


Introduction to Algorithms

- Slides by Avi Wigderson


Evaluating how good (how efficient) an algorithm is

How does the number of basic steps of an algorithm increase with the data size (input length) ?


input




Rubik's cube




2



3



4



5

...

Sudoku

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

3

1	2	3	4		12	6		7			
	8		7		1	3		10	6	11	
	12		10		7		13	11		14	
3	15	2		14				9	10	12	
13		8		10		12	2		1	15	
	11	7	6		16		15			5	13
		10		5	15		4	8		11	
16		5	9	12		1				8	
	2				13		12	5	8	3	
13		15	3		14	8		16			
5	8		1		2			13	9	15	
		12	4	6	16	13		7		5	
3		12			6		4	11	16		
	7		16	5	14		1		2		
11	1	15	9		13		2			14	
14				11	2		13	3	5	12	

4

Sudoku

y		b	a	c	x	n	h	t	f	i	d	e									
c	u	j	h	v	d	q	c	o	k	b	n	a	w	p							
w	h	m	n	i	u	k	p	r	y	s	k	d	q	c	o	j	i	b			
b	j	p	s	t		i	m	v	n	g	h	a	q	r	x	y					
x	o	i	d	i	p	r	e	f	u	j	w	y	m	h	s	c					
w	q	u	j		i	e	x	b	o	m	a	n	h	k	c	s					
n	c		w	x	u	s	t	q	i		e	m	k	v		j	i	a			
a	i	x	t	c	t		m	v	k	w	q	i		d	g	b	h				
s	v	h	k	p	o	b	u	f	j	n	g	t		d	i	m	r	q			
b	d	m	t	v		j	h	p		o	g	y	w		t	u					
y	p	e	t	a	m	v	h	o	b	x	i	t	s	q	u	w	g	r	c	d	k
q	d	i	e	s	r	h	c		t	k		x	y	i	a	o					
u	t	k	n	o		i	r	m	q	y	b	a	v	j		i	p	h			
x	r	w	p	y	k	i		i	e	j		o	m	r	t	q	v	u			
s	n	b	o	c	g	w	k	a	u	t	p	y	o	r	x	j	m				
j	h	q	v	x	y	h	u	t	p	o	g	t	m	f	d		w	i	k	r	
u	w	b	t	i	e	r	p	o	m	c	d	f	k	v		i	s	q			
d	h	m	s	c	f	q	j	k	n	g	w	b		i	v	u	e				
i	k	o	e	d	i	k	n	q	w	u		j	a	i		h	b	p	m		
i	k	v	j	t	w	a	s	h				u	r	q	c	d	f	n			
o	d	y	r	w		c	i	i	n	p	v	a	t	e	q						
v	x	p	o	c	t	b	d	n	f	w		g	s	a	h	y	i				
i	k	w	c	g	q	x	h			a	u	i	d	e	s	m	f	v			
a	y	r	d	f	e	n	x	k	s	h	b	u	p								
q	i	r	n	m	i	v	w	h	x	t	y		c	d							

5


Complexity

# digits	# steps	
	Hindu	
1	6-1	
5	6-5	
10	6-10	
100	6-100	
N	6-N	
N	~N	



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

Google maps

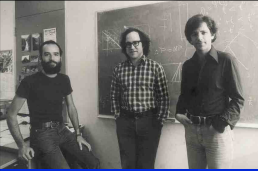
Shortest paths

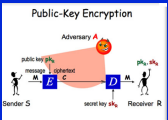
FFT

Audio processing
Image processing
Tomography, MRI



Public-Key Encryption



RSA

encryption
e-commerce

CDs
DVDs



Satellite communication
Cell phone communication




Error Correction

PageRank

web search



The class P

All problems having an efficient algorithm to *find* solutions

Are all practically interesting problems in P?