RCI – Oct 28, 2007

The Science in Computer Science

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The SCIENCE in Computer Science

1. How is CS unique?
2. What is Science?
3. Is computer science a Science?
4. Building the CS Universe
5. Areas of Study
6. Concluding Remarks
7. Questions

The SCIENCE in Computer Science

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2. What is Science?
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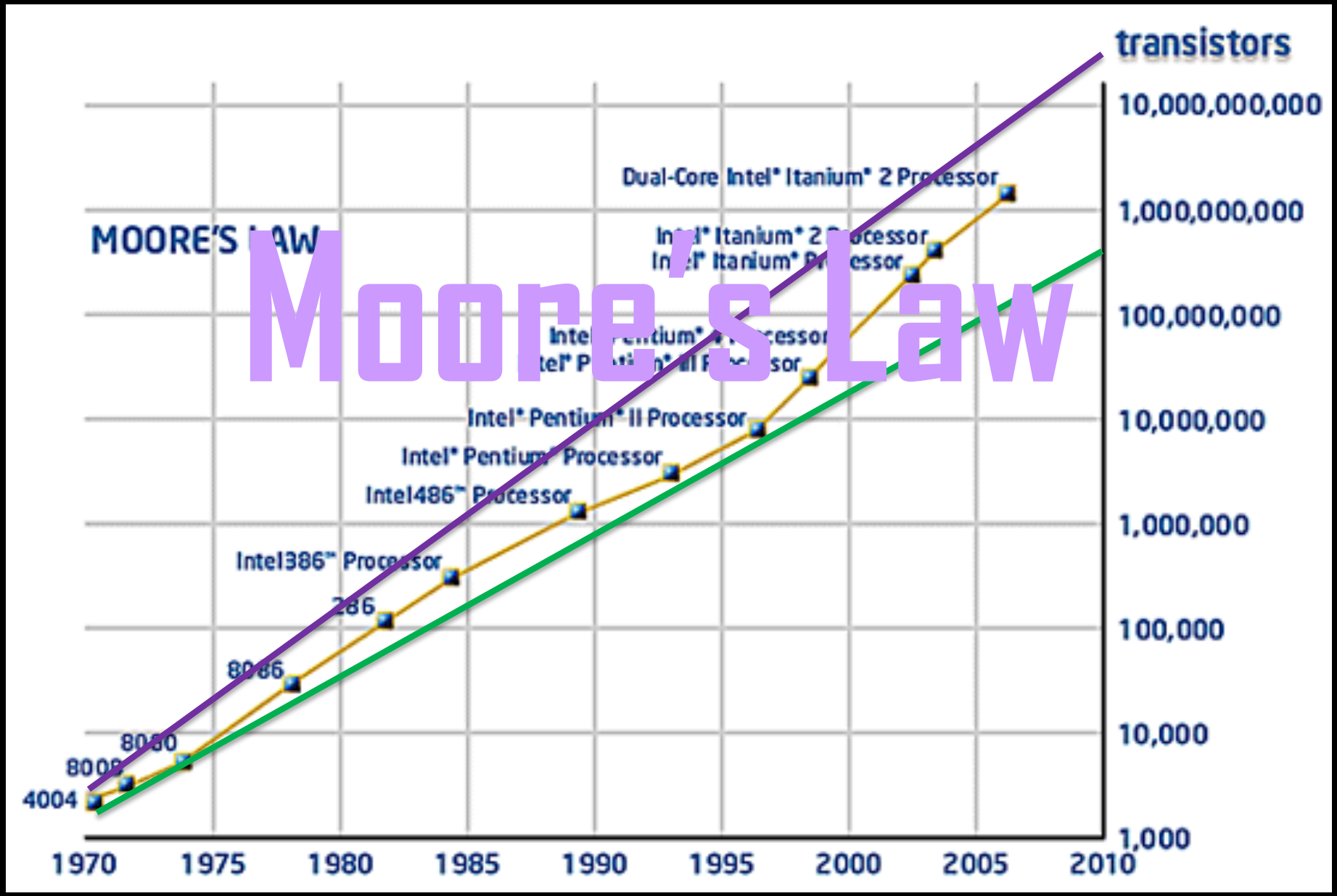
How is Computer Science Unique?

Pace
of Progress

Pervasiveness
into "everything"



Source: www.intel.com

PERVASIVENESS

- Telecom, Manufacturing, Banking, …
- IP-Based Intellectual Property
- Enables ~ $5T = 10% World GDP
- Infrastructure of the economy
- Consumer-centred services
- Web 2.0 Societies
- Physics, Biology, … even Math

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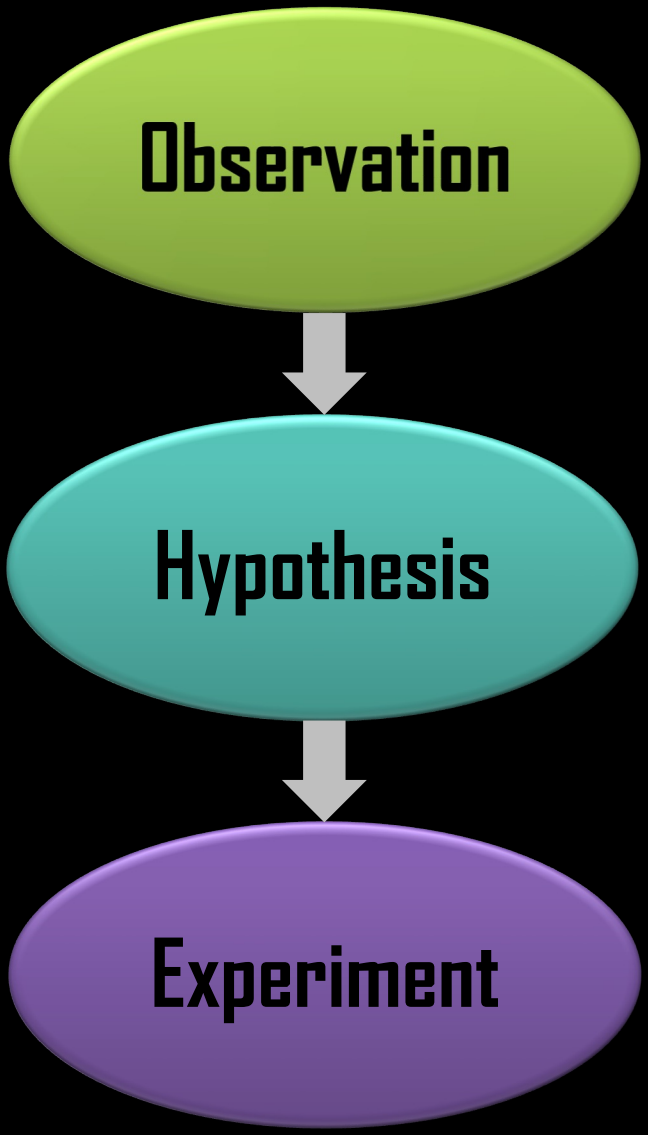
What?

How?

The Scientific Method



Examine a phenomenon

WHAT

Propose an explanation

HOW

Test your hypothesis

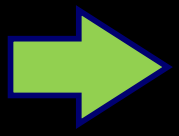
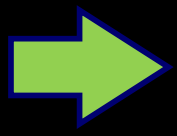
No amount of experimentation can ever prove me right; a single experiment can prove me wrong.

Albert Einstein (1879-1955)

The Evolution of Knowledge

Having established one hypothesis, find another that explains it at a deeper level.

Having established several hypotheses, find one that incorporates all of them.

Hypotheses  Theories  Laws of Nature

The Spectrum of Sciences

Astronomy: parsec = 10^{16} m

Geosciences: 1 km = 10^{3} m

Biology: 1 micron = 10^{-6} m

Chemistry: 1 nanometer = 10^{-9} m

Physics: 1 fermi = 10^{-15} m

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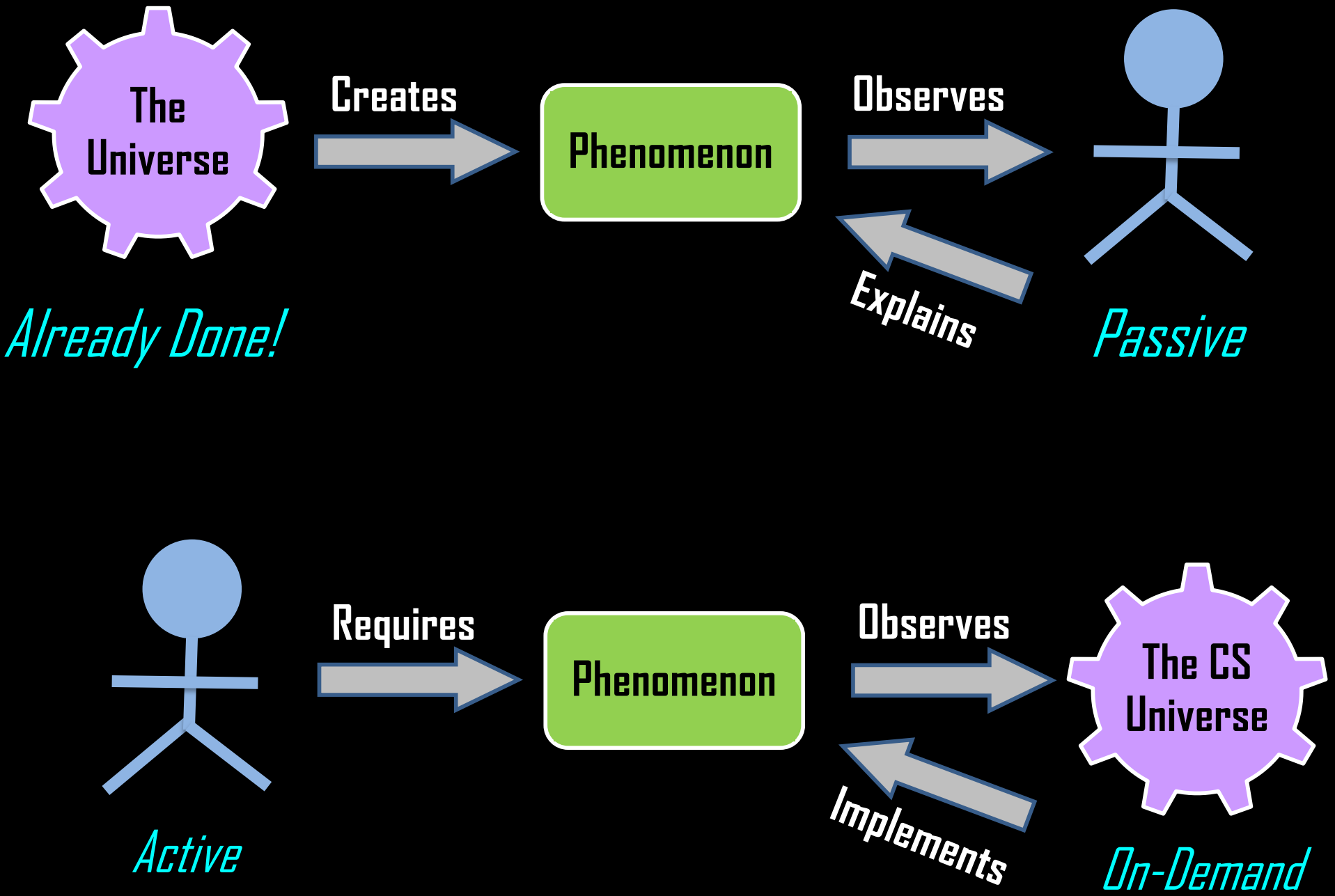
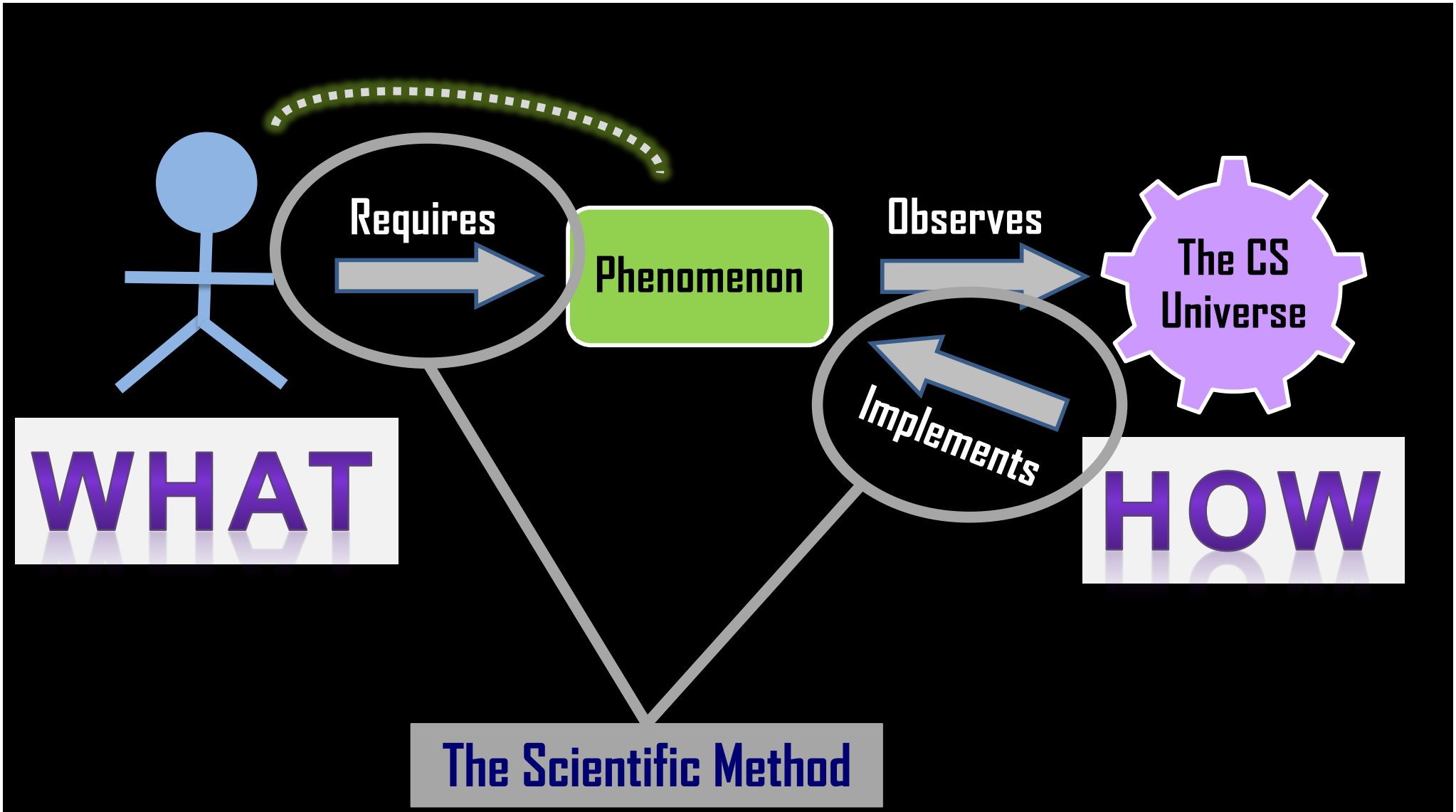

The Universe
Creates
Phenomenon
Observes
Explains
Already Done!
Passive
Requires
Phenomenon
Observes
Implements
The CS Universe
Active
On-Demand


Requires
Phenomenon
Observes
The CS Universe
Implements
WHAT
HOW
The Scientific Method

Program testing can be used to show the presence of errors, not their absence.

Edsger W. Dijkstra (1930-2002)

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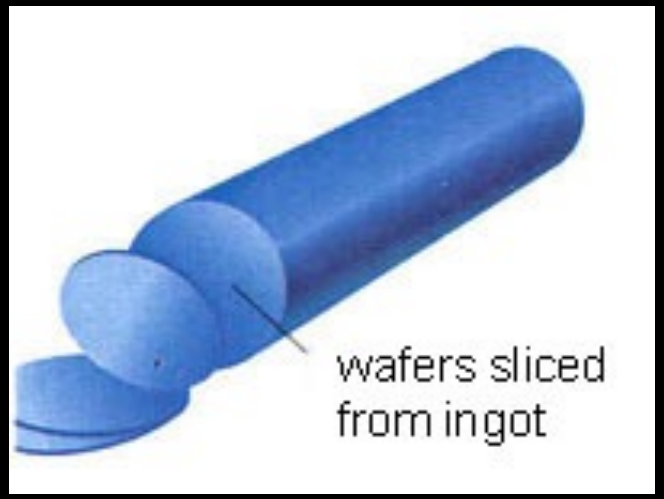
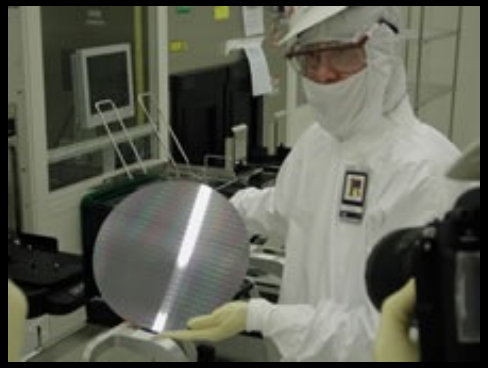
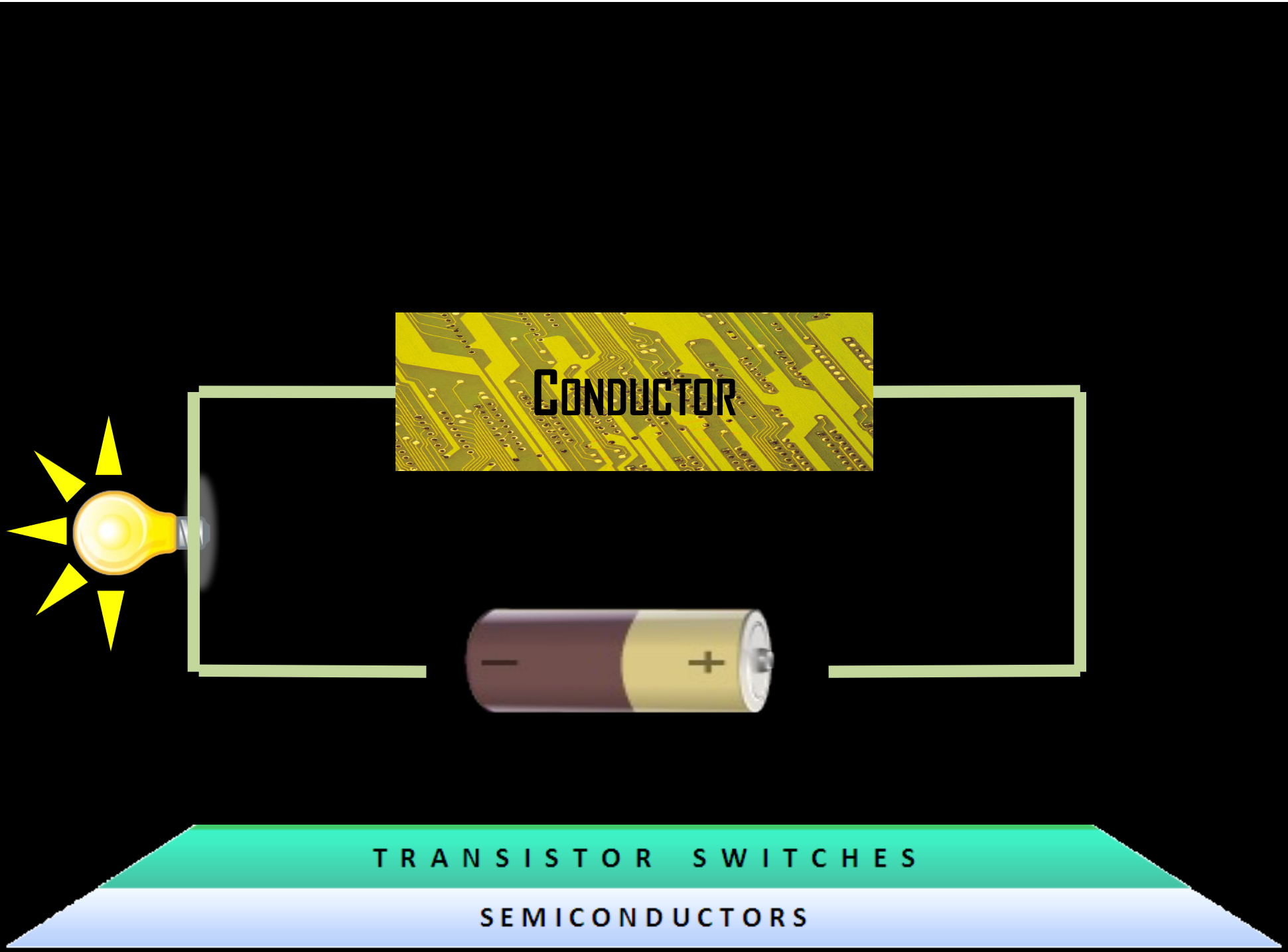
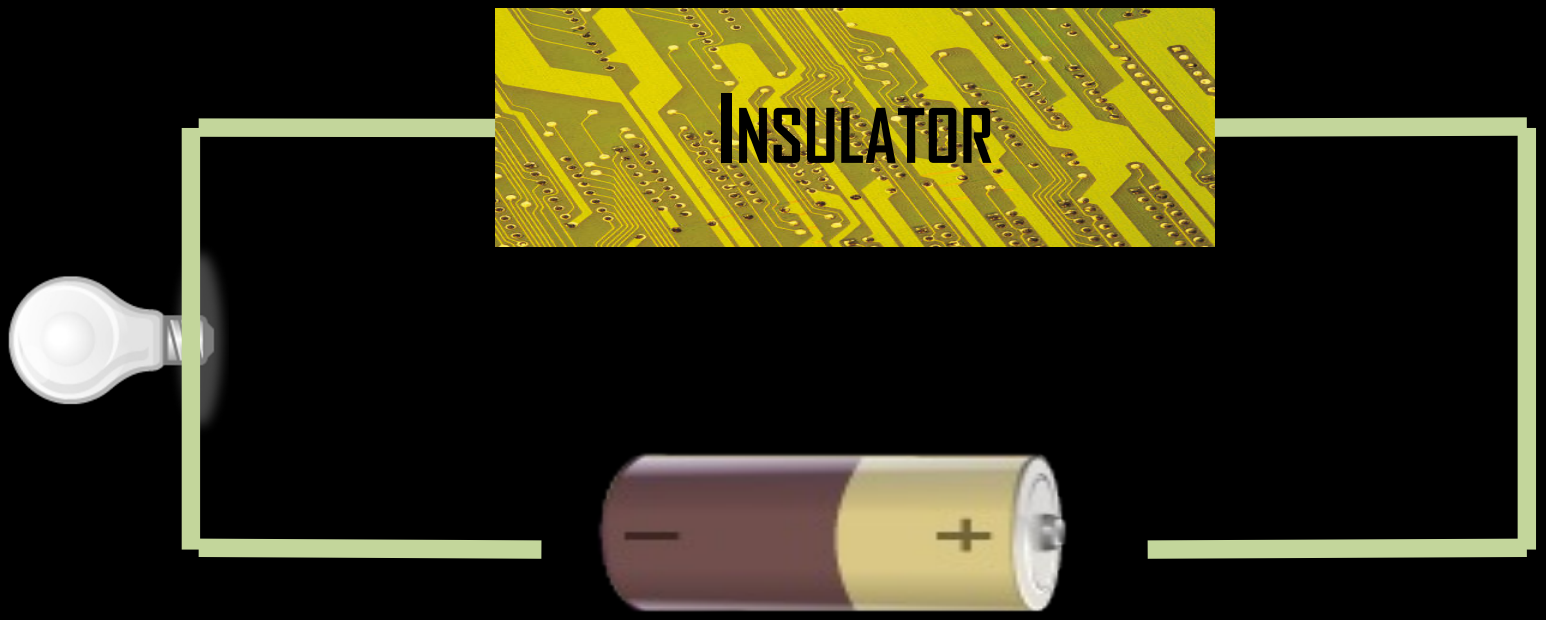




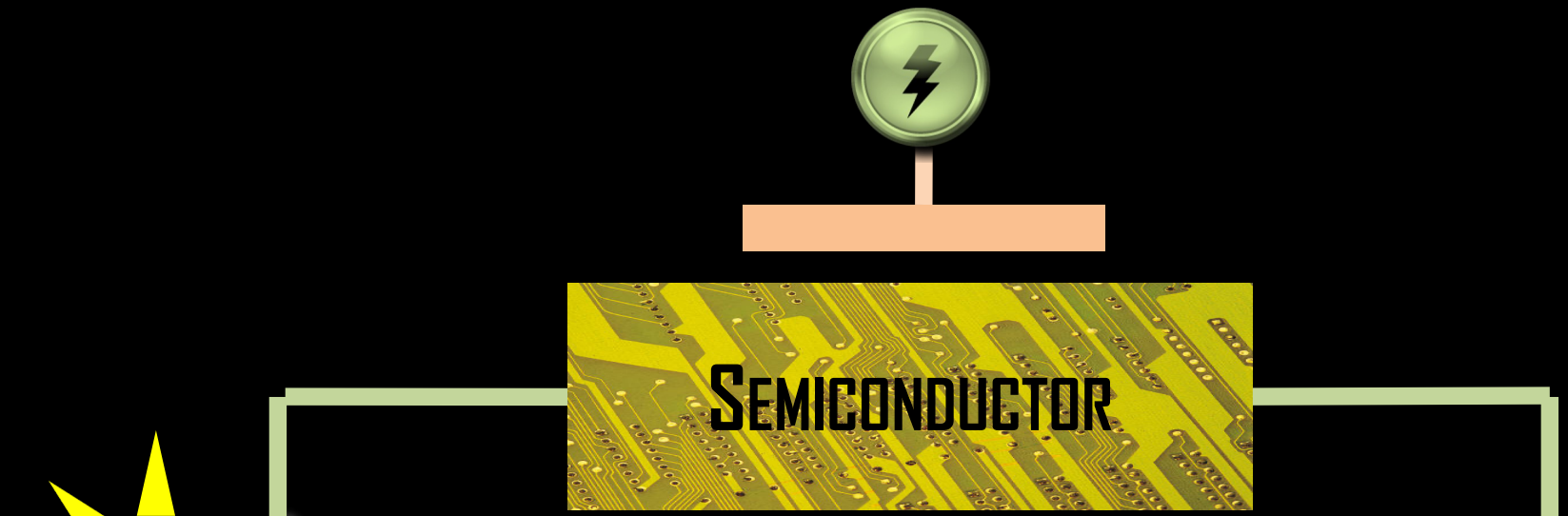
SEMICONDUCTORS


CONDUCTOR
TRANSISTOR SWITCHES
SEMICONDUCTORS



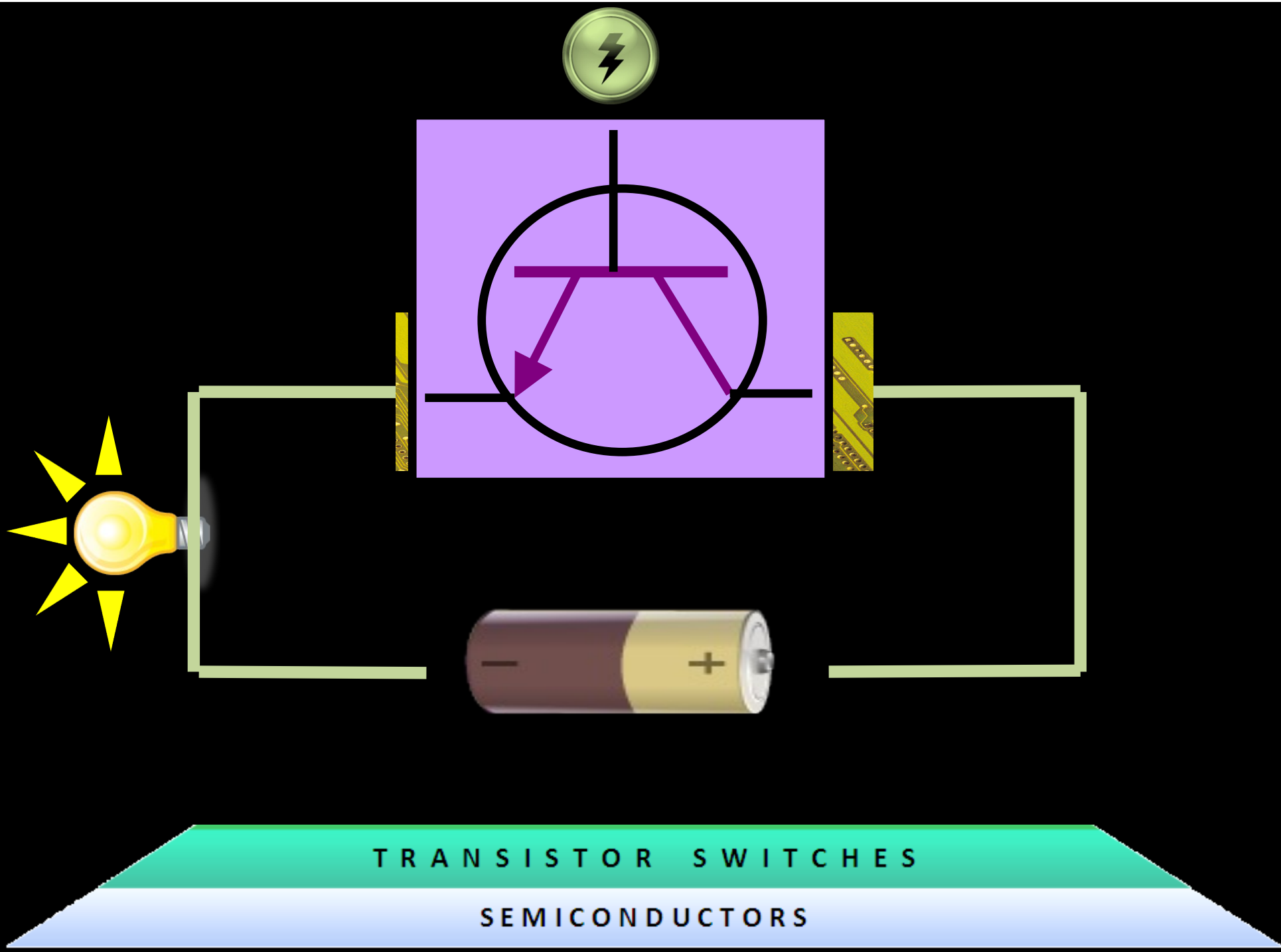
TRANSISTOR SWITCHES

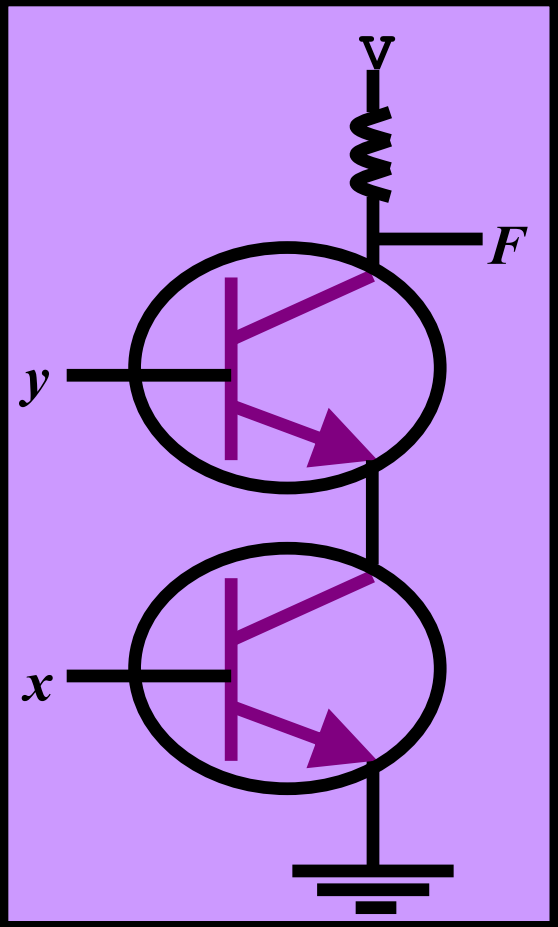
SEMICONDUCTORS

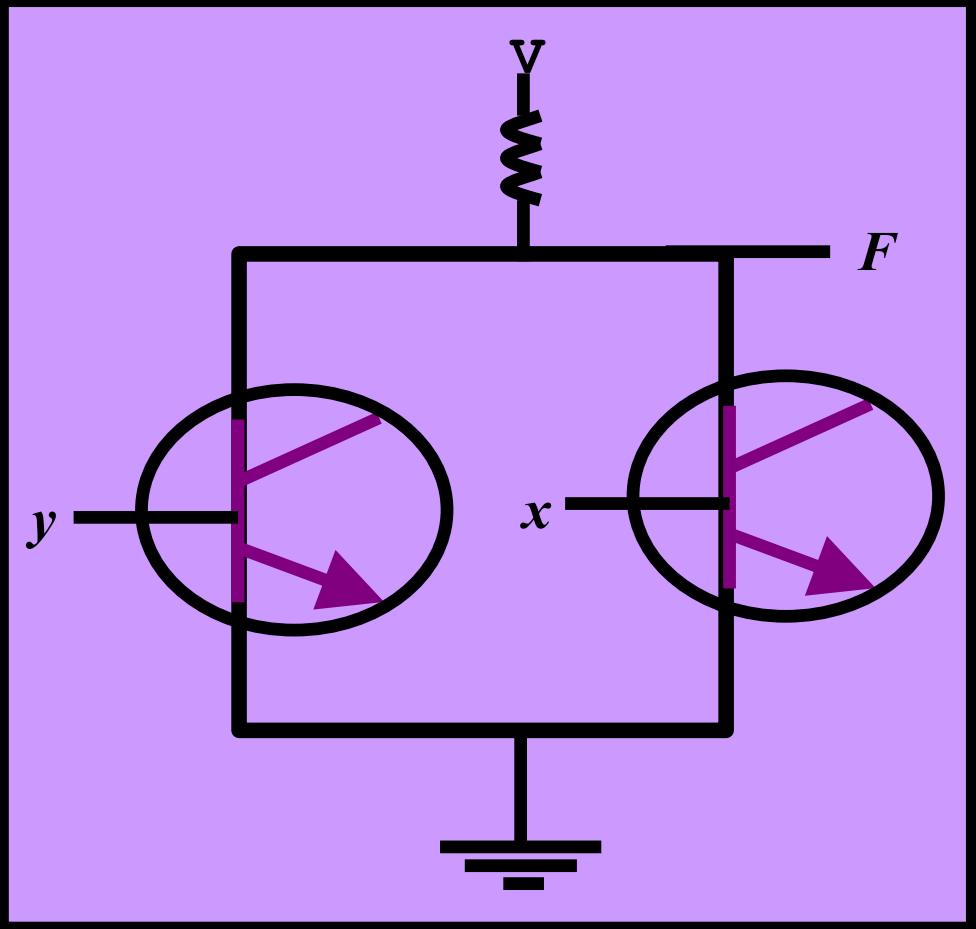


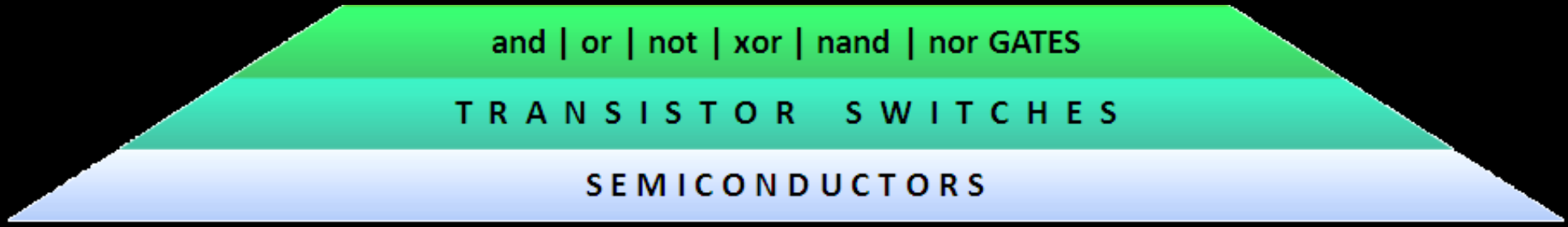
TRANSISTOR SWITCHES

SEMICONDUCTORS

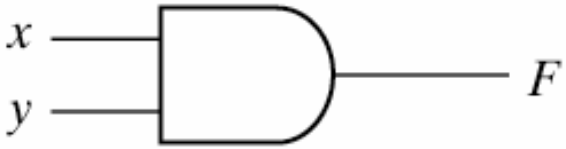

TRANSISTOR SWITCHES
SEMICONDUCTORS


V
F
y
x


V
F
y
x


and | or | not | xor | nand | nor GATES
TRANSISTOR SWITCHES
SEMICONDUCTORS

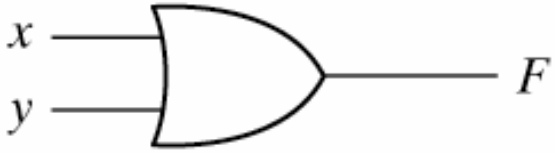
AND



$F = xy$

x	y	F
0	0	0
0	1	0
1	0	0
1	1	1

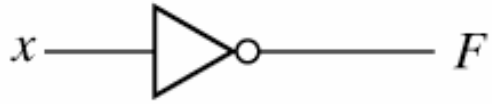
OR



$F = x + y$

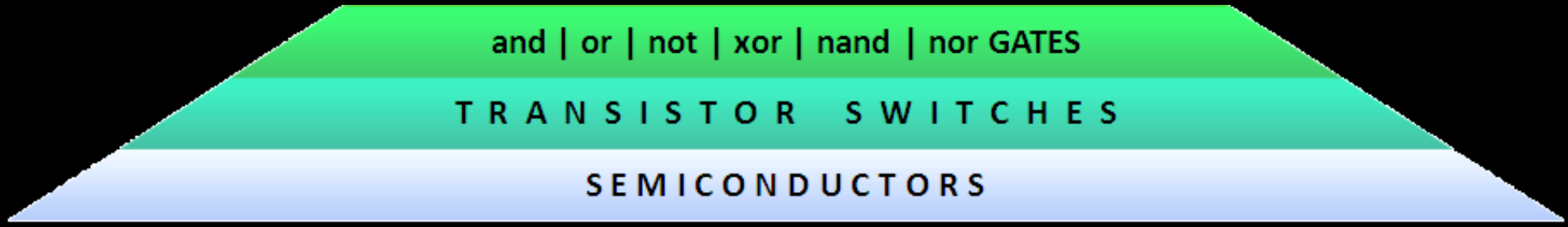
x	y	F
0	0	0
0	1	1
1	0	1
1	1	1

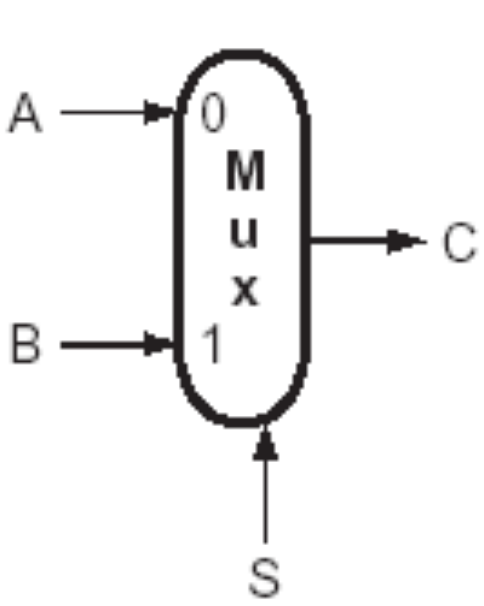
Inverter

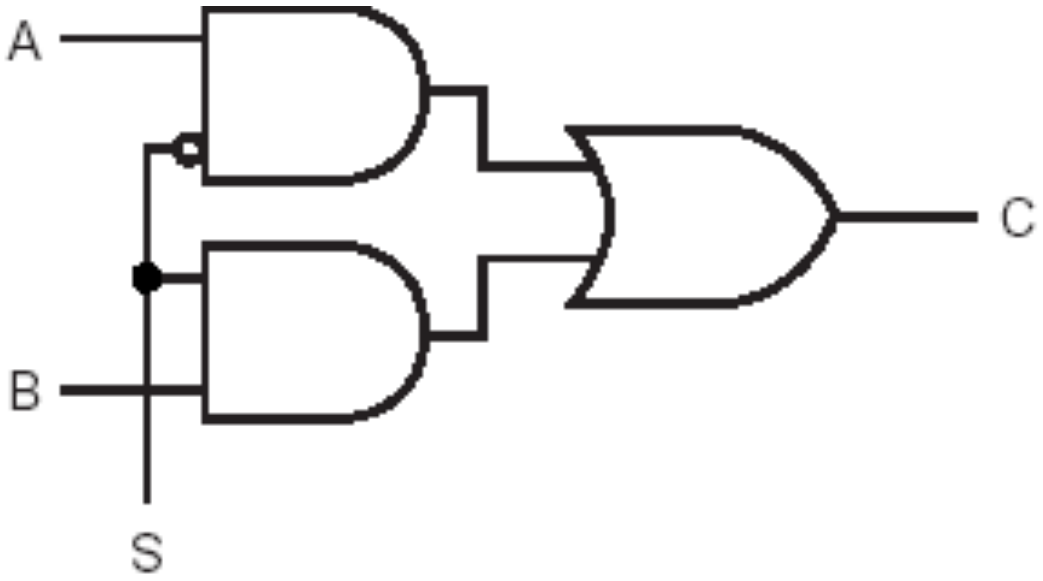


$F = x'$

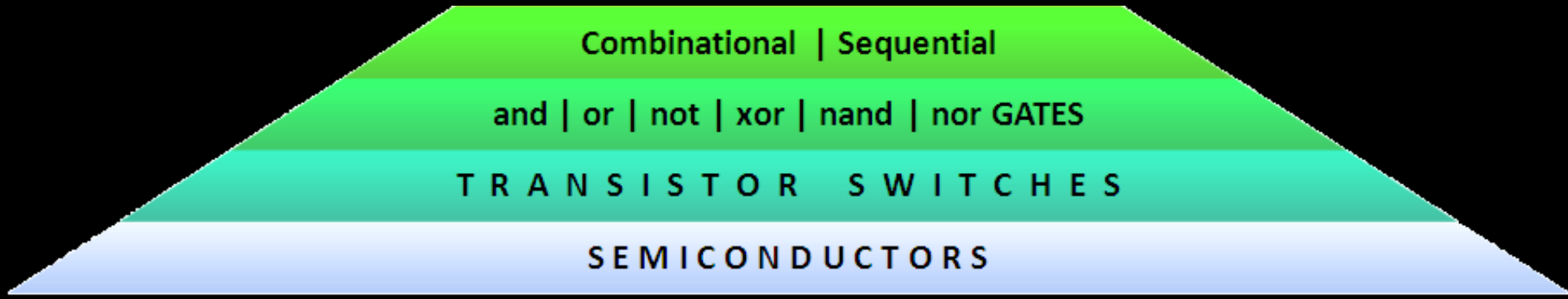
x	F
0	1
1	0





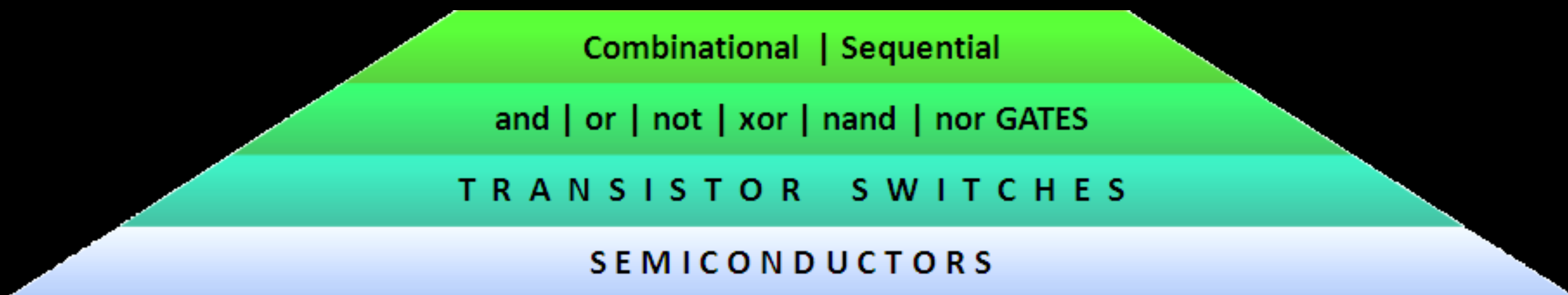


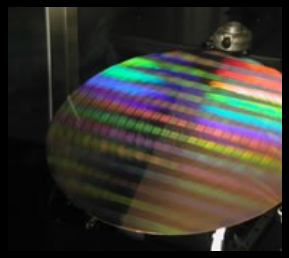
Select between two alternatives A and B



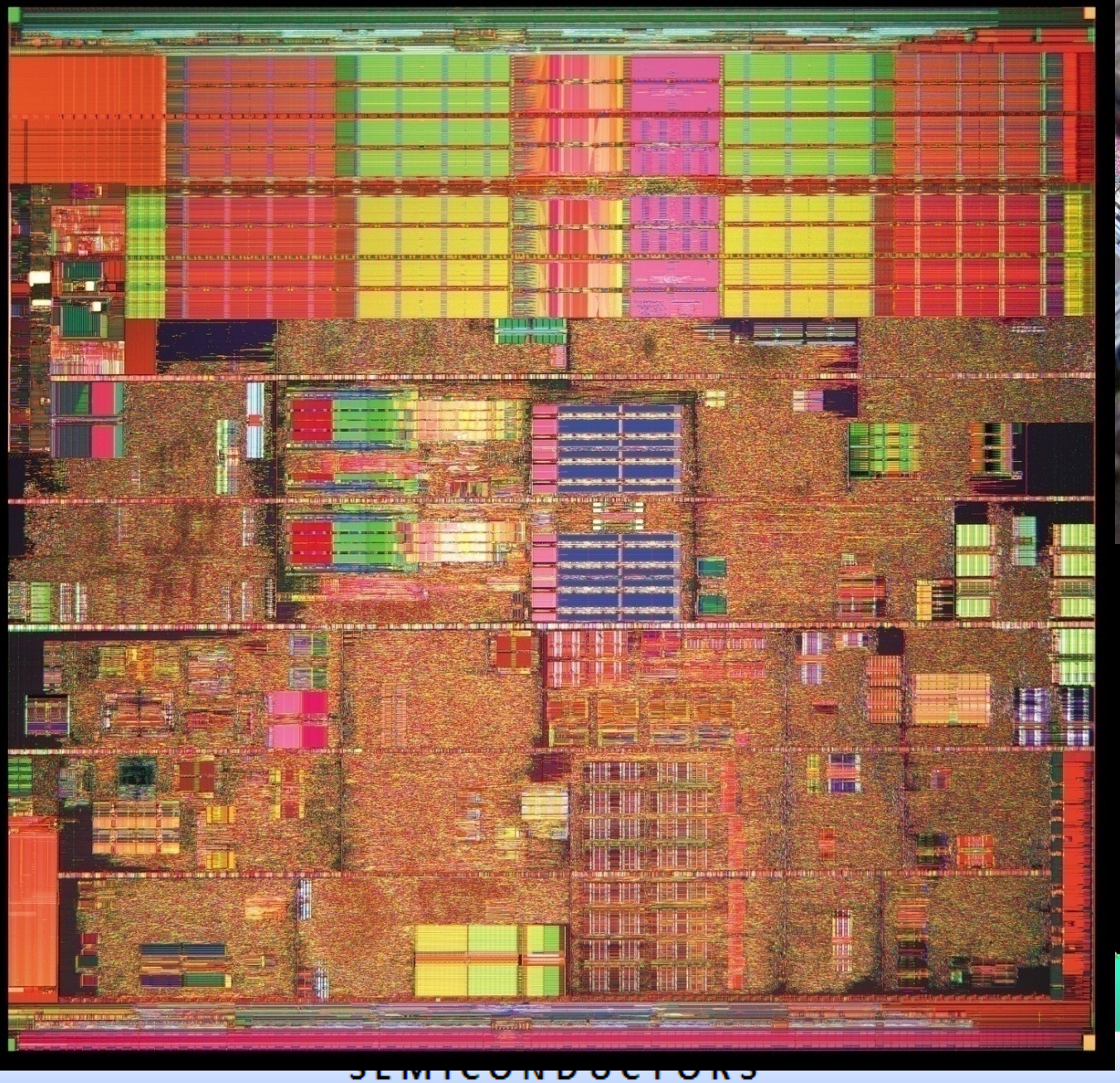
$$\begin{array}{c}0\\0\\\hline 0\end{array}\qquad\begin{array}{c}0\\1\\\hline 1\end{array}\qquad\begin{array}{c}1\\0\\\hline 1\end{array}\qquad\begin{array}{cc} & 1\\ & 1\\\hline 1 & 0\end{array}$$

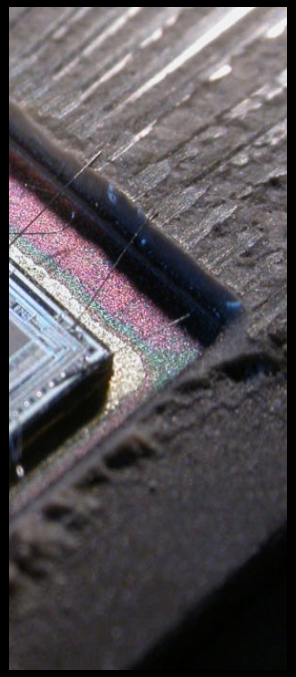
Add two numbers with ***XOR*** *and* ***AND***



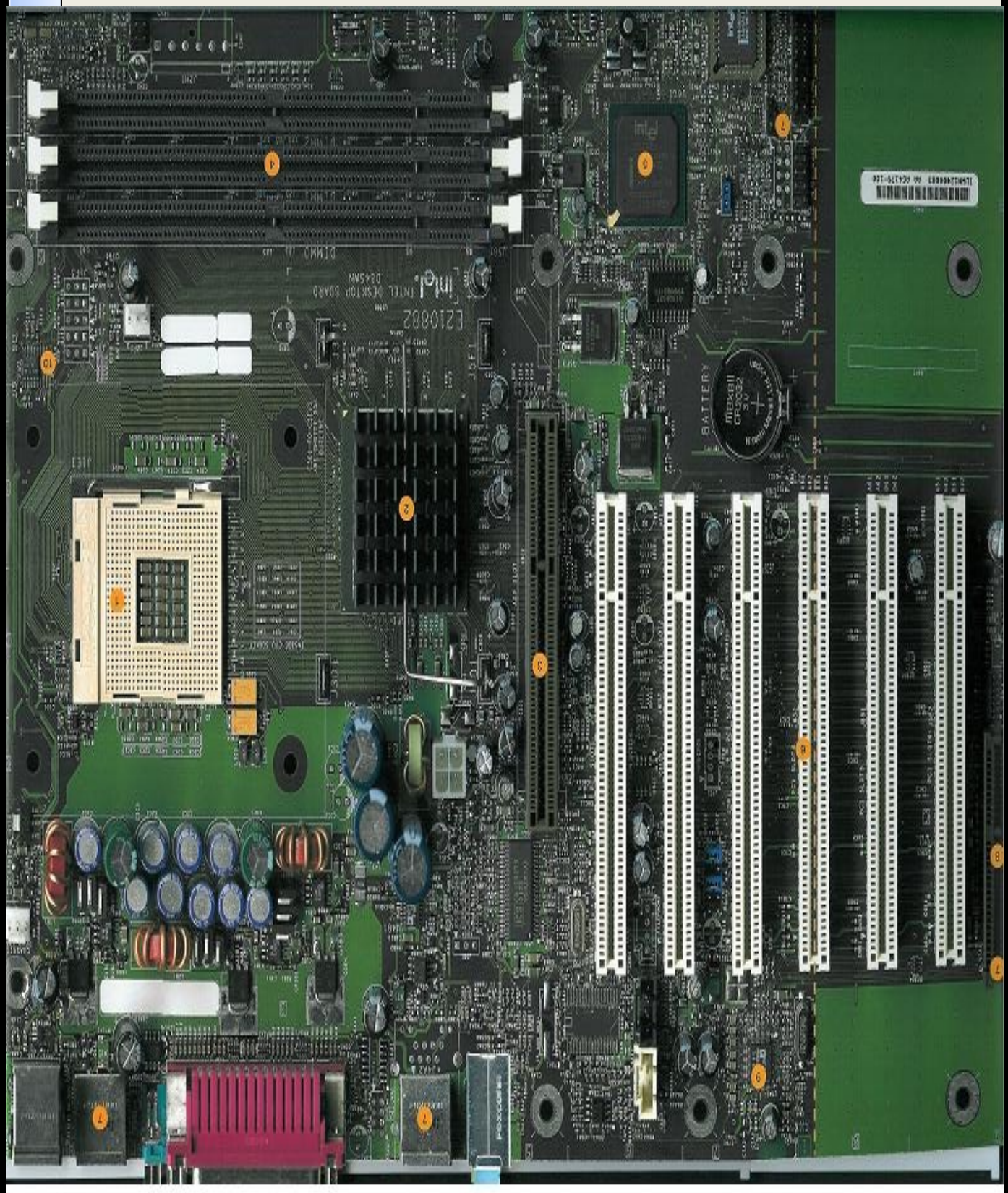


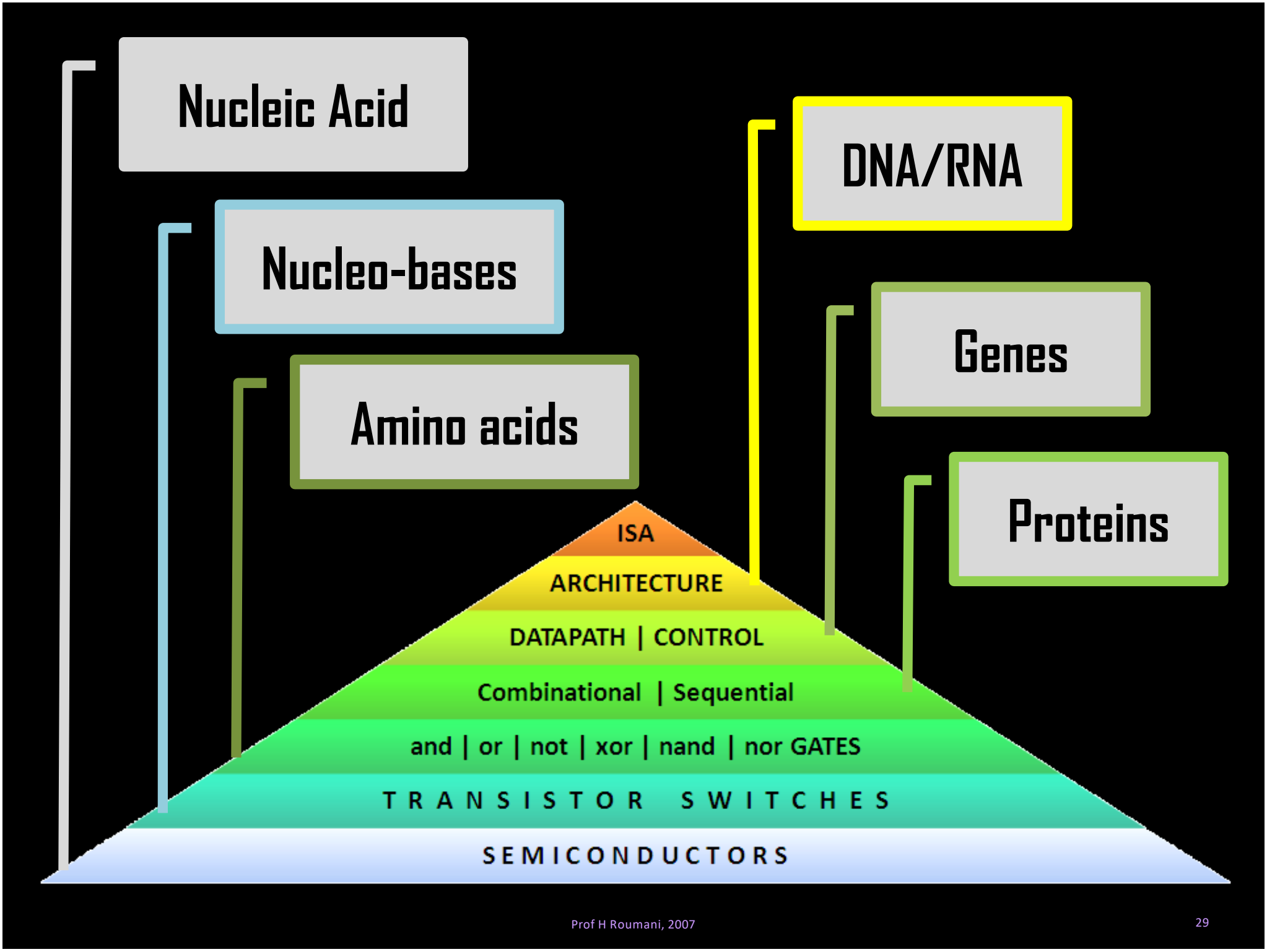
Tested dies

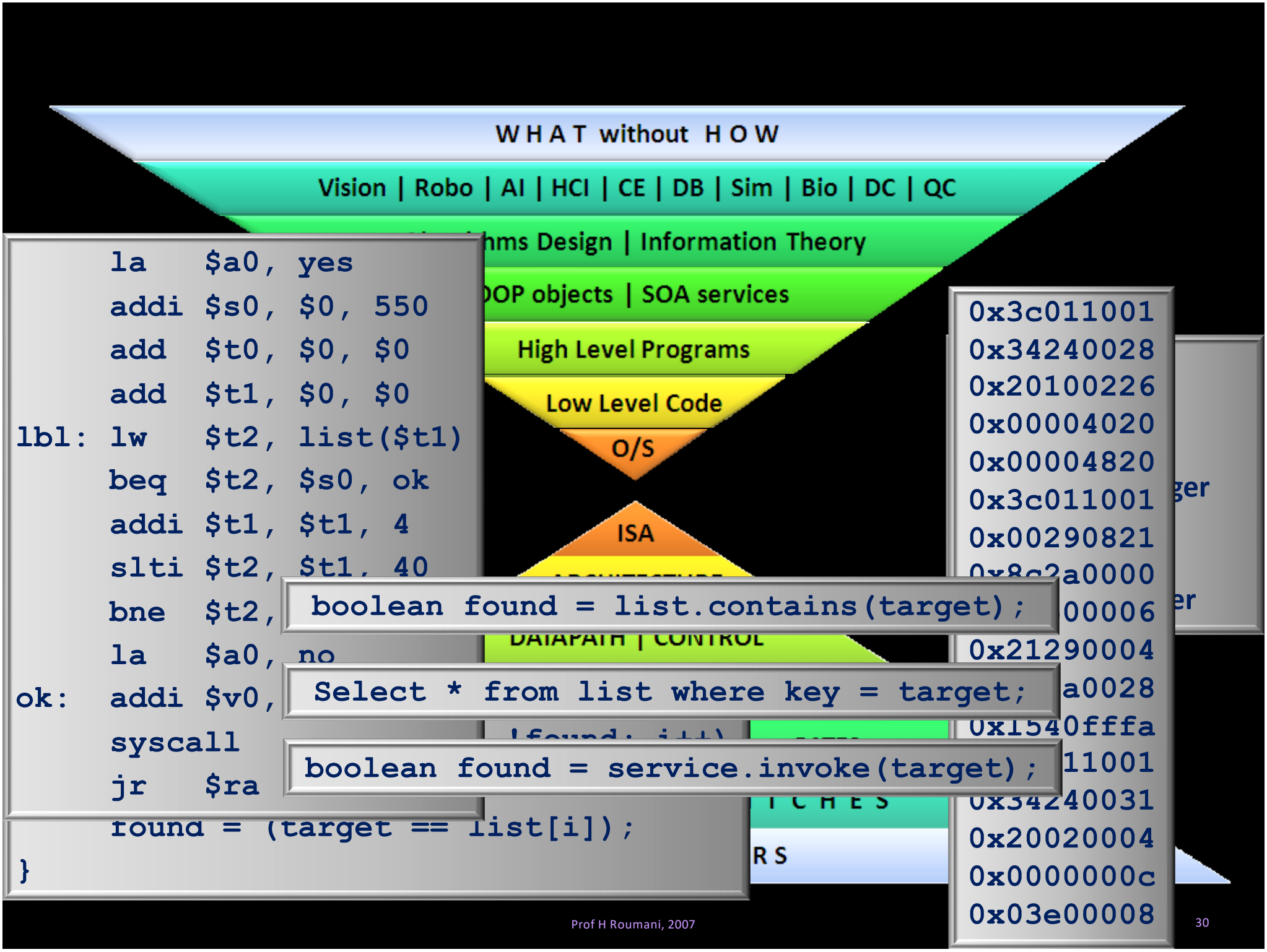




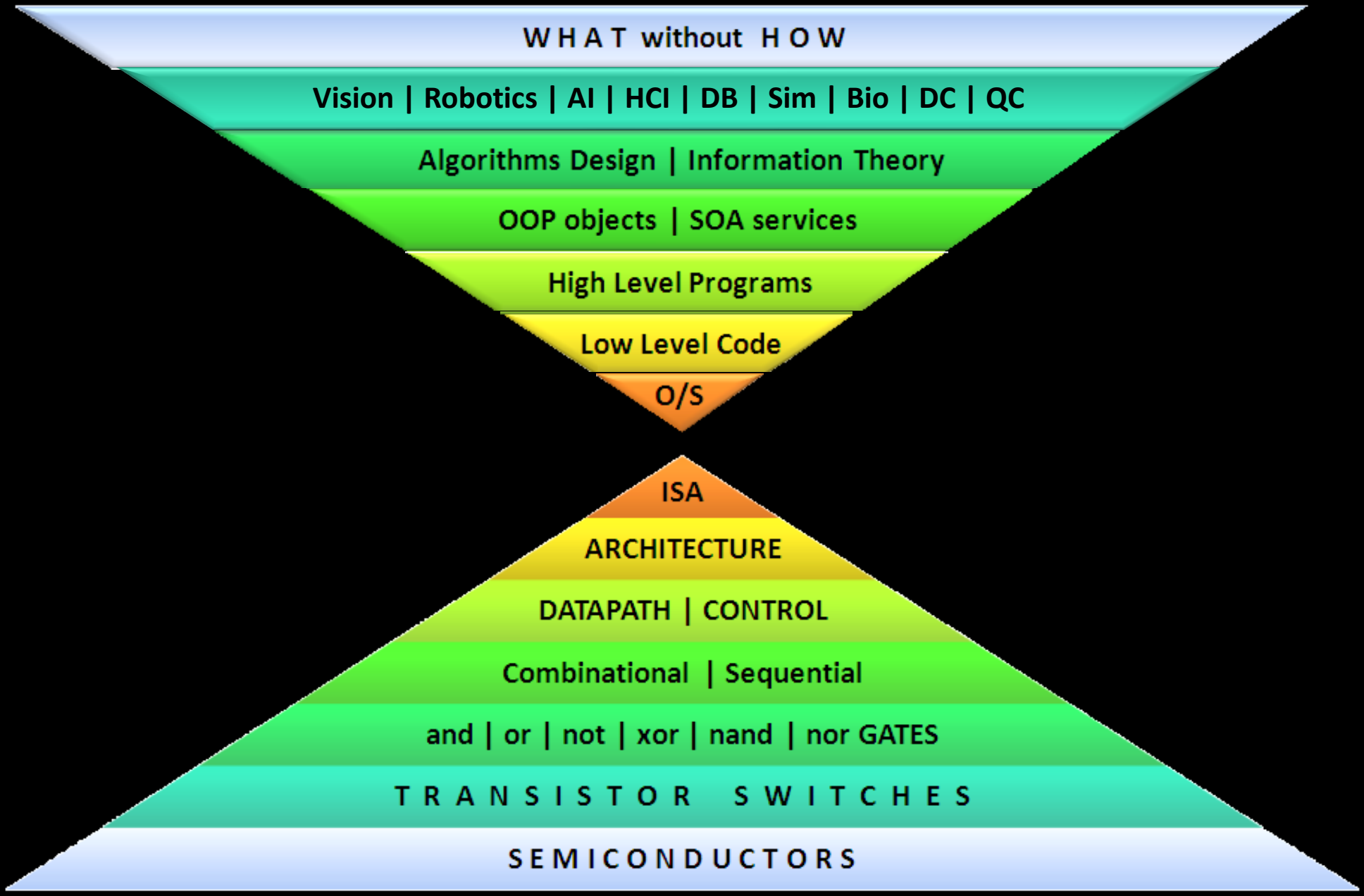
The von Neumann Architecture




Nucleic Acid
Nucleo-bases
Amino acids
DNA/RNA
Genes
Proteins
ISA
ARCHITECTURE
DATAPATH | CONTROL
Combinational | Sequential
and | or | not | xor | nand | nor GATES
TRANSISTOR SWITCHES
SEMICONDUCTORS


WHAT without HOW
Vision | Robo | AI | HCI | CE | DB | Sim | Bio | DC | QC
hms Design | Information Theory
OOP objects | SOA services
High Level Programs
Low Level Code
O/S
ISA
DATAPATH | CONTROL
R S
la $a0, yes
addi $s0, $0, 550
add $t0, $0, $0
add $t1, $0, $0
lbl: lw $t2, list($t1)
beq $t2, $s0, ok
addi $t1, $t1, 4
slti $t2, $t1, 40
bne $t2,
la $a0, no
ok: addi $v0,
syscall
jr $ra
found = (target == list[i]);
}
boolean found = list.contains(target);
Select * from list where key = target;
boolean found = service.invoke(target);
0x3c011001
0x34240028
0x20100226
0x00004020
0x00004820
0x3c011001
0x00290821
0x21290004
0x1540fffa
0x34240031
0x20020004
0x0000000c
0x03e00008

The Computing Universe



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1. How is CS unique?
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4. Building the CS Universe
5. **Areas of Study**
6. Concluding Remarks
7. Questions

Areas in the Discipline

1. Two Myths About CS
2. Computing Careers
3. CS versus Computer Engineering
4. A Day in the Life of a CS researcher

Fallacies

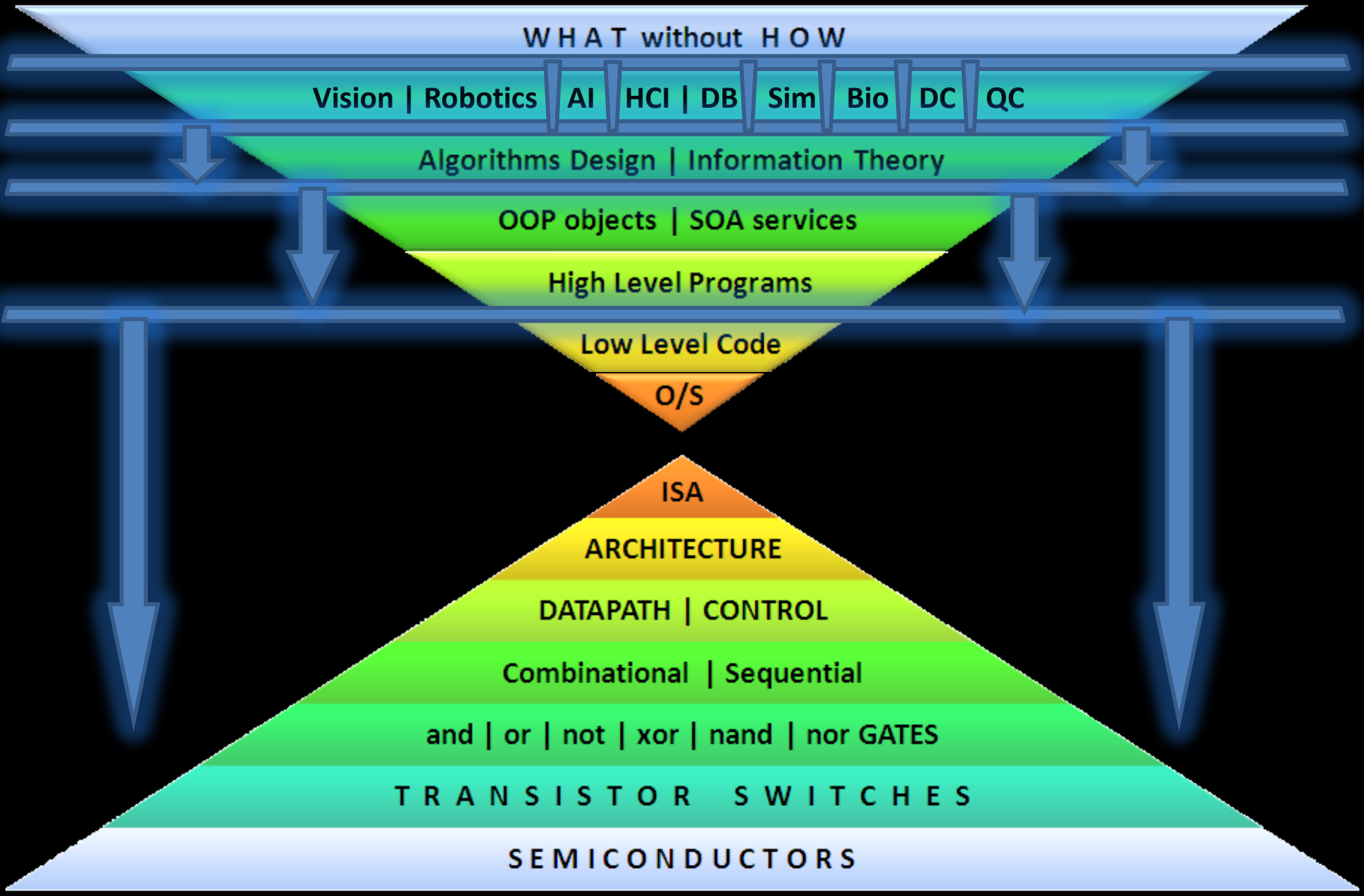
- CS is about Computers

  As much as Astronomy is about Telescopes!

- CS is about Programming

  As much as Literature is about Word Processing!

Proposal: the WHOW Science.


W H A T without H O W
Vision | Robotics
AI
HCI | DB
Sim
Bio
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Algorithms Design | Information Theory
OOP objects | SOA services
High Level Programs
Low Level Code
O/S
ISA
ARCHITECTURE
DATAPATH | CONTROL
Combinational | Sequential
and | or | not | xor | nand | nor GATES
T R A N S I S T O R S W I T C H E S
S E M I C O N D U C T O R S

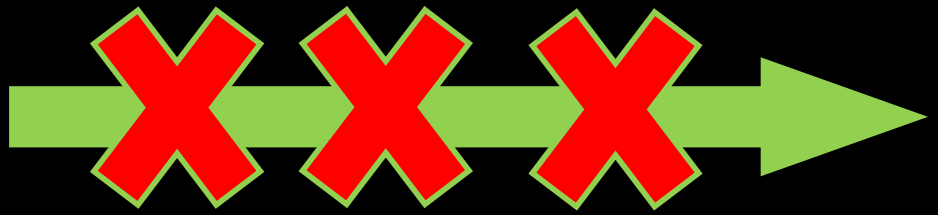
General Areas

1. Hardware and Systems
2. Software and Applications
3. Theory
4. Computing Methodologies

   AI, Graphics, Image Processing, Vision, Robotics, Information Systems, HCI, Symbolic Computing, ...

Software and Applications

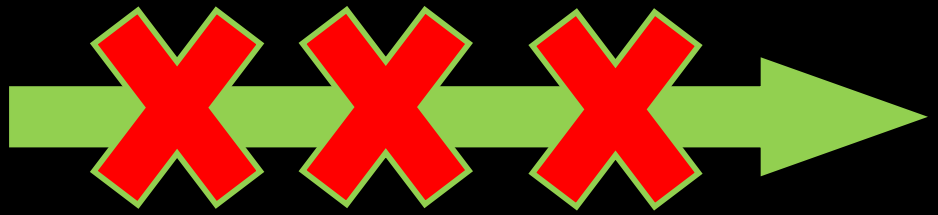
Users



Developers

Software and Applications

Users



Developers

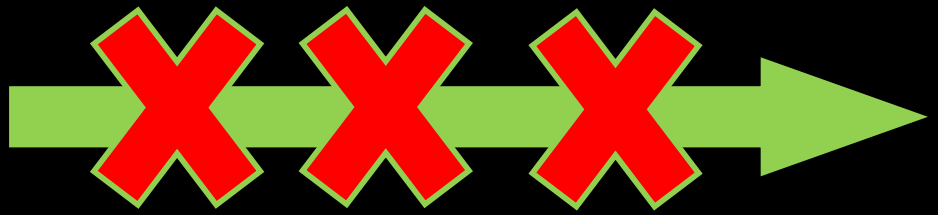
Requirement

Specification

Analysts

Software and Applications

Users



Developers

Requirement

Specification

Architect

Analysts

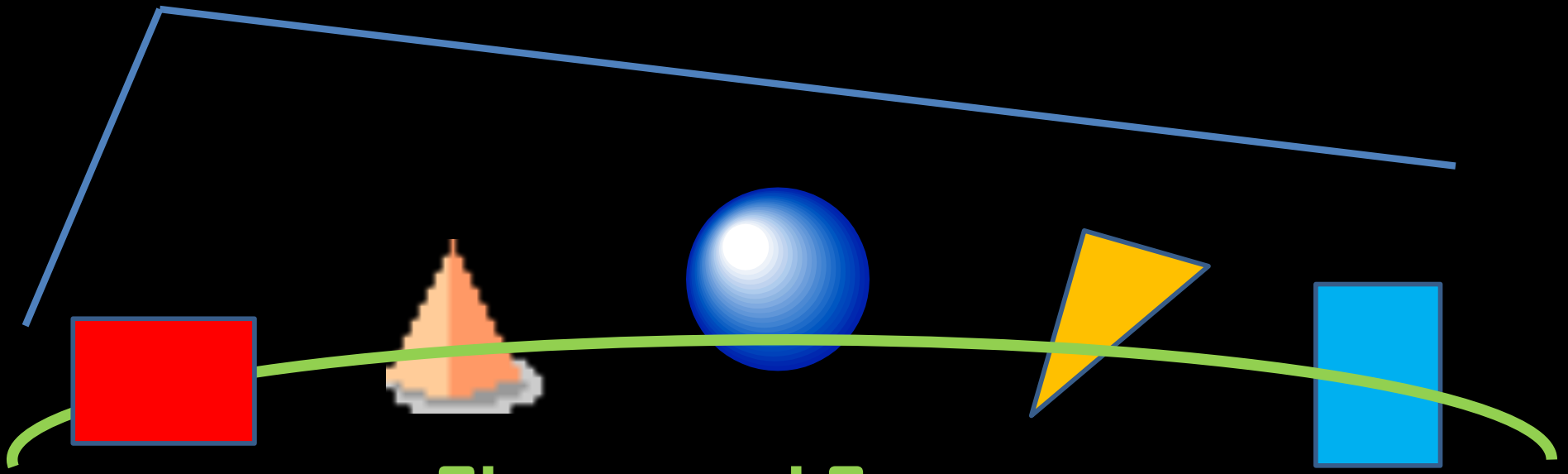
- Business Analyst
- System Analyst
- Data Analyst

- Database Specialist
- Network Specialist
- Security Specialist

Software and Applications

Developers

- XML Technologies
- Assembly of Components
- Automatic Code Generation



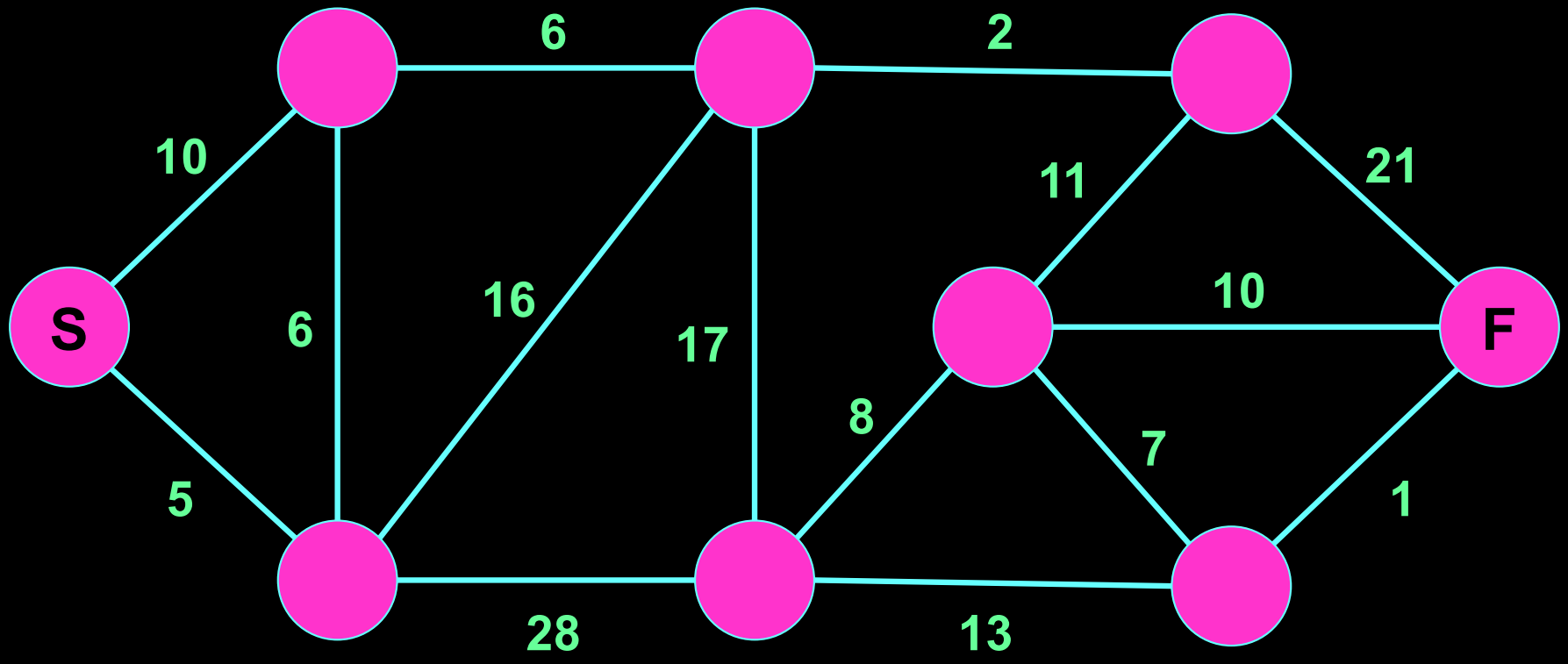
Objects and Services

Theory

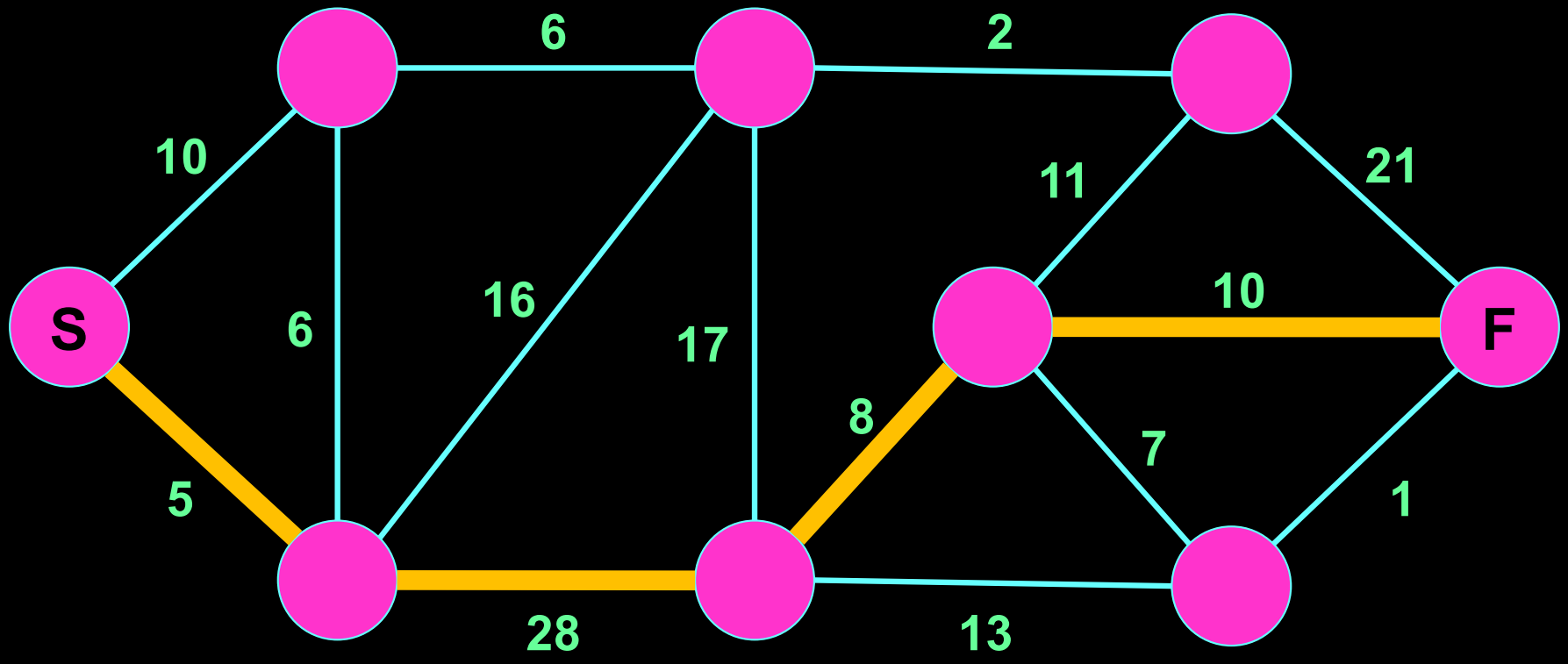
1. What is Computable?
2. How Quickly can we Compute?
3. Algorithms, Serial and Parallel
4. Cryptography

...

What is the shortest path from S to F?

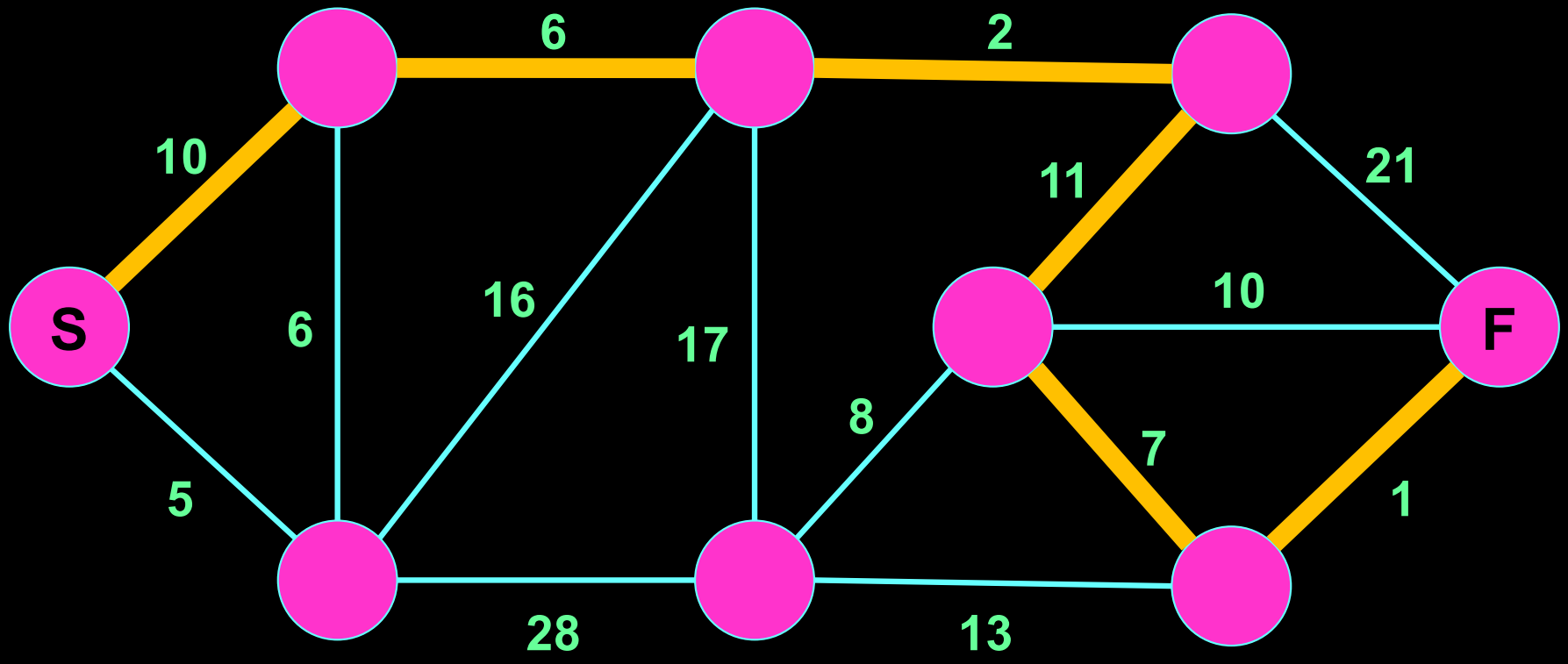


Is this Optimal?



5 + 28 + 8 + 10 = 51

The Optimal Path:



10 + 6 + 2 + 11 + 7 + 1 = 37

HCI: Human-Computer Interaction







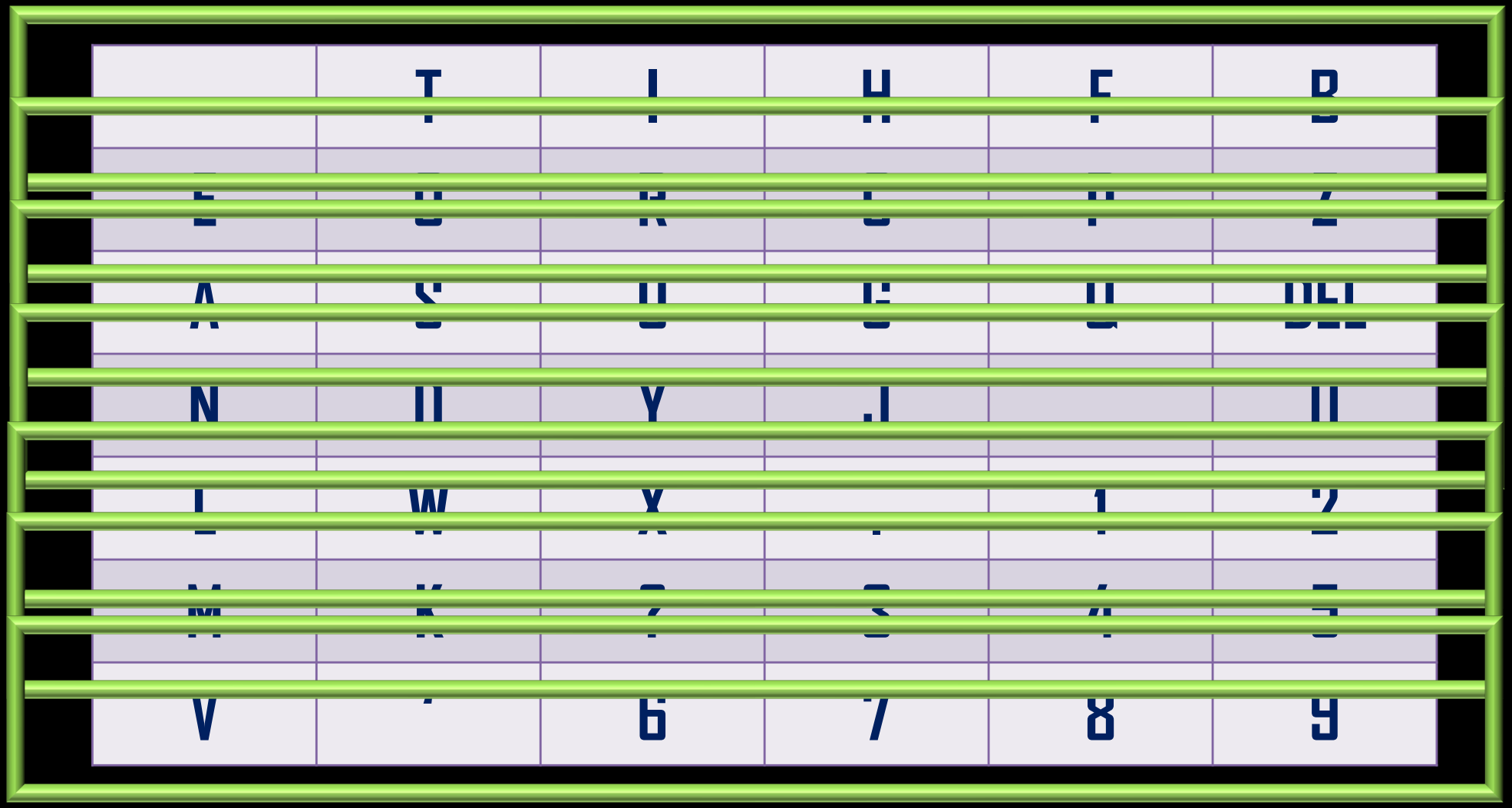
Prof H Roumani, 2007


Backspace
Tab
Caps Lock
Enter
Shift
Shift
Ctrl
Alt
Alt
Ctrl

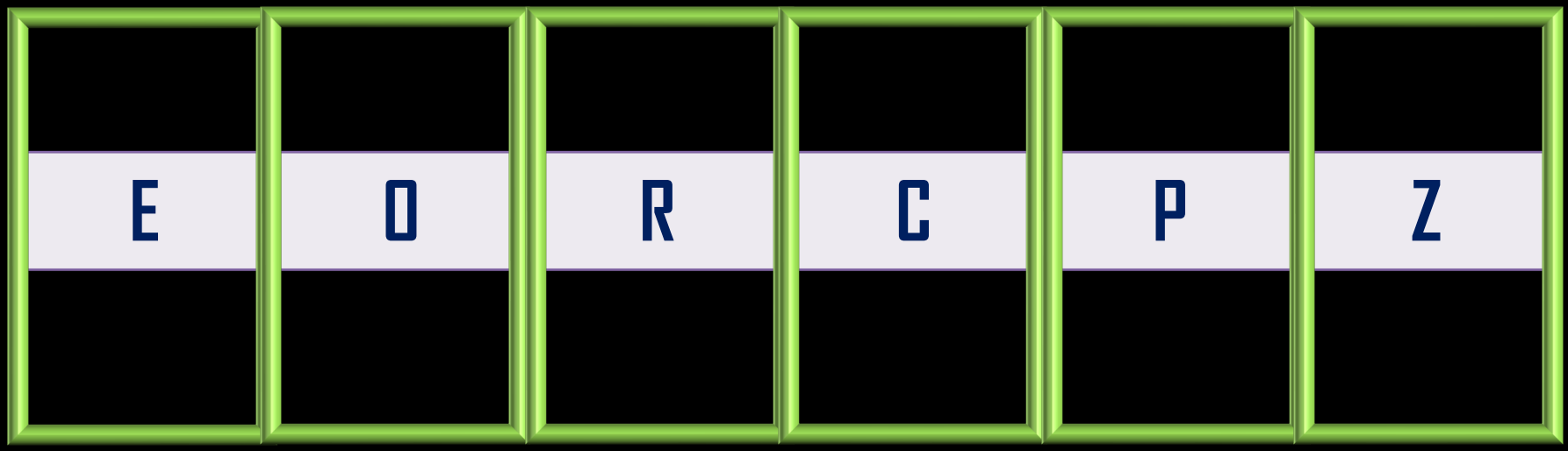

1
2 abc
3 def
4 ghi
5 jkl
6 mno
7 pqrs
8 tuv
9 wxyz
0

-	T	I	H	F	B
E	O	R	C	P	Z
A	S	U	G	Q	DEL
N	D	Y	J	,	0
L	W	X	.	1	2
M	K	?	3	4	5
V	‘	6	7	8	9

Prof H Roumani, 2007



E	O	R	C	P	Z


E
O
R
C
P
Z

Vision and Robotics

- Human and Machine Vision
- Visual Processes
- Motor and Cognitive Processes
- Visually-Guided Robotics
- Related Clinical Diagnosis and Treatment

Centre for Vision Research

http://www.cvr.yorku.ca

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1. Are We There Yet?
2. Acknowledgments

Civilization advances by extending the number of important operations which we can perform without thinking of them.

Alfred North Whitehead (1861-1947)

Acknowledgments

- **Souad Al-Hakim**,
  Solution Architect, Royal Bank of Canada
  For being an inspiration to managing complexity

- **Colleagues and Students**,
  Faculty of Science and Engineering, York University
  For sharing their knowledge, insights, and experiences

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