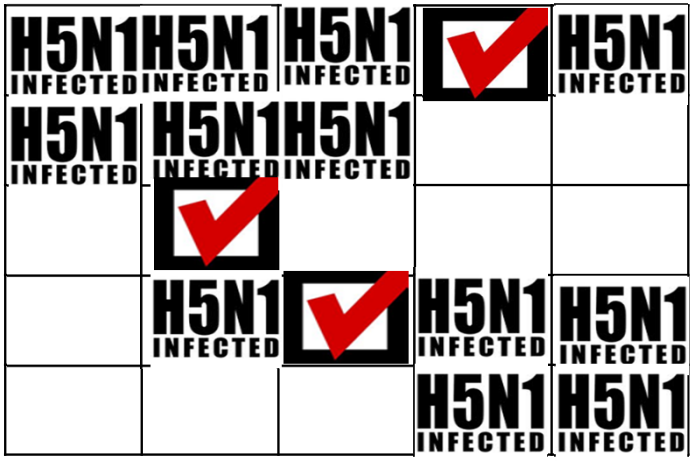
Time Step = 1



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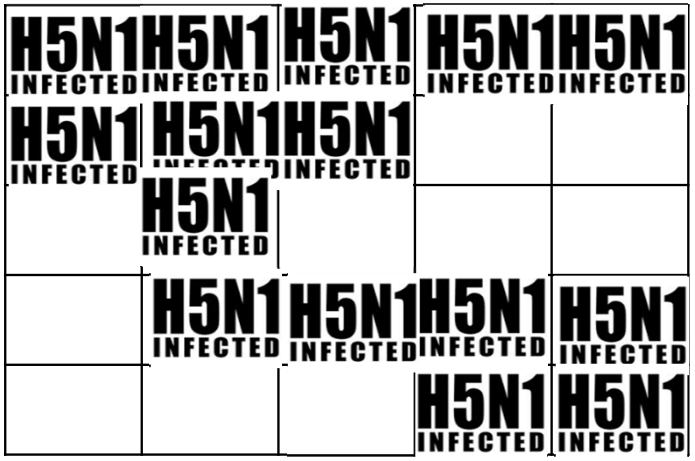
Time Step = 2



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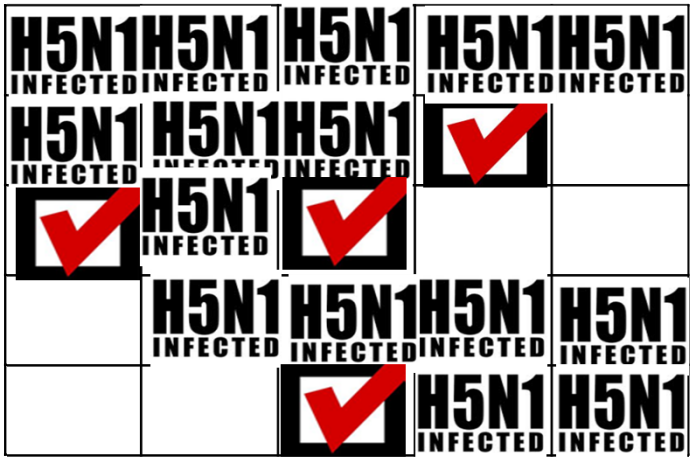
Time Step = 2



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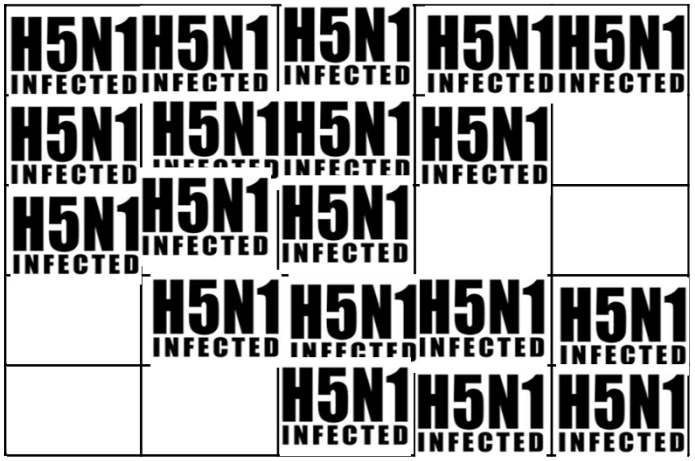
Time Step = 3



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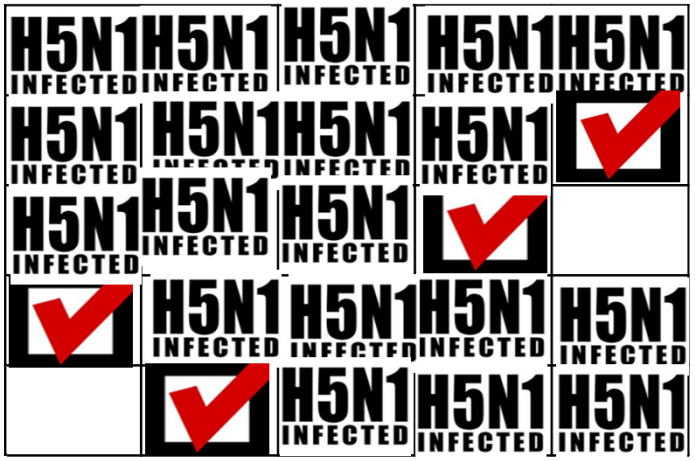
Time Step = 3



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Time Step = 4

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Time Step = 4

Béla Bollobás: The Spread of Infection on a Square Grid

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② At the start, some squares are infected, and some are healthy.

③ From one generation to the next, a healthy square will become infected if it has two or more infected neighbors.

④ What is the minimum number **of initially infected squares** that can result in every square eventually becoming infected?

Time Step = 5

7 initially infected squares in the target set

min-seed(*5* X *5* square grid, 2) ≤ 7

Béla Bollobás: The Spread of Infection on a Square Grid

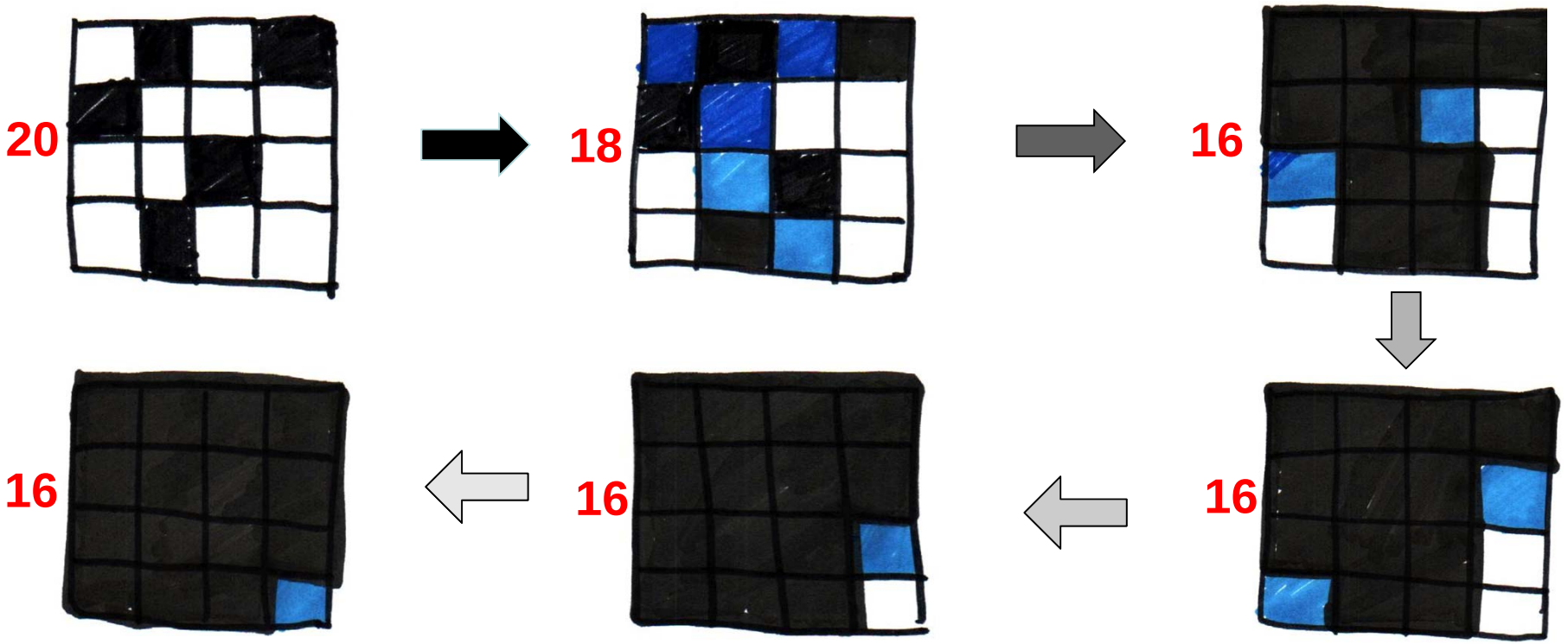
- **min-seed(*n* X *n* square grid, 2)**

  = **the minimum number of initially infected squares**

  that can result in every cell eventually becoming infected?

min-seed(*5* X *5* square grid, 2) ≤ 5

Béla Bollobás: The Spread of Infection on a Square Grid



Perimeter length of the black domain does not increase !

s:= **the number of initial black cells**

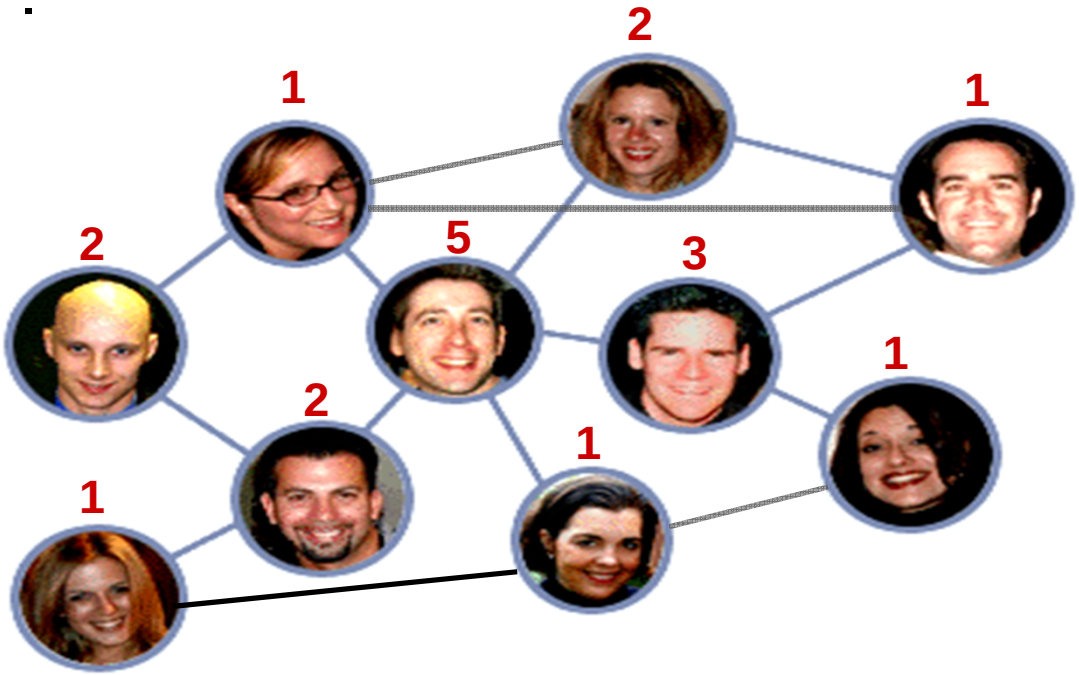
$$4s \geq 16$$

Béla Bollobás: The Spread of Infection on a 5 X 10 Grid

The Spread of Infection on a Graph

- **Threshold Model** (G, θ)

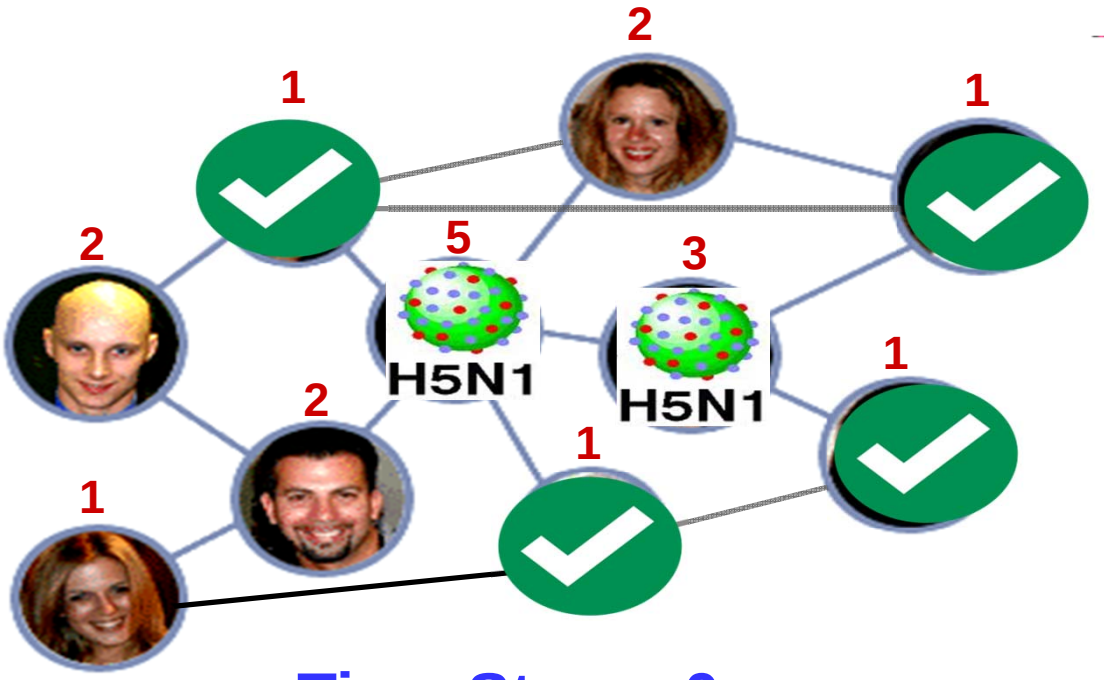
Let $G = (V, E)$ be an undirected graph equipped with *thresholds* $\theta : V \to \mathbb{N}$ such that $1 \leq \theta(v) \leq d_G(v)$ for each $v \in V$.



The Spread of Infection on a Graph

- **Updating Rule:**

All healthy vertices v that have at least $\theta(v)$ already-infected neighbors become infected.



The Spread of Infection on a Graph

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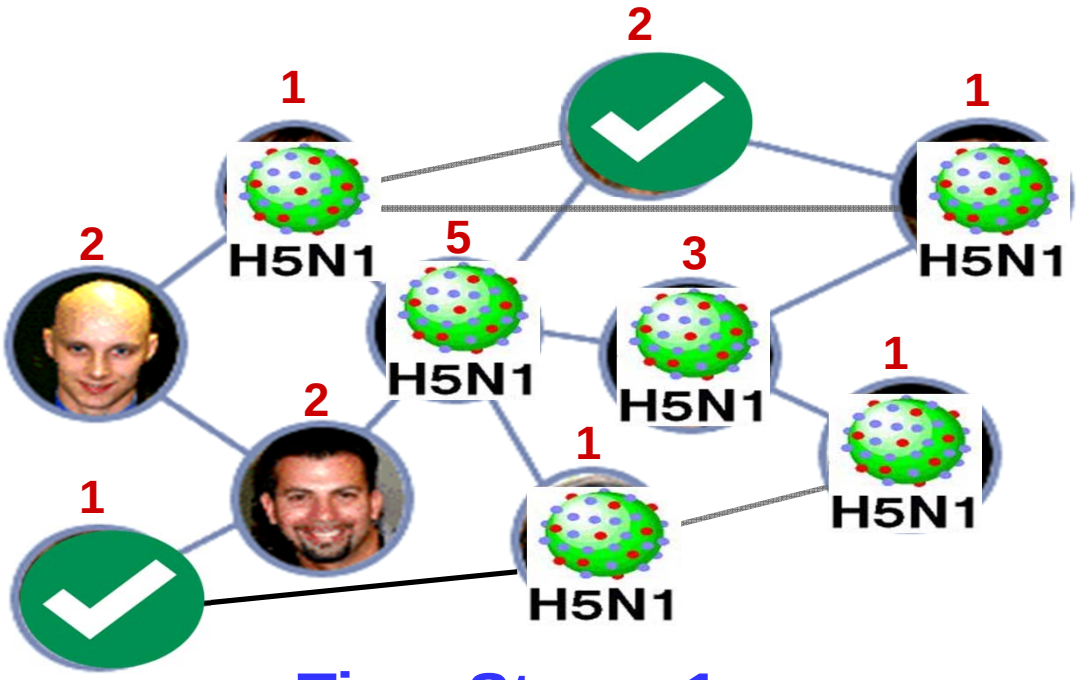
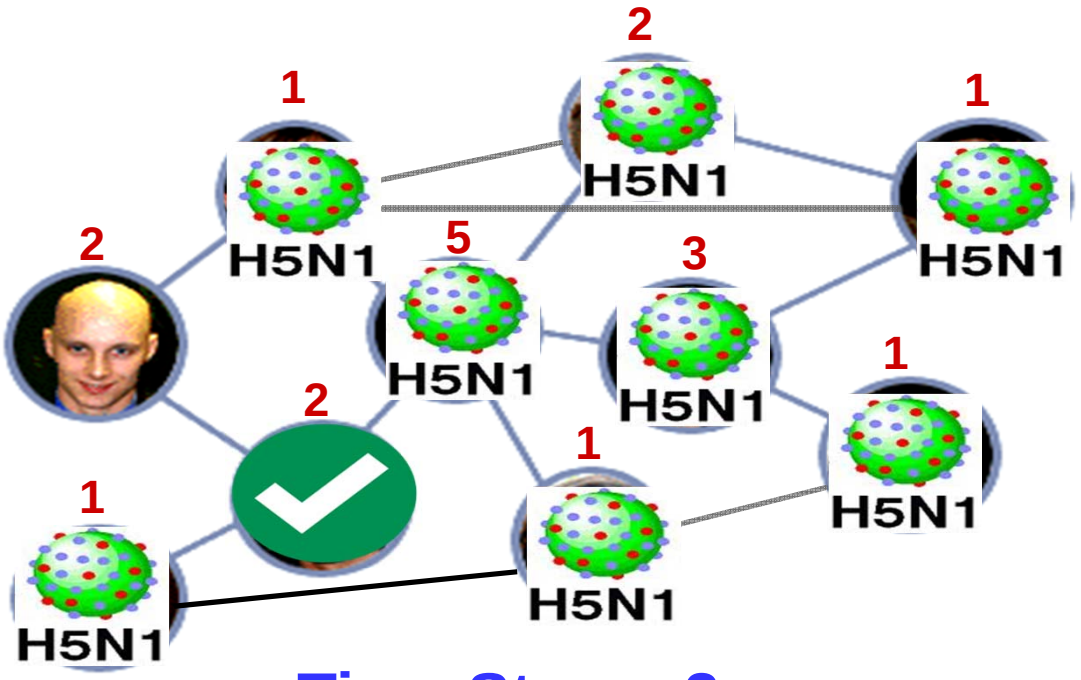


2 initially infected nodes

The Spread of Infection on a Graph

- **Updating Rule:**

All healthy vertices v that have at least $\theta(v)$ already-infected neighbors become infected.



The Spread of Infection on a Graph

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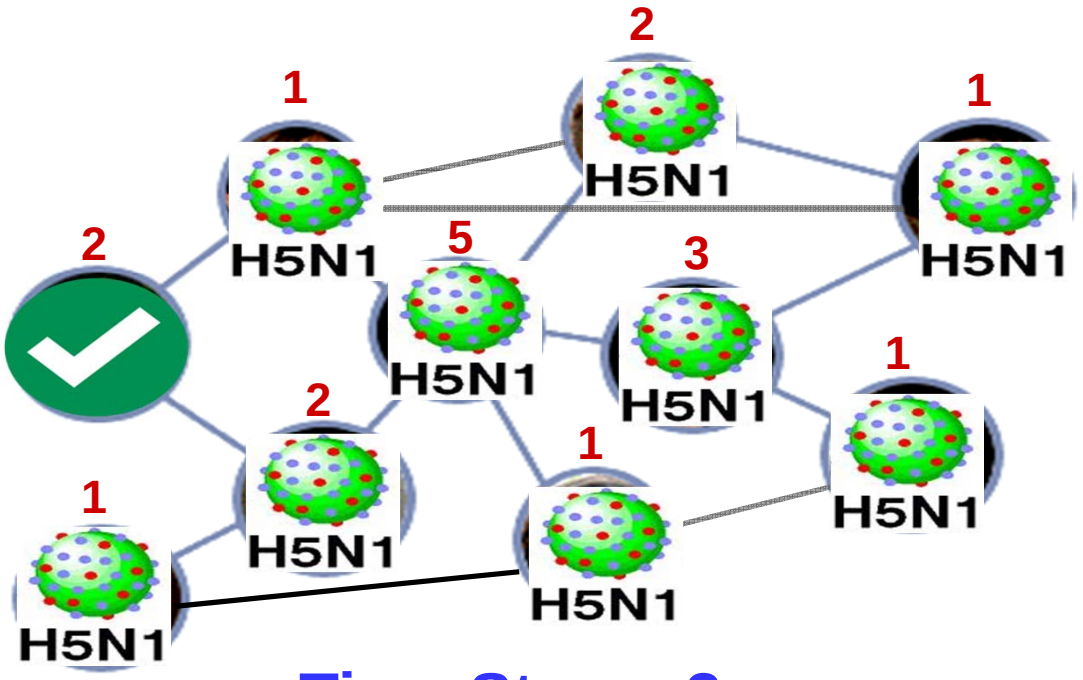
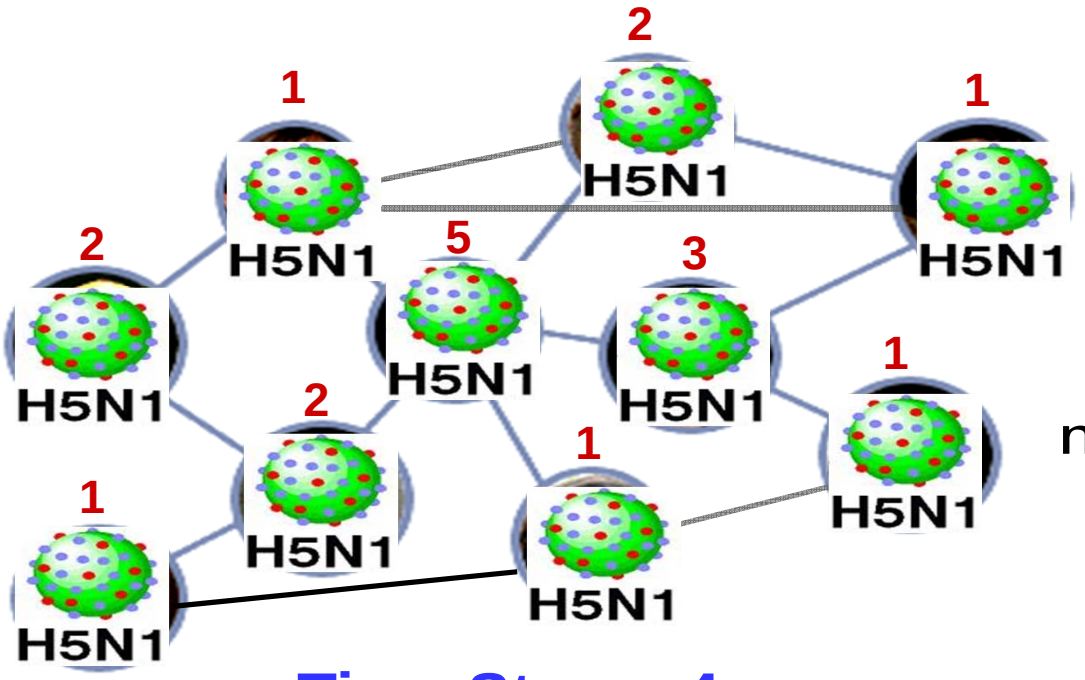


2 initially infected nodes

The Spread of Infection on a Graph

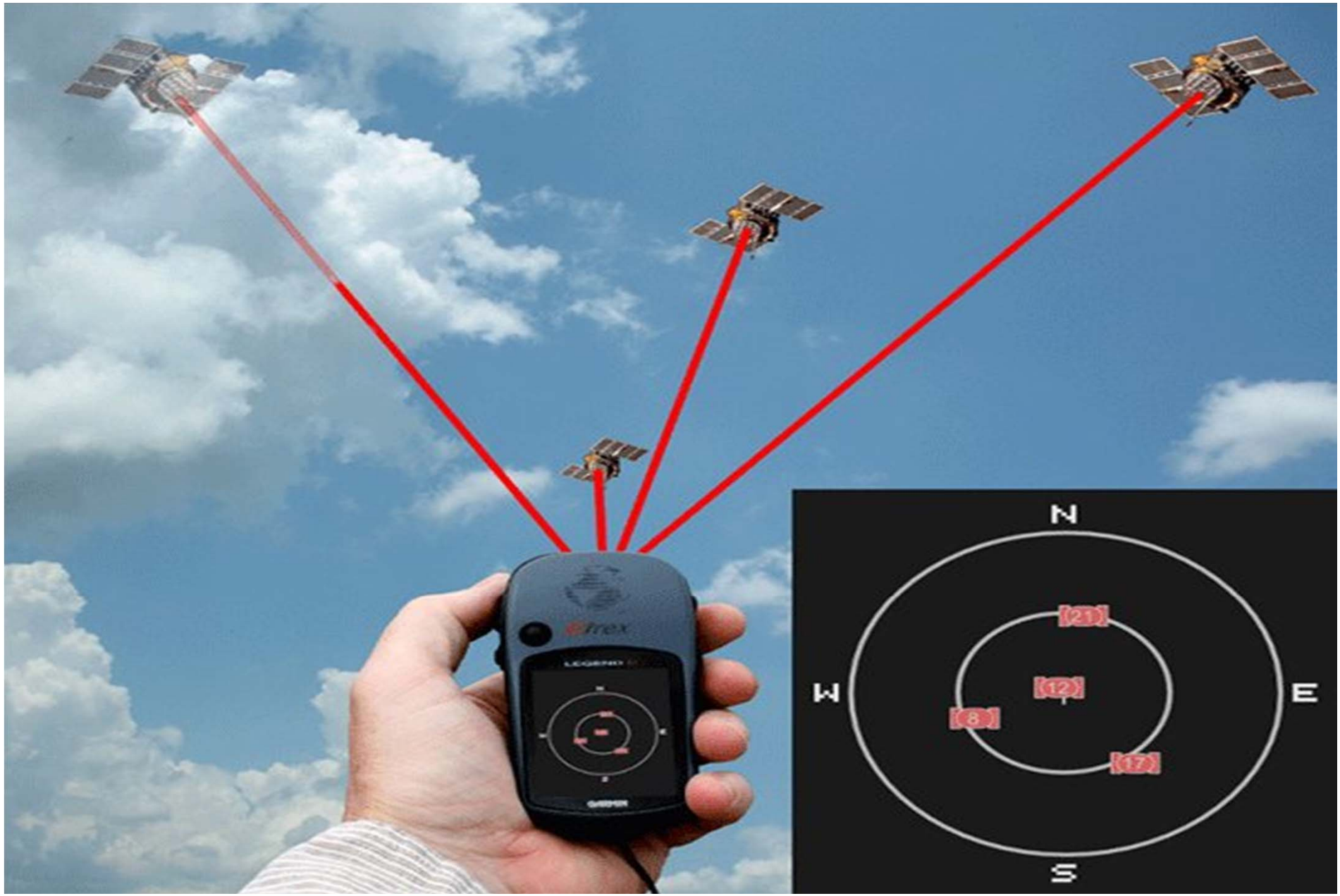
- min-seed(G, θ)= the minimum number of initially infected nodes so that all nodes in G are infected at the end of the process.



2 initially infected nodes

min-seed$(G, \theta) \leq 2$

THE MATHEMATICS BEHIND GPS


N
W
E
S
21
12
8
17

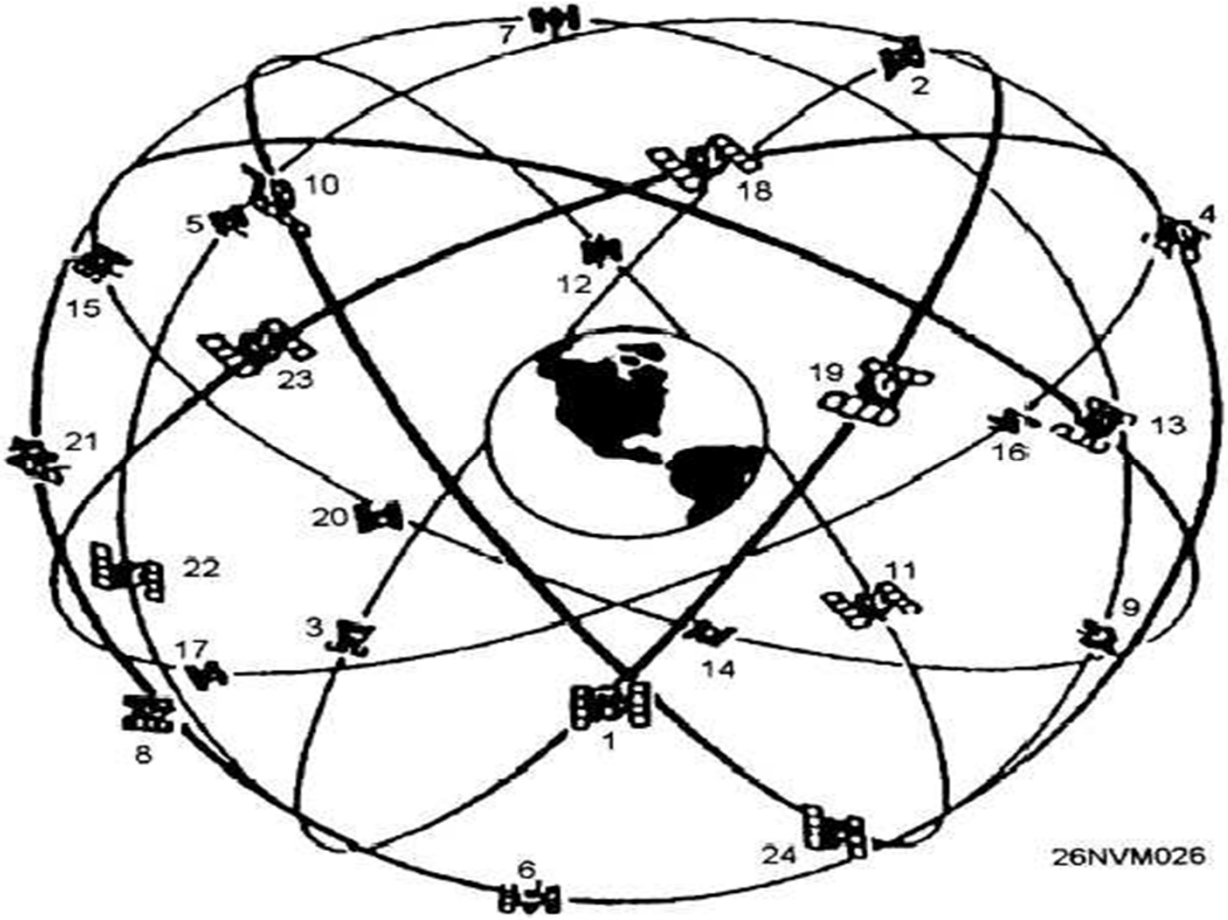

800m
Praça Biota Júnior (Sto. Amaro)
Rua Vicente L
Rua República
Jabaquara
Congonhas
Centro
Chegada
14:30
Velocid.
70km/h
70
GARMIN


40m
延平北路七段
延平北路
社子島
北 投
淡 水
延平北路
(社子島)
106巷
通河
到達時間
PM3:57
延平北路六段
速度
70km/h


台灣大哥大
12:15
96%
準備導航
大安區
公園路
3
9
5
300 mt
行車方向
西南
速度
0 km/h

- **Global Positioning System** (GPS) is **a satellite- based system of signals**.
- There is also a Russian GPS system, GLONASS.
- **4 satellites** are located in each of **six circular orbits** (20,200 km high-altitude). Which are **evenly spaced every 60° around the earth** and **inclined at 55° from the equator**, which means that satellites cross the equator tilted at a **55°** angle. This constellation provides the user with between five and eight satellites visible from any point on the earth.

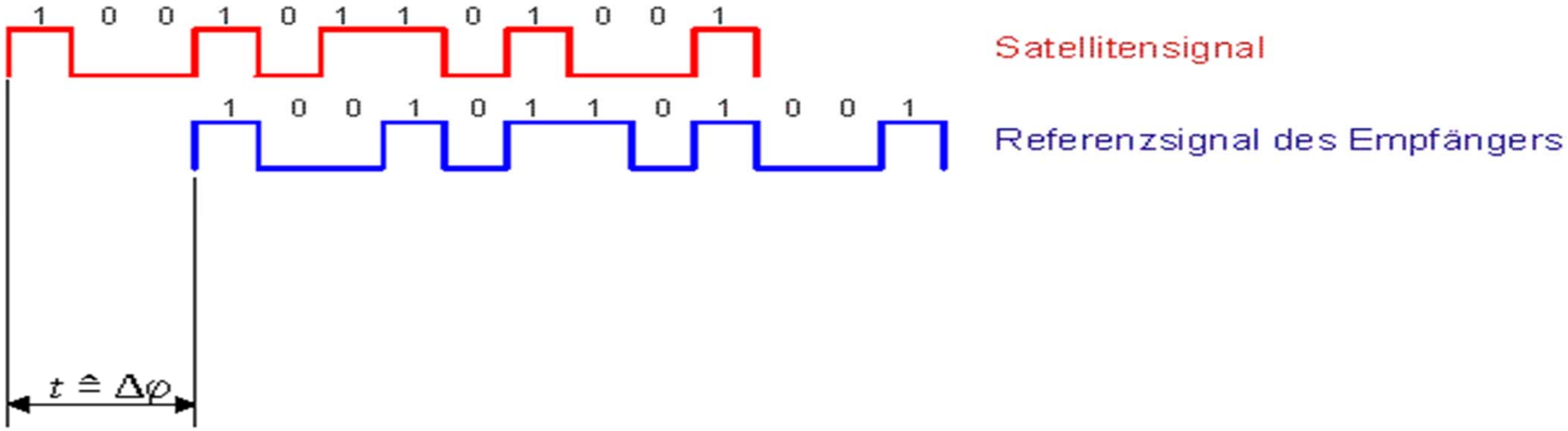
- GPS, operated by the **U.S. Department of Defense** (DoD), became fully operational in **1995**.



- **The system uses a constellation of satellites transmitting on radio frequencies, 1227.60 mHz and 1575.42 mHz.**

- GPS determines distance between a GPS satellite and a GPS receiver by measuring the amount of time it takes a radio signal to travel from the satellite to the receiver (figure 1). Radio waves travel at the speed of light, which is about 300,000 kilometer per second. So, if the amount of time it takes for the signal to travel from the satellite to the receiver is known, the distance from the satellite to the receiver (distance = speed x time) can be determined. If the exact time when the signal was transmitted and the exact time when it was received are known, the signal's travel time can be determined.

- In order to do this, **the satellites and the receivers use very accurate clocks which are synchronized so that they generate the same code at exactly the same time**.



- The code received from the satellite can be compared with the code generated by the receiver. By comparing the codes, the time difference between when the satellite generated the code and when the receiver generated the code can be determined.

What sort of information is received from the satellites?

- **Each satellite sends signals, on both of its frequencies, giving**
  - ❶ **its position and**
  - ❷ **the exact times at which the signals were transmitted.**

How does a GPS receiver use satellite information to determine our position?

① When a signal comes in from a satellite, the receiver records the difference, Δt, in the time at which the signal was transmitted and the time at which it was received.

② This information shows that we are located at some point on a sphere of radius $d=c\times\Delta t$, centered at the point from which the satellite transmitted.

③ Information from several satellites is combined to give the coordinates-latitude, longitude, and altitude-of our position

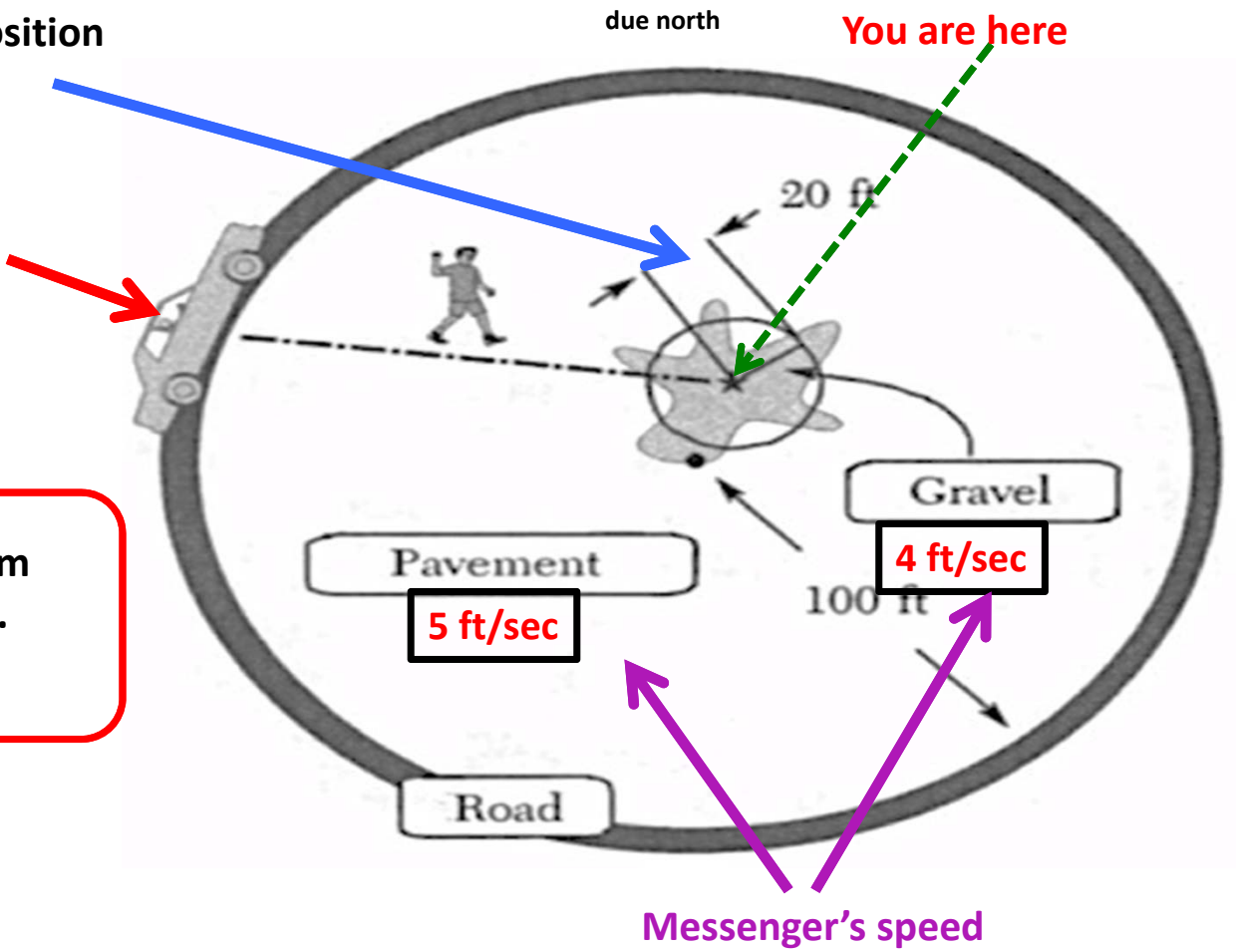
A Simple Model

The **mean distance** from your position

to the edge of the grave

The location of car will be described
by its angular distance from due north,
measured in a clockwise direction.

To determine your position, messengers leave from cars on the road and walk straight forward to you.



Example

the coordinates (x_0, y_0), of your p

$$\begin{cases} (x_0 - 70.7)^2 + (y \\ (x_0 - 70.7)^2 + (y \end{cases}$$

system has two solutions, $(-20.0$ (- 20.0, 39.2)
he latter point is outside of the lot
and 39.2 ft north of the center of

45°, leave pm 12:00:00
arrive pm 12:00:20.2

20ft + 5×[20.2-(20/4)]=96.0 ft

(70.7, 70.7)

135°, leave pm 12:01:00
arrive pm 12:01:29.5

20ft + 5×[29.5-(20/4)]=142.5 ft

(70.7, -70.7)

ppose that, just to be careful, you decide
essenger leave the road at a point 180° fr
ives at 12:02 pm and, according to your v

⇨ **(- 20.0, 39.2)** and
(161.4, 39.2)

What has happened?

$$\left.\begin{aligned} 0.7)^2 &= 96.0^2 \\ 0.7)^2 &= 142.5^2 \end{aligned}\right\}.$$

and (161.4, 39.2), rounded to
can conclude that you are locat
ot. The situation is shown in Fi

45°, departure pm 12:00:00
arrival pm 12:00:20.2

- **The most likely problem is that your watch does not agree with the times used at the departure points on the road.**
- **Suppose your watch has a fixed error of ε seconds, a positive ε means that your watch is ahead of the road time.**

180°, departure pm 12:02:00
arrival pm 12:02:32.2

135°, departure pm 12:01:00
arrival pm 12:01:29.5

20ft + 5×[29.5-(20/4)]=142.5 ft

sengel leaves the road at a point 135° from north
position. On his arrival, your watch shows that it is

- **The radius of each circle is in error by the same amount, -5ε ft and there must be a value of ε for which the three circles have a common point.**

$\varepsilon = 5$ sec $\varepsilon = 6$ sec $\varepsilon = 7$ sec $\varepsilon = 9$ sec

FIGURE 5
Effect of Watch Error.

It appears that your watch has an error of approximately 5 sec. The error and th coordinates of your position are a solution for the following system of equations:

$$\left\{\begin{array}{l}(x_0 - 70.7)^2 + (y_0 - 70.7)^2 = d(20.2, \varepsilon)^2 \\ (x_0 - 70.7)^2 + (y_0 + 70.7)^2 = d(29.5, \varepsilon)^2 \\ (x_0 - 0.0)^2 + (y_0 + 100.0)^2 = d(32.2, \varepsilon)^2\end{array}\right\}.$$

The system can be solved numerically, starting with seed values of 0 for ε an stimated coordinates of your position for x_0 and y_0. There is only one solution givin location inside of our lot. Rounding this to our level of precision yields (x_0, y_0, ε) = 10.9, 31.2, 4.9). You conclude that you are 10.9 ft east and 31.2 ft north of the cente

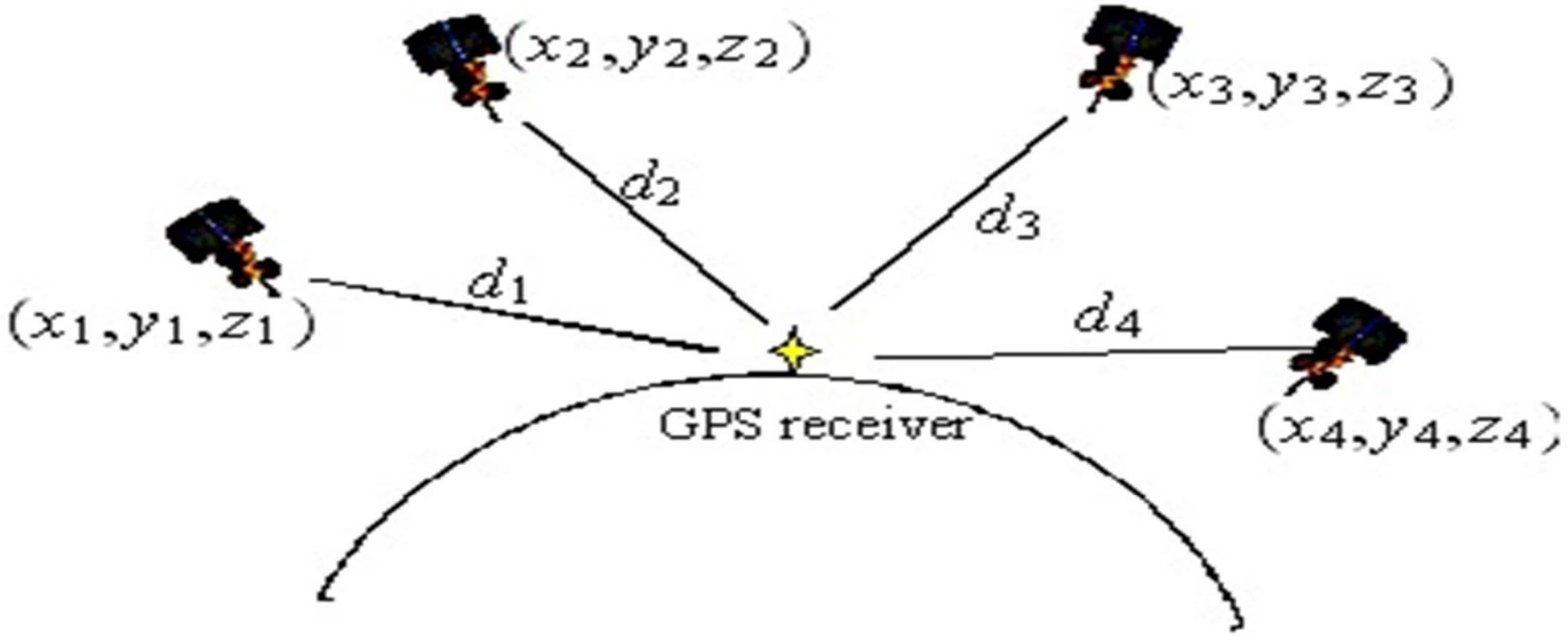
It appears that your watch has an error of approximately 5 sec.

- **The error** and **the coordinates of your position** are a solution for the following system of equations

your watch has an error of approximately 5 sec.
ır position are a solution for the following systen

$(x_0, y_0, \varepsilon) = (10.9, 31.2, 4.9)$.

- You only need a **steady**, but not necessarily accurate, **watch** and the ability to approximate the solution of a system of three equations in three unknowns.


(x_2, y_2, z_2)
(x_3, y_3, z_3)
d_2
d_3
d_1
d_4
(x_1, y_1, z_1)
GPS receiver
(x_4, y_4, z_4)

Back to the Satellite (3D)

left from $Q_1 = (74.1340, 67.3568)$. This is only a 1.0% error in the first coordinate and

Our location is determined by solving a system equations.

ften attributed to alteration of the satellite signals by the
Department does, at times, degrade the satellite data and
. This *Selective Availability* (SA) will be phased out withi
stated that SA is used for reasons of national secur
of the signals explains very little of the variation in p
rimarily caused by random errors in measurement, th

A practical matter

- When a numerical solution is found, the rectangular coordinates **(x_0, Y_0, Z_0) of your position are converted into** the essentially spherical coordinates of **latitude, longitude**, and **altitude above sea level**.
- There are times and locations when a GPS receiver can receive data from only **three satellites**. In such cases, **a position at sea level can still be found**. The receiver simply **substitutes the surface of the Earth for the missing fourth sphere**.

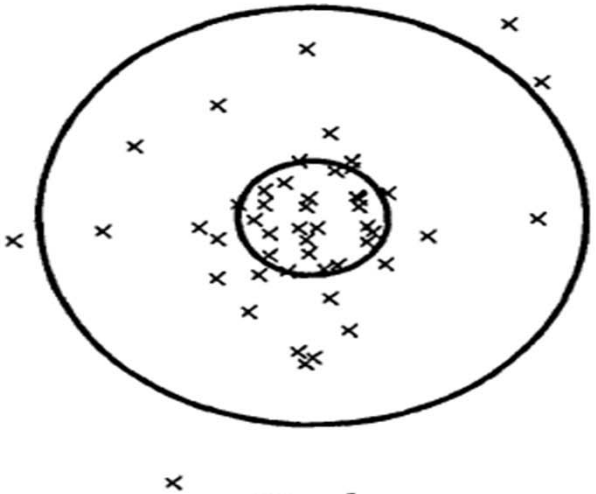
Variability of Positions

- Why does the determined position **change with each new computation, even though we are not moving**?
- Selective Availability (SA) ended a few minutes past midnight EDT after the end of **May 1, 2000**. The change occurred simultaneously across the entire satellite constellation.

Computer simulation of what happens if you stay in your fixed location and make repeated computations of your position (2D model)

- **Each determination of a position is made with the following assumptions.**
  - ❶ **Three points of departure for messengers are picked at random, assuming that the angle between any two points of departure is at least 30°, but not more than 150°.**
  - ❷ **The distance over which a messenger must walk on gravel is a normal random variable with a mean of 20 ft and a standard deviation of 5 ft.**
  - ❸ **The relative error in each coordinate of the point of departure is a normal random variable, with a mean of 0 and a standard deviation of 0.3%.**

The positions computed in a run of 50 simulations are plotted on the left side of FIGURE 6, along with circles of radii d_{50} and d_{95}. *Our probabilistic model yields results that agree quite well with plots of successive positions found with an actual GPS receiver from a fixed location.*



Single Messengers

FIGURE 6
Simulations.

Commercially available GPS units operate under what is called the **Standard Positioning Service (SPS)**, measuring distances using satellites' **1575.42 mHz** frequency.
Under the best circumstances, the **50% c.e.p. for the SPS is 40 meters**.

Messengers

What is done to improve the accuracy of these varying positions?

1. **Precise Positioning Service (PPS)** uses signals transmitted on both of the GPS frequencies to eliminate much of the variability caused by the passage of signals through the Earth's atmosphere
2. **Differential Global Positioning System (DGPS)**

What is done to improve the accuracy of these varying positions?

❷ Differential Global Positioning System (DGPS)

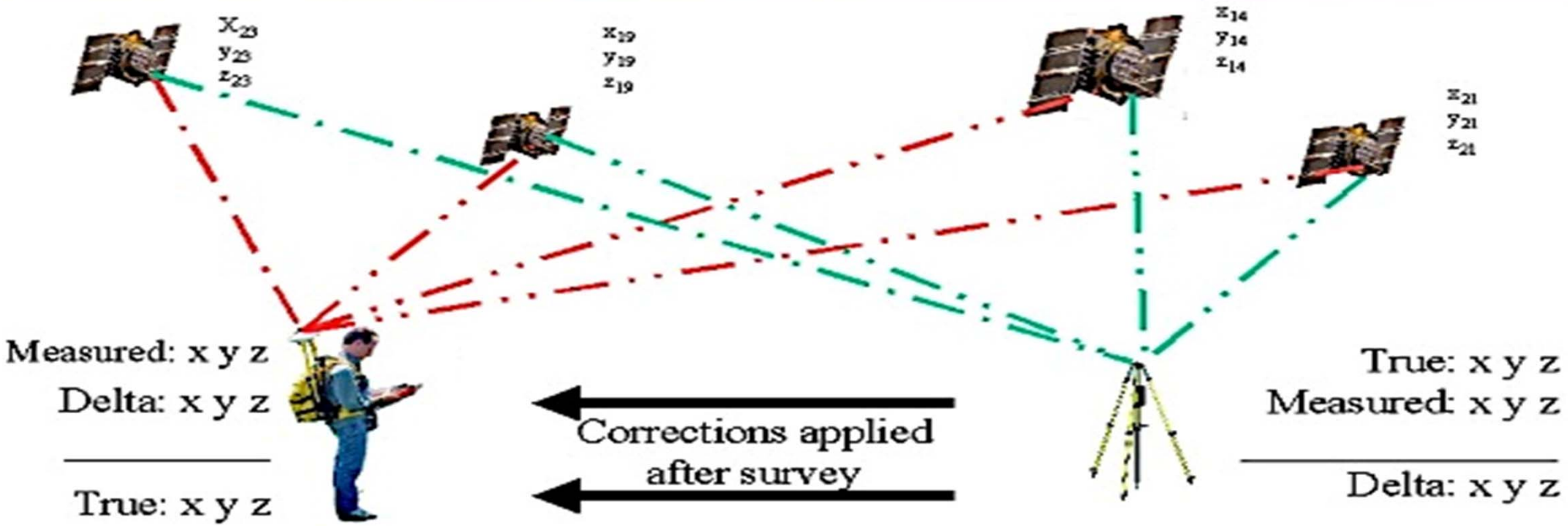
- Most of the error in a GPS position is due to random variables in the atmosphere and the satellite system.
- Within a small geographical area, the error at any instant tends to be independent of the exact location of the receiver.
- DGPS establishes a fixed base station, whose exact location is already known. Equipment at the base station computes its current "GPS position," compares this with its known location, and continuously broadcasts a correction term.

What is done to improve the accuracy of these varying positions?

❷ **Differential Global Positioning System (DGPS)**

- DGPS establishes a fixed base station, whose exact location is already known. Equipment at the base station computes its current "GPS position," compares this with its known location, and continuously broadcasts a correction term.
- A DGPS receiver in the area receives its own satellite information and computes its position. Simultaneously it receives the current correction from its base station, and applies this to its computed position. The result is a very accurate determination of the receiver's position; 50% c.e.p.'s for GDPS run close to 9 meters.

Differential GPS



NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
National Ocean Service
National Geodetic Survey

Positioning America for the Future


Thank You!


Any Questions

Any Questions?

What you should know about before starting University

2016-03-29 學士班

好好規劃四年大學的訓練--跨系修課或自己進修

- 坐下來寫張求職履歷表
- 讓自己在某技術、某學術領域變強!
- 讓自己在某方面具有不可替代性!!

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- 讓自己在某方面具有不可替代性!!
- 英語、英語、英語

大學裏最重要的七項學習

- **李開復**（微軟公司全球副總裁，是微軟亞洲研究院的首任院長）
- **自學的能力** ：老師只會充當引路人的角色，學生必須自主地學習、探索和實踐。
- **基礎知識**：**數學**、**英語**、**電腦**、**互聯網** --你對數學、英語和電腦有興趣，那你是幸運兒，可以享受學習的樂趣；但就算你沒有興趣，你也必須把這些基礎打好。打基礎是苦功夫，不願吃苦是不能修得正果的。
- **積極主動**：**果斷負責，創造機遇** --沒有人比你更在乎你自己的工作與生活。"讓大學生活對自己有價值"是你的責任。許多同學到了大四才開始做人生和職業規劃，而一個主動的學生應該從進入大學時就開始規劃自己的未來。

大學裏最重要的七項學習

- **掌控時間：**事分輕重緩急，人應自控自覺。沉迷于網路遊戲是對於現實的逃避，是不願面對自己不足的一面。要脫離網路遊戲，就得珍惜自己寶貴的大學時間，找到自己感興趣的方向，做一些有意義並能給自己帶來滿足感的事情。
- **學會與人相處: 培養真正的友情: 以誠待人，以責人之心責己、以恕己之心恕人。** 。
- 學習團隊精神和溝通能力。


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- 誠徵博士後研究
- 誠徵助理
- 誠徵研發替代役
- 誠徵暑期實習生

最新消息／榮譽

恭賀楊得年博士榮獲2015年中央研究院年輕學者研究著作獎

恭賀陳昇瑋博士升等為本所研究員，自104年3月19日生效。

資訊所簡訊

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:: 誠徵助理
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誠徵暑期實習生

誠徵研究及行政助理

自動化實驗室

刊登期間： 2015-09-03 – 2015-12-31

職　　稱： 誠徵大學部工讀生、專任研究助理或博士後(研發替代役可)一名

工作內容： 協助機器人研究(理論分析、數值模擬分析或實驗)

應徵資格/條件： good experience in computer programming like C/C++, Matlab

工作待遇： 依所內規定

應徵方式： 意者請將個人履歷、自傳、相關論文或作品等有利資料寄至
liu@iis.sinica.edu.tw 合格者約面試
劉進興老師 liu@iis.sinica.edu.tw

劉庭祿老師實驗室

刊登期間： 2015-09-01 – 2015-10-31

職　　稱： 專任研究助理(研發替代役可)

工作內容： 參與電腦視覺與機器學習相關研究

應徵資格/條件：
1. 國內外大學資工、電機、數學相關科系，具碩士或學士學位
2. 熟悉computer vision, pattern recognition, machine learning
3. 計畫攻讀國內外博士班者優先考慮

工作待遇： 依中央研究院標準支薪

應徵方式： 請於應徵函件載明『應徵研究助理』，email 至 : liutyng@iis.sinica.edu.tw 或郵寄至「台北市115南港區研究院路2段128號 中研院資訊所 劉庭祿 老師收」，如有合適人選，即不再收件，條件符合則邀請面談，不合者恕不退件不函覆。

劉庭祿 liutyng@iis.sinica.edu.tw 02-27883799 ext. 1508

參考網站： http://www.iis.sinica.edu.tw/~liutyng/

黃文良老師實驗室

刊登期間： 2015-07-30 – 2016-05-01

職　　稱： 研究助理 或 博士後

工作內容： 信號處理、影像處理、機器學習、應用數學、大數據分析等。

應徵資格/條件： 電機、資訊、數學、物理或相關背景之碩(博)士。

工作待遇： 依照規定

應徵方式： 請備妥履歷表，以電子郵件郵寄至黃文良博士信箱
黃文良 博士 whwang@iis.sinica.edu.tw 02-27883799#1609

TOP

網路研究實驗室

網路研究實驗室

刊登期間： 2015-07-01 – 2015-12-31

職　　稱： 專任研究助理(研發替代役可)

工作內容： 協助進行與下列主題相關的研究(但不限於以下主題)
- 網路感測系統(Networked Sensing Systems)
- 稀疏資訊處理與分析(Sparse Information Processing)
- 名稱資料網路(Named Data Networking)

應徵資格/條件： 1. 國內外大學資訊/電機/數學/統計相關科系畢業
2. 具備程式設計與問題解決的能力
3. 具備閱讀及簡報英文論文的能力
4. 對學術研究有熱情，並計畫攻讀國內外博士班者優先錄用

工作待遇： 比照科技部或中央研究院支薪規定起薪 (學士 31K起，碩士 36K起)，年資另計，或具特殊(或優秀)成果者面談另議薪資

應徵方式： 採取先收到先審查，審查通過以mail方式通知面試。意者請備個人詳細履歷、成績單及代表作（碩士論文或專題研究成果），寄至

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楊得年老師實驗室

刊登期間： 2015-06-11 – 2015-09-11

職　　稱： 專任研究助理 (研發替代役可)

工作內容： Networking或Social Network或資料探勘或應用數學相關研究

應徵資格/條件： 相關領域學士或碩士畢業 (研發替代役或準備出國佳)。
1. 具相關領域研究經驗 或
2. 具備演算法設計、圖論、最佳化、賽局理論、隨機程序、機器學習等相關理論背景 或
3. 熟悉演算法或系統實作

工作待遇： 比照國科會或院內支薪規定

應徵方式： 意者請備個人詳細履歷、自傳及成績單寄至 dnyang@iis.sinica.edu.tw
楊得年 dnyang@iis.sinica.edu.tw 2788-3799 ext. 1728

參考網站： http://www.iis.sinica.edu.tw/pages/dnyang/index_zh.html

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呂及人老師實驗室

刊登期間： 2015-05-13 – 2015-12-31

職　　稱： 研究助理

工作內容： 參與機器學習、賽局理論、或是計算理論等相關方面的研究

應徵資格/條件： 國內外大學資訊、電機、數學相關系所

工作待遇： 依中央研究院標準支薪

應徵方式： 意者請備履歷、自傳、成績單，寄至cjlu@iis.sinica.edu.tw。審查通過者以email方式通知面試。
呂及人 cjlu@iis.sinica.edu.tw

參考網站： http://www.iis.sinica.edu.tw/pages/cjlu/index_zh.html

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馬偉雲老師實驗室

馬偉雲老師實驗室

刊登期間： 2015-04-16 – 2015-12-31

職　　稱： 專任研究助理(研發替代役可)

工作內容： 本實驗室主要工作內容為學術研究及系統開發。我們利用大數據來從事自然語言處理(Natural Language Processing)的研究，兼顧理論與應用，具體研發項目如下：

1. 深度學習(Deep Learning)的理論與應用
2. 社群媒體(如Facebook)的內容語義分析
3. 網路的知識擷取

應徵資格/條件：
1. 具備電機、資訊或應用數學相關科系之學士或碩士學位(研發替代役或準備出國者佳)。
2. 熟悉機器學習、最佳化、演算法設計或自然語言處理等相關領域，具備獨立思考能力，有相關研究經驗者佳。
3. 具備 C/C++/Java/Python/Perl 程式設計能力，有系統開發經驗者佳。

工作待遇： 比照科技部或中研院支薪規定，享勞健保、勞退與年終獎金

應徵方式： 視情形擇優通知面試，不合者恕不函覆。意者請備妥個人詳細履歷、自傳/Research Statement、成績單及其他有助審查資料之pdf電子檔，註明可開始工作日期，寄至 ma@iis.sinica.edu.tw

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何建明老師研究室

刊登期間： 2015-03-23 – 2015-12-31

職　　稱： 專任 / 兼任 研究助理 (專任研發替代役可)

工作內容： 社群反應分析 (Social Response Research)
大資料應用研究 (Big Data)
機器學習(Machine Learning)
關鍵字分析 (Keyword Extraction)
推薦系統 (Recommendation System)
雲計算資訊服務與技術研究 (Cloud Computing)
雲端字型服務與影像技術研究 (Font Cloud Research)
其他相關研究，程式撰寫與系統開發。

應徵資格/條件： (專任)資訊電機相關領域學士或碩士畢業
具相關研究經驗，或機器學習、演算法、程式設計相關理論背景， 具獨立思考能力及系統開發經驗者佳
(兼任)大學部大四以上及碩博士在學生可

工作待遇： 比照科技部或中研院支薪規定，專任享勞健保、勞退與年終獎金(學士第1年起薪約31K-33K，碩士約36K-39K)，兼任以日薪計酬

應徵方式： 視情形擇優通知面試，不合者恕不函覆。意者請備妥個人詳細履歷、自傳及

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古倫維老師實驗室

刊登期間： 2015-03-16 – 2015-12-31

職　　稱： Java/Python工程師

工作內容： 網路與專案程式撰寫、系統開發、演算法設計、論文報告

應徵資格/條件： 資訊電機相關領域學士或碩士畢業 具優秀程式撰寫能力，學習能力佳，對工作有熱忱，具一定英文聽說讀寫能力。

加分條件：具研究經驗，或自然語言處理、人工智慧、機器學習相關理論背景，具獨立思考能力及系統開發經驗，準備出國，對中英文語言處理研究有興趣者

工作待遇： 比照科技部或中研院支薪規定(學士第1年起薪約31K-33K，碩士約36K-39K)，享勞健保、勞退與年終獎金

應徵方式： 視情形擇優通知面試，不合者恕不函覆。意者請備妥個人詳細履歷、自傳及成績單pdf電子檔 (不接受人力銀行制式履歷)，註明應徵職缺及可開始工作日期寄至
古倫維 lwku@iis.sinica.edu.tw (02)27883799 ext 1808

參考網站： http://www.iis.sinica.edu.tw/pages/lwku/index_zh.html

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古倫維老師實驗室

刊登期間： 2015-03-16 – 2015-12-31

職　　稱： 專兼任研究助理

工作內容： 自然語言處理 (Natural Language Processing)
情緒分析 (Sentiment Analysis)
機器學習、深度學習 (Machine Learning, Deep Learning)
推薦系統 (Recommendation System)
計算語言學 (Computational Linguistics)
相關研究，程式撰寫與系統開發。

應徵資格/條件： (專任)資訊電機相關領域學士或碩士畢業（準備出國佳）具相關研究經驗，或語言學、機器學習、演算法設計相關理論背景， 具獨立思考能力及系統開發經驗者佳
(兼任)大學部大四以上及碩博士在學生可

工作待遇： 比照科技部或中研院支薪規定，專任享勞健保、勞退與年終獎金，兼任以日薪計酬

應徵方式： 視情形擇優通知面試，不合者恕不函覆。意者請備妥個人詳細履歷、自傳及成績單pdf電子檔，註明應徵職缺及可開始工作日期寄至
古倫維 lwku@iis.sinica.edu.tw (02)27883799 ext 1808

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參考網站： http://ants.iis.sinica.edu.tw

葉彌妍老師實驗室

刊登期間： 2015-01-05 – 2015-12-31

職　　稱： 專任研究助理-碩士級 (研發替代役可)

工作內容： 參與巨量資料探勘等相關研究

應徵資格/條件： 1. 國內外大學資工、電機、數學相關科系，具碩士學位
2. 熟悉data mining, social network analysis, time series analysis, machine learning等相關研究

工作待遇： 依中央研究院/科技部標準支薪

應徵方式： 請於應徵函件載明『應徵專任研究助理』，email 至：miyen@iis.sinica.edu.tw 或郵寄至「台北市115南港區研究院路2段128號 中研院資訊所 葉彌妍 老師收」， 如有合適人選，即不再收件，條件符合則邀請面談，不合者恕不退件不函覆。
葉彌妍 miyen@iis.sinica.edu.tw

參考網站： http://www.iis.sinica.edu.tw/~miyen/

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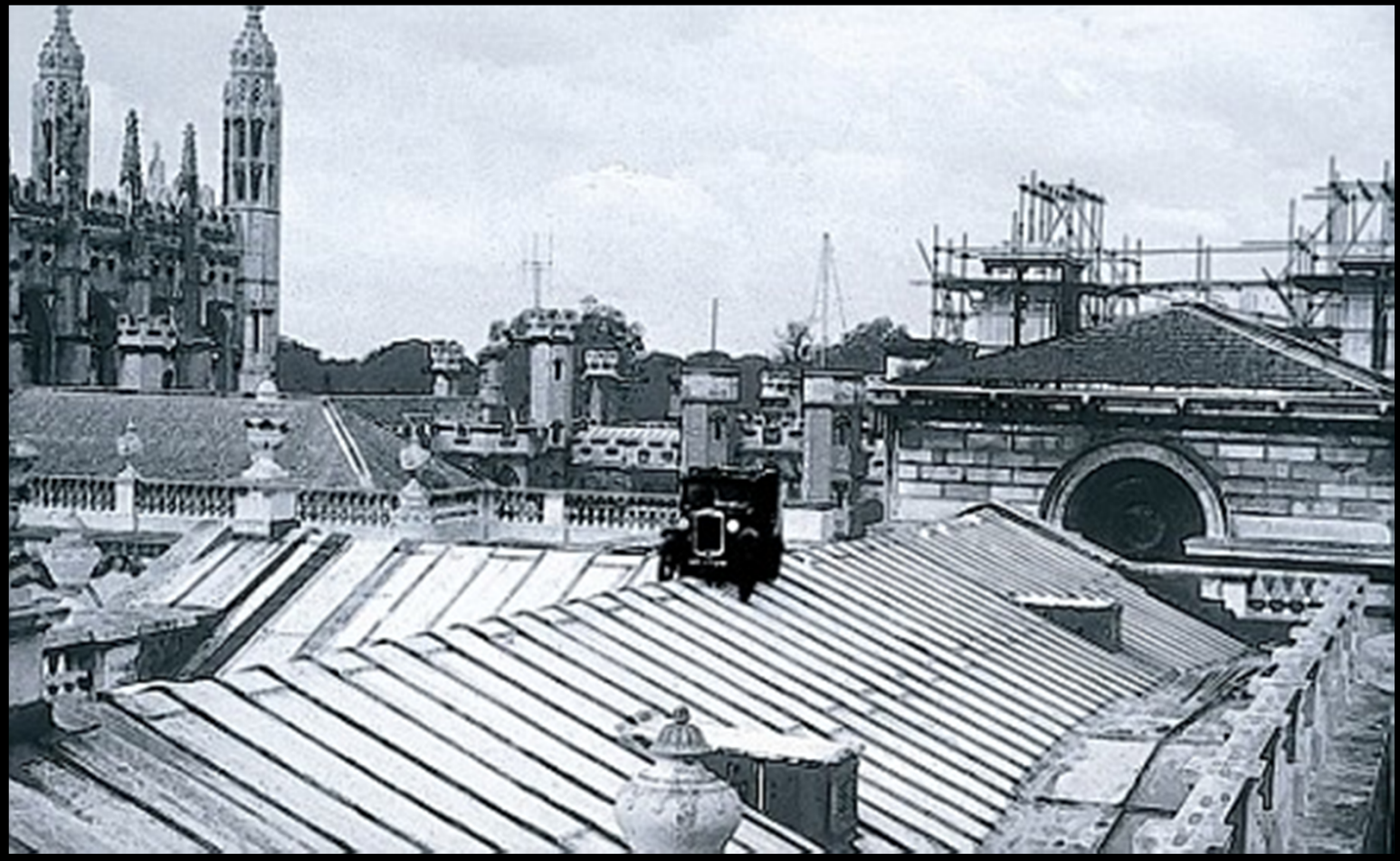
先進網路與服務實驗室Advanced Network Technologies and. Services Laboratory

刊登期間： 2015-01-05 – 2015-12-31

職　　稱： 博士後研究及碩士級研究助理(研發替代役可)

Cambridge University's 1958 car on roof prank secrets revealed



劍橋大學評議堂屋頂上的奧斯丁

驚人的是，屋頂有21公尺高，而且沒有任何階梯通到屋頂。這顯然是惡作劇，問題不只是誰幹的？是他怎麼辦到的？

劍橋的人議論紛紛，事情還登上世界各大報。消防隊死搞活搞快一星期都沒法把車子搞下來。當地政府動員大型機具，才硬是把車子弄回地面。

各方要求要找出「兇手」，一半是義憤，認為這是侮辱大學，一定要嚴懲。一半是好奇，很想知道這不可能的任務是如何達成的？

學校查不出來，一直沒有真相。這「屋頂上的奧斯丁」像鬼故事一樣代代流傳，成為劍橋最神秘的傳奇。事情傳了五十年.....

2008年終於謎底揭曉。當年參與惡搞的兇手齊聚，慶祝「屋頂奧斯丁」事件五十周年。帶頭者叫彼得・戴維（Peter Davey），他這時已七十二歲。

Source: http://www.appledaily.com.tw/realtimenews/article/new/20151121/736929/

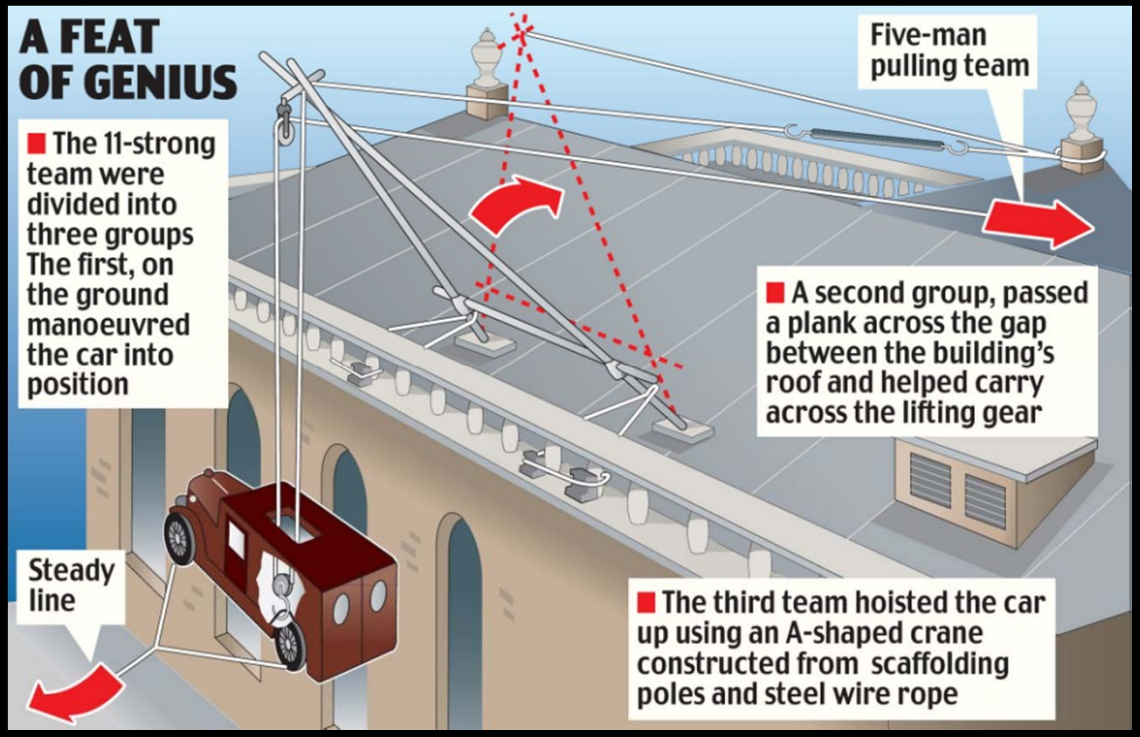
Cambridge University's 1958 car on roof prank secrets revealed

Cambridge University's 1958 car on roof prank secrets revealed

Cambridge University's 1958 car on roof prank secrets revealed

劍橋大學屋頂上的奧斯丁

五十年前，戴維是劍橋 的學生，有一次上課，天空下小雨，他望出窗外，看著評議堂高聳綿長的屋頂，感覺好無聊。下課後，他在附近遛達，發現角落有一輛廢棄的奧斯丁汽車。這根本是上帝給他的明示，他決定把這輛破車弄上屋頂。



他同寢室的五個同學和隔壁的六個都加入。他們先潛伏在教室，等到深夜行動。為了動作迅速，戴維把十二個人分成三組，地面、橋梁、抬吊。地面組負責把車子推到評議堂，橋梁組負責從岡維爾與凱斯學院的塔樓，架一塊木板搭到評議堂的屋頂，並把由繩索、鉤子和滑輪組合的簡易吊車送到屋頂。抬吊小組利用吊車把奧斯丁吊上屋頂，然後迅速撤離。全程一氣呵成，每個環節都配合完美，好像攝影機一鏡到底，沒有NG。成功躲過警衛巡邏，神不知鬼不覺的把車吊上屋頂。第二天震驚劍橋，轟動世界！

Source: http://www.appledaily.com.tw/realtimenews/article/new/20151121/736929/

有狀元學生，當然老師不是白癡。學院很快查到，有兩個寢室的學生6月7日在深夜才回來。院長休・蒙帝菲爾（Hugh Montefiore）立刻秘密把這十二個學生召集來，戴維以為這下完蛋了，搞不好會被退學。

沒想到院長弄清楚他們是怎麼搞的，不但沒有責罰，連教訓也沒有。還一直稱讚他們聰明、厲害，能幹出如此驚人創舉。院長只要求他們要保守秘密，不要吹噓、愛現、說漏嘴，因為他要保護他們。

私下還買了兩箱香檳送他們，祝賀行動完美成功。院長一直沒有說出是誰幹的好事，秘密就這樣保守了五十年，直到戴維他們自己出來公開。

當年這批惡作劇的學生，後來各個成就不凡，像戴維是英國自動化和機器人工程的先驅，還得過皇室特頒的勳章呢！

Source: http://www.appledaily.com.tw/realtimenews/article/new/20151121/736929/

A Small Truth To Make Your Life 100% Successful

- If

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

= 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

A Small Truth To Make Our Life 100% Successful

- L+U+C+K = 12+21+3+11 = 47%

A Small Truth To Make Our Life 100% Successful

- L+U+C+K = 12+21+3+11 = 47%
- L+O+V+E=12+15+22+5= 54%

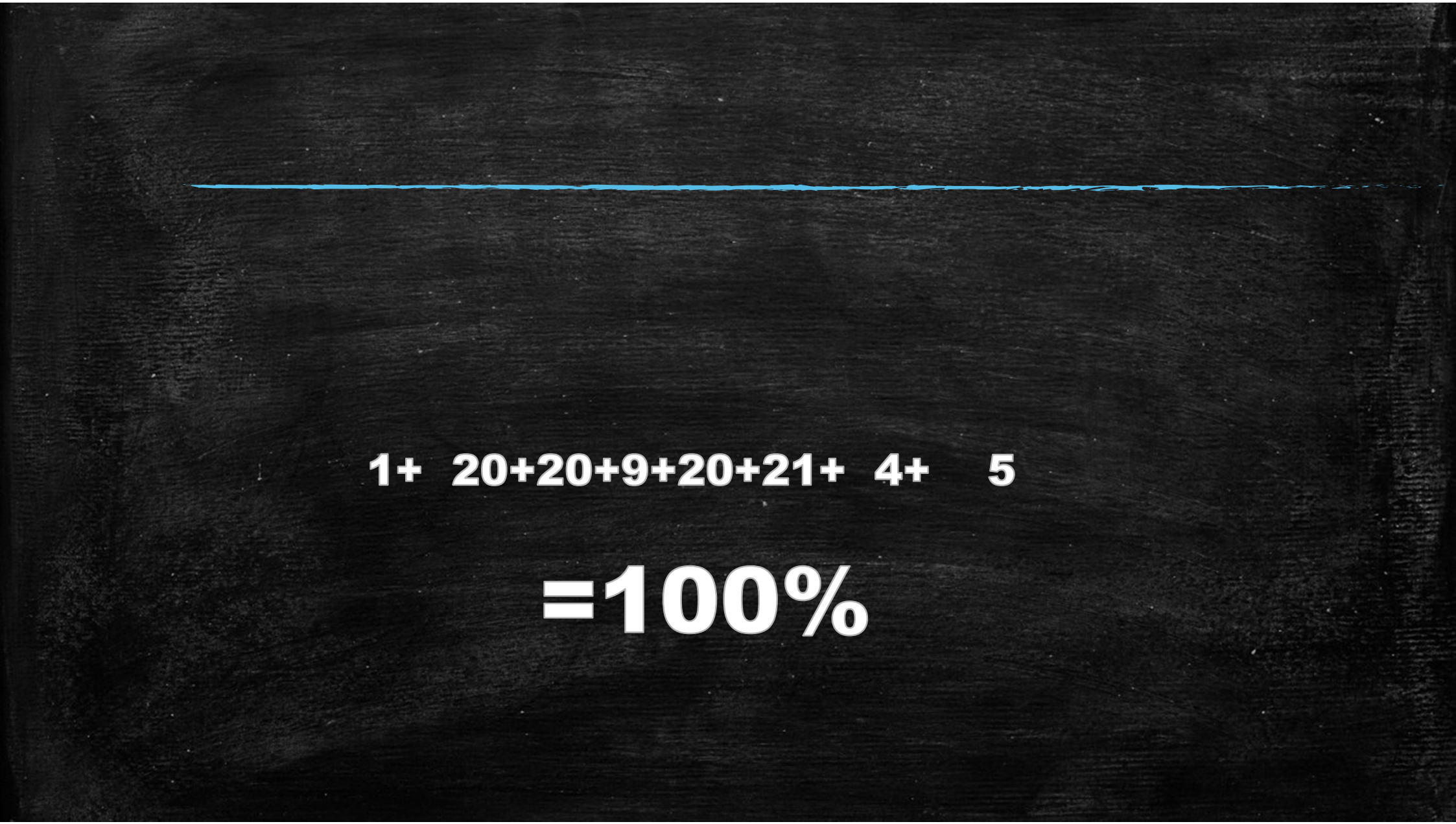
A Small Truth To Make Our Life 100% Successful

- L+U+C+K = 12+21+3+11 = 47%
- L+O+V+E=12+15+22+5= 54%
- K+N+O+W+L+E+D+G+E = 11+14+15+23+12+5+4+7+5 = 96%

A Small Truth To Make Our Life 100% Successful

- L+U+C+K = 12+21+3+11 = 47%
- L+O+V+E=12+15+22+5= 54%
- K+N+O+W+L+E+D+G+E = 11+14+15+23+12+5+4+7+5 = 96%
- H+A+R+D+W+O+R+K = 8+1+18+4+23+15+18+11 = 98%

That's all don't score full mark...but


1+ 20+20+9+20+21+ 4+ 5
=100%

態度決定一切

Attitude

1+ 20+20+9+20+21+ 4+ 5

=100%

Any Question?

- http://scienceblogs.com/dotphysics/2009/03/04/error-propagation-and-the-distance-the-sun/
- http://spiff.rit.edu/richmond/asras/measure_ss/measure_ss.html
- http://www.astronomyforbeginners.com/astronomy/howknow.php