



GRAĐA RAČUNALA

Logika

Računalna logika

- Formalna logika
- Dio matematike
- Formalni način zapisivanja logičkih izraza
- Osnova rada digitalnih računala

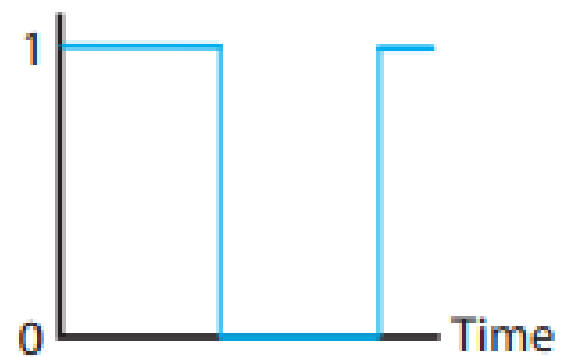
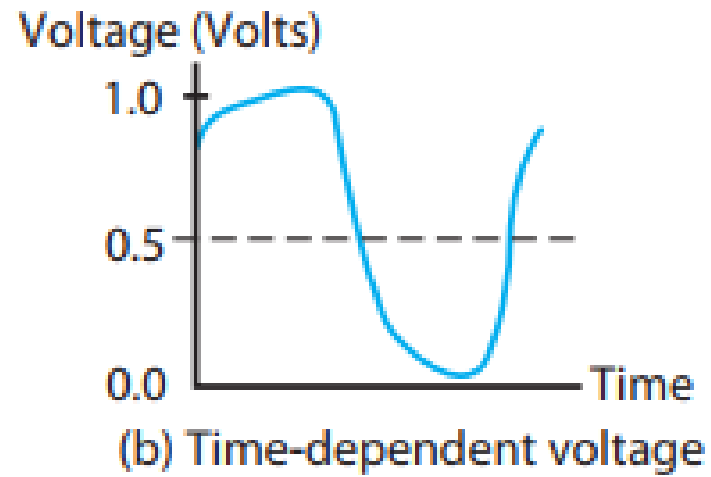
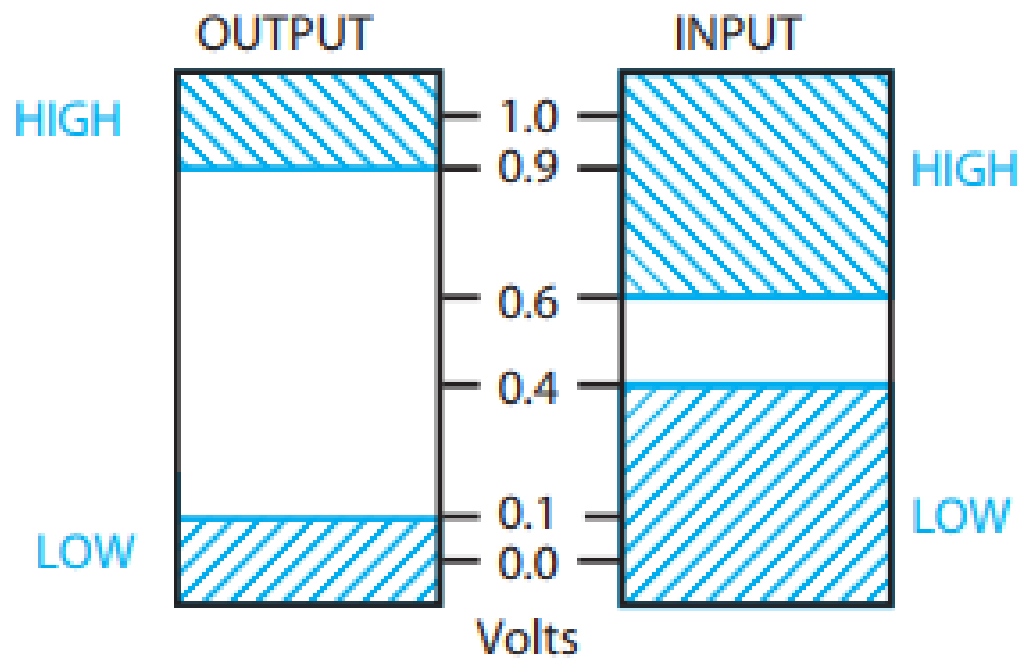
Računalna logika

- Nastala u doba Aristotela
- Nije se puno koristila dok nije bilo računala
- Koristi bazu 2
- Više u nastavku

Osnove logike:

- Dva stanja
- 0 – netočno, false, F, nema signala, nema napona*
 - *zbog niza razloga ovo u stvarnosti nije tako
- 1- točno, true, T, ima signala, ima napona

- Treće stanje
- Z ili N – sustav ne daje izlaz
 - Koristi se kako bi se olakšala konstrukcija sklopova
 - Ne treba ga miješati sa logikom koja koristi bazu 3 (ternarna logika)



DEMO

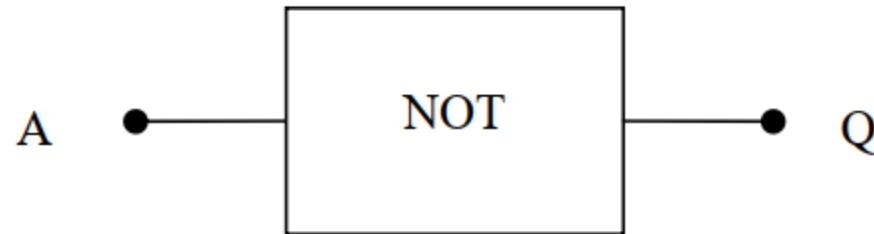
- <https://logic.ly/demo/>

Tablica istinitosti

- Definira kako izgleda istinitost (stanje)
- Svaki sklop ima svoju
- Sve se rade pomoću osnovnih logičkih operacija (sklopova, elemenata)
- Tablica stanja definira apstraktno stanje
- Neke stvari nije moguće izravno realizirati jednostavno
- Recimo NOT

NOT

- Jedan ulaz – jedan izlaz
- $Q = \bar{A}$

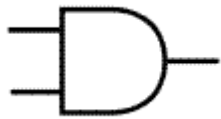


- Tablica istinitosti:

Ulaz	Izlaz
A	Q
0	1
1	0

Logičko I (AND)

- Rezultat je istinit samo ako su oba ulaza istina



A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

Logičko ILI (OR)

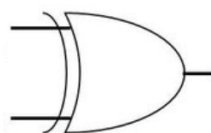
- Rezultat je istinit ako je najmanje jedan od ulaza istinit



A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

Logičko XILI (XOR)

- Rezultat je istinit ako je jedan ulaz istinit, ali ne i oba

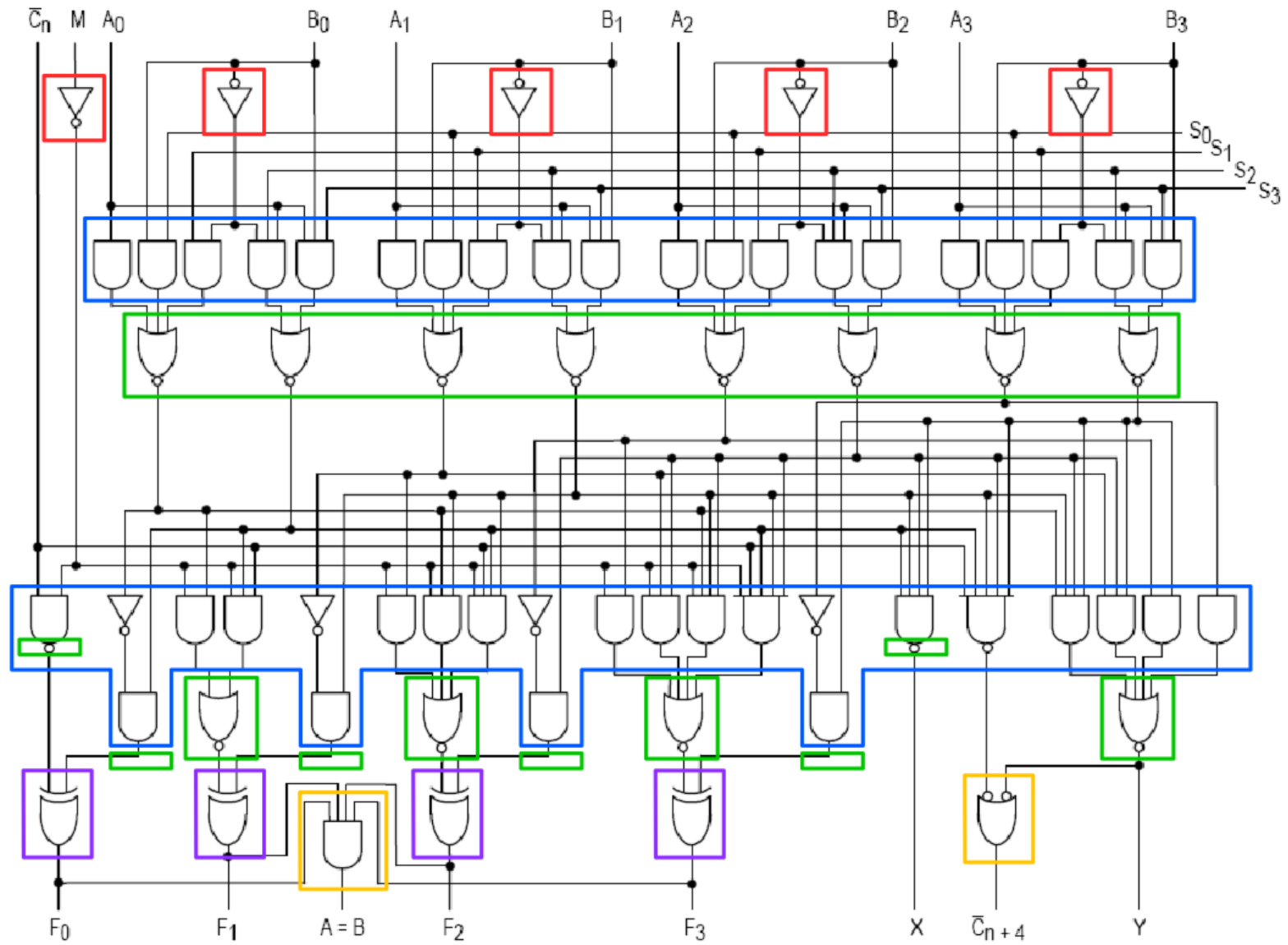


A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

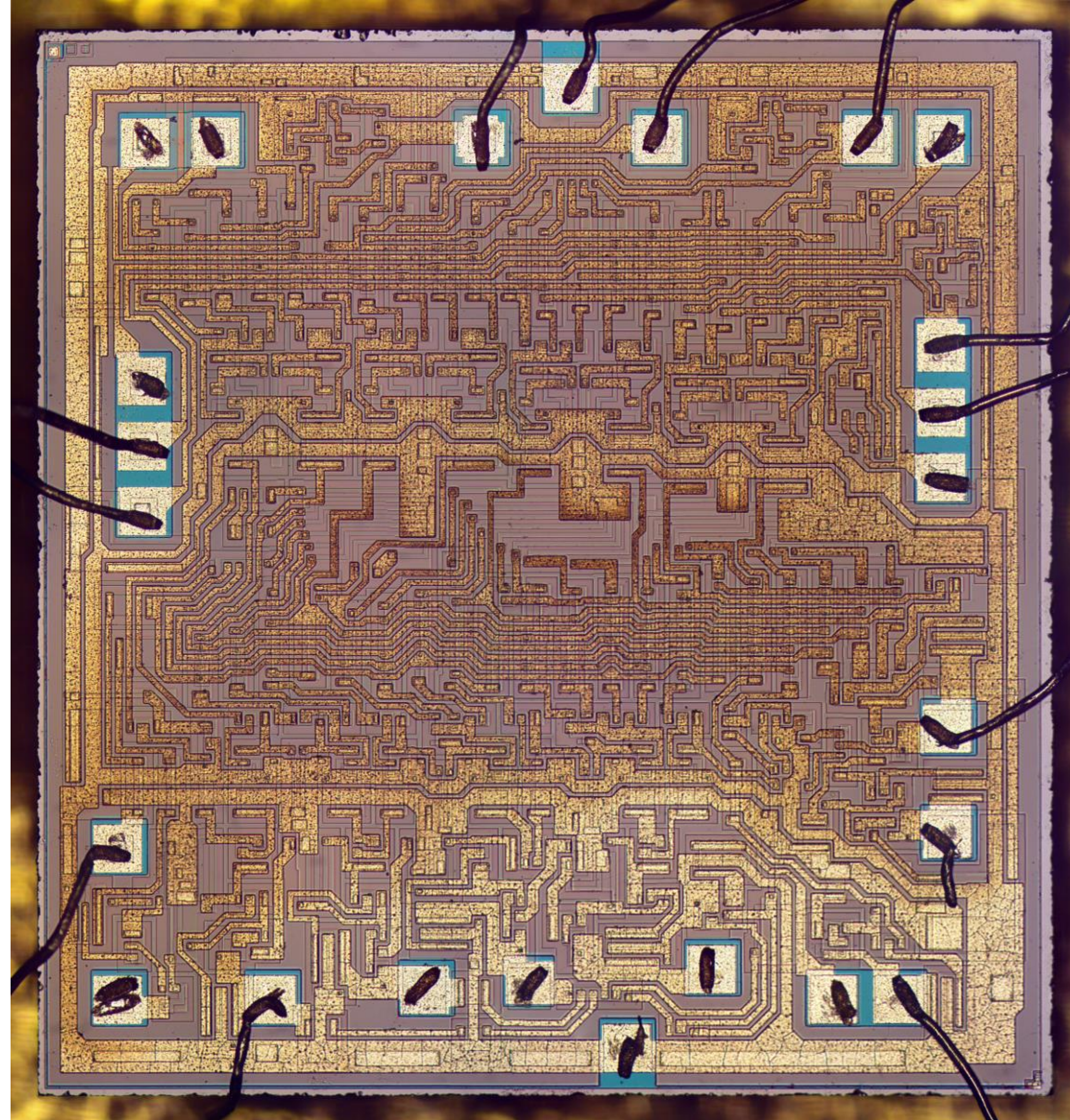
Sklopovi

- Bilo koji skup elemenata koji ima neku svrhu
- „element” može biti pasivni ili aktivni
- Otpornici
- Zavojnice
- Kondenzatori
- Tranzistori
- Diode
- Triaci
-

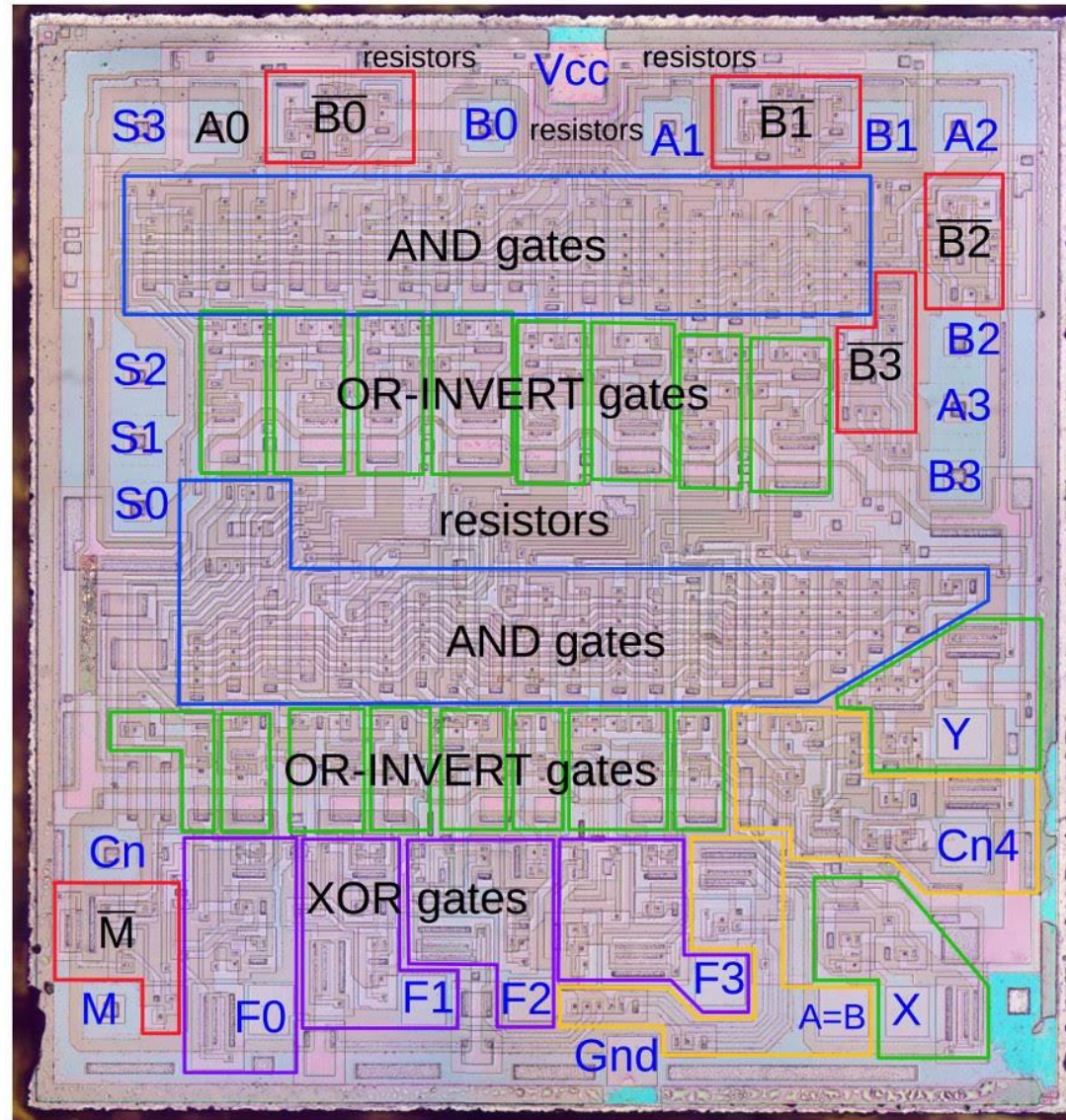
TTL 74181

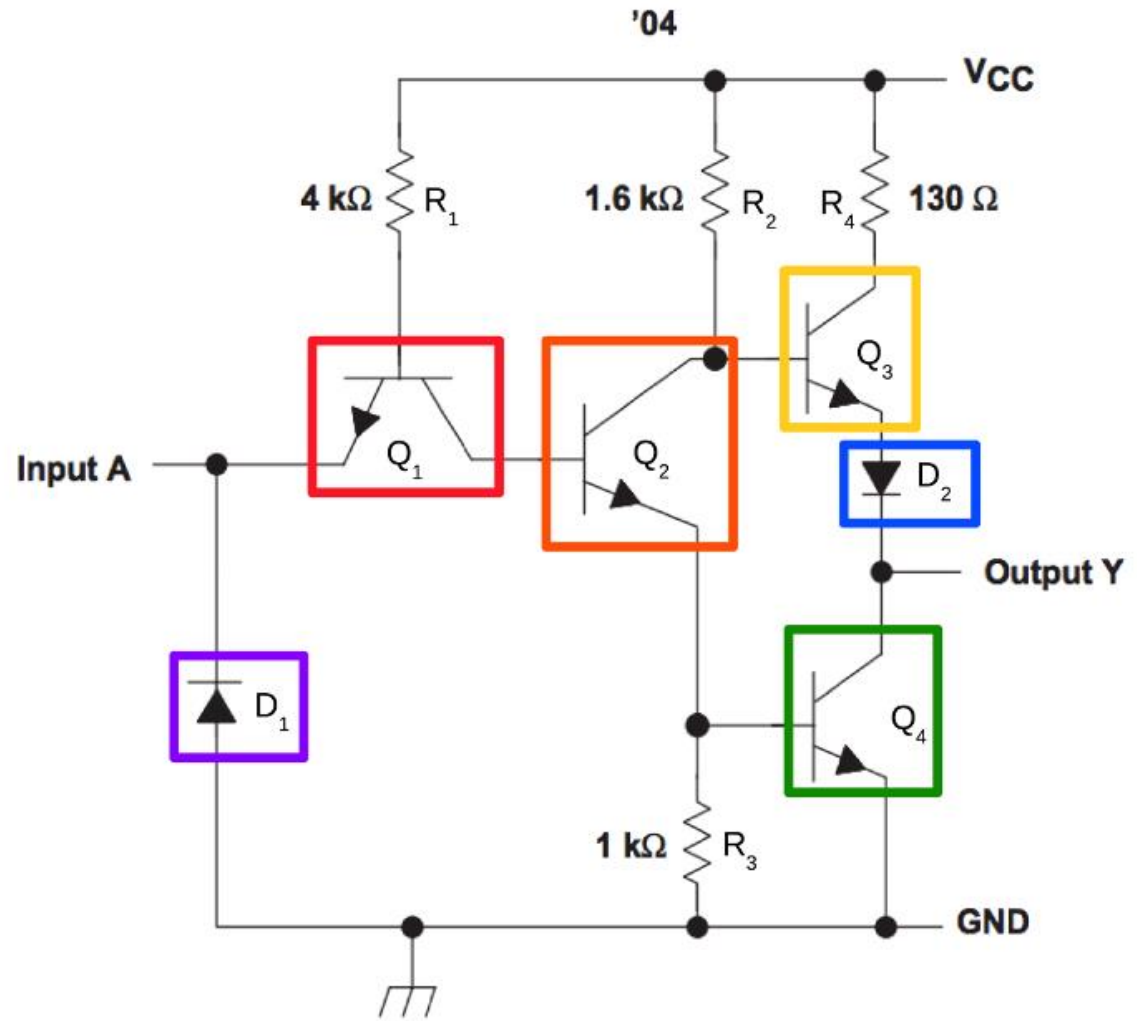
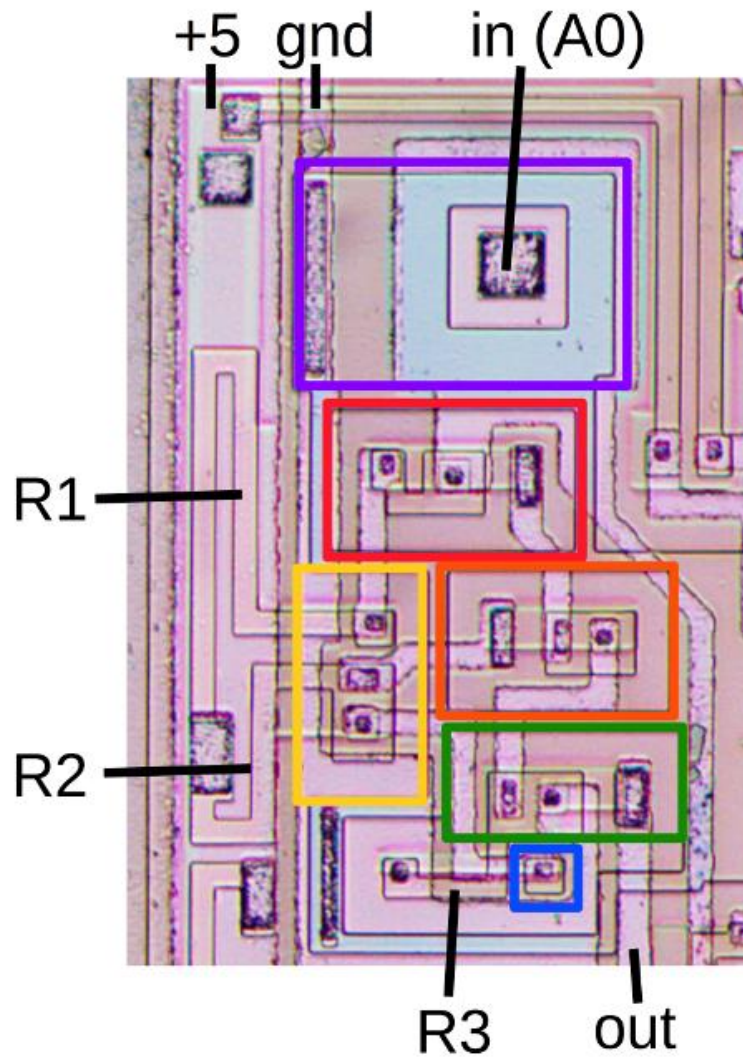


TTL 74181



Preuzeto sa:
<http://www.righto.com/2017/01/die-photos-and-reverse-engineering.html>





Sklopovi

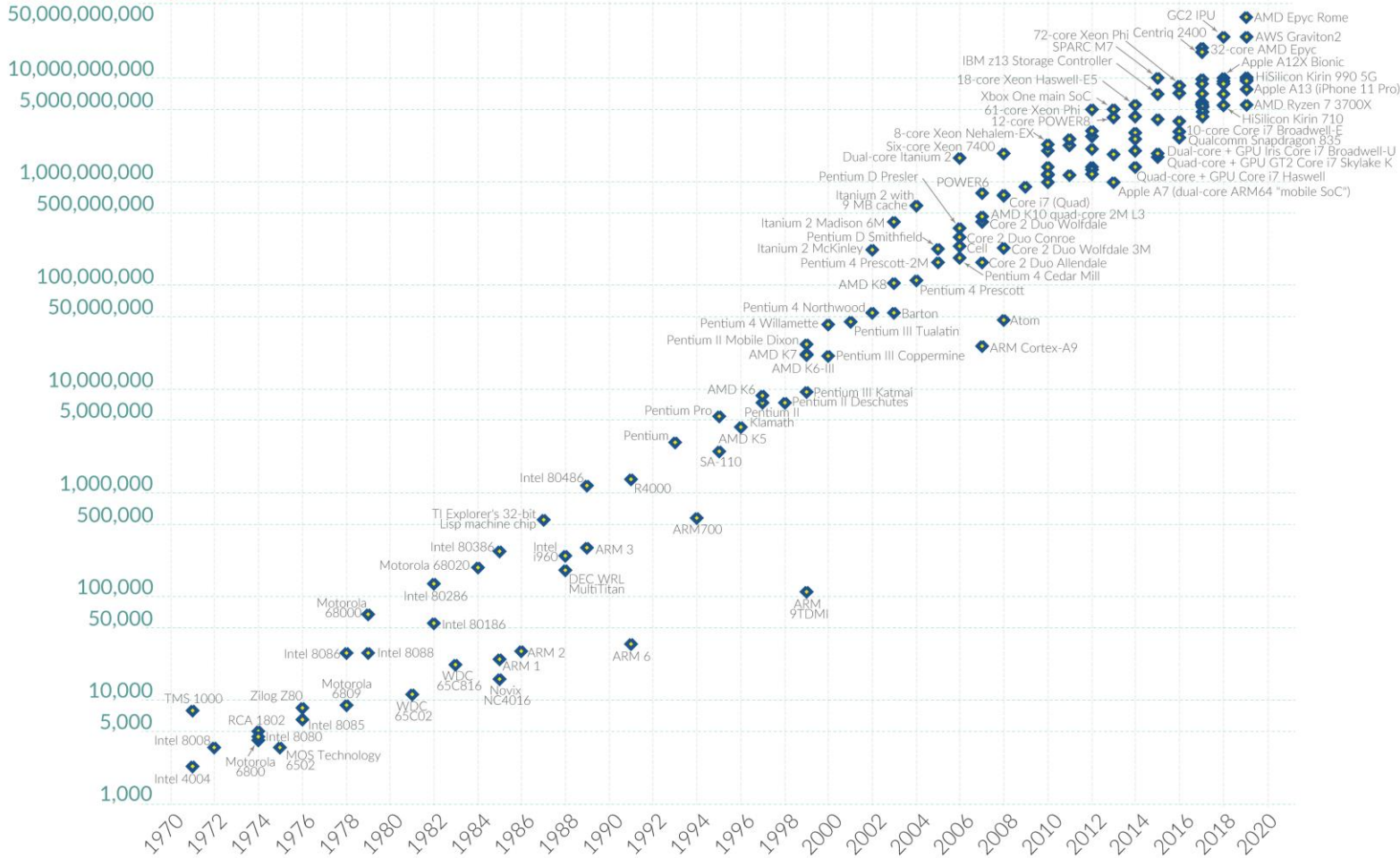
- Uglavnom ih tretiramo kao crne kutije
- Razlog je kompleksnost
- Današnji sklopovi mogu imati desetke milijardi tranzistora
- Analogni i digitalni

Moore's Law: The number of transistors on microchips doubles every two years



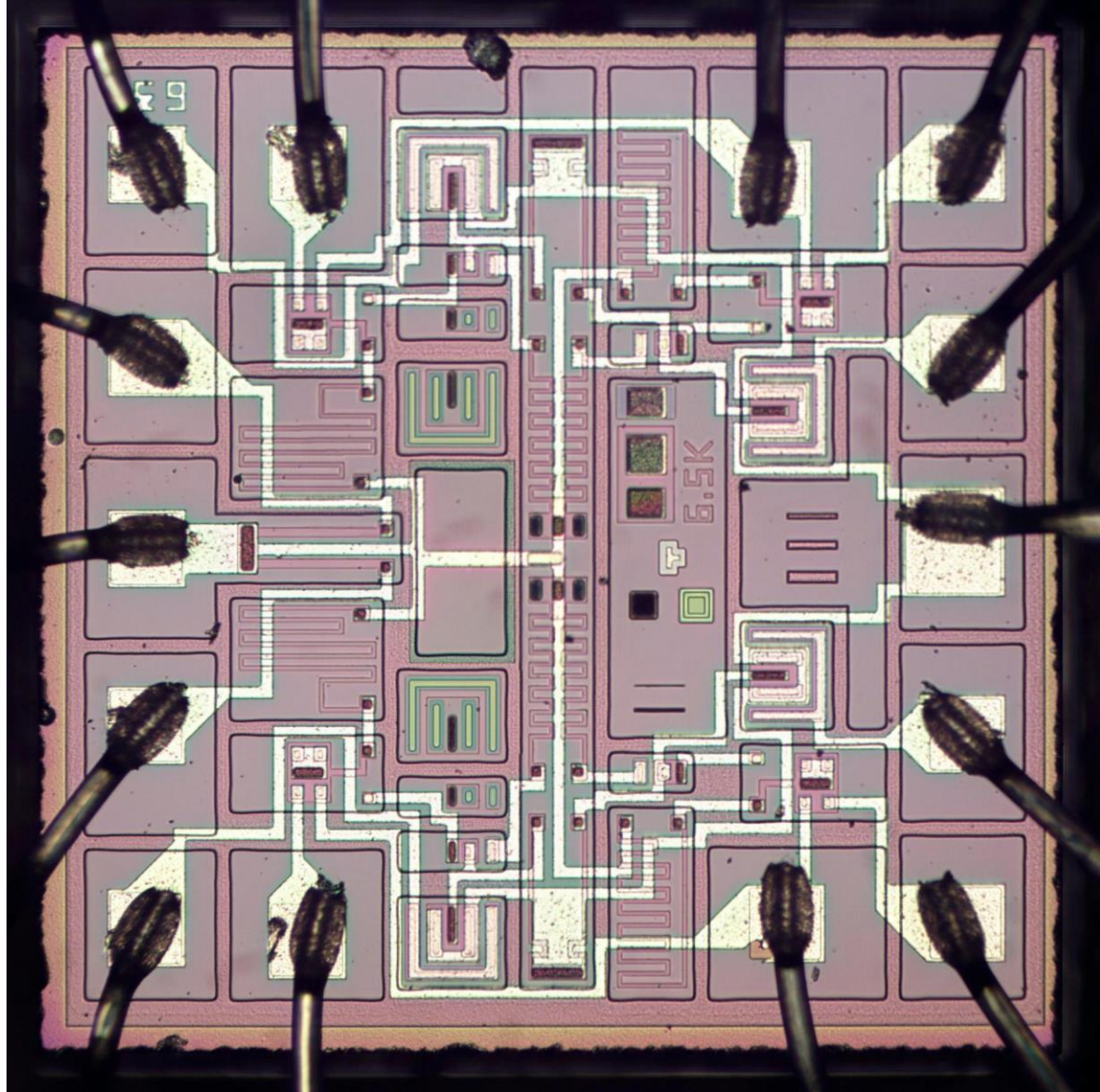
Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important for other aspects of technological progress in computing – such as processing speed or the price of computers.

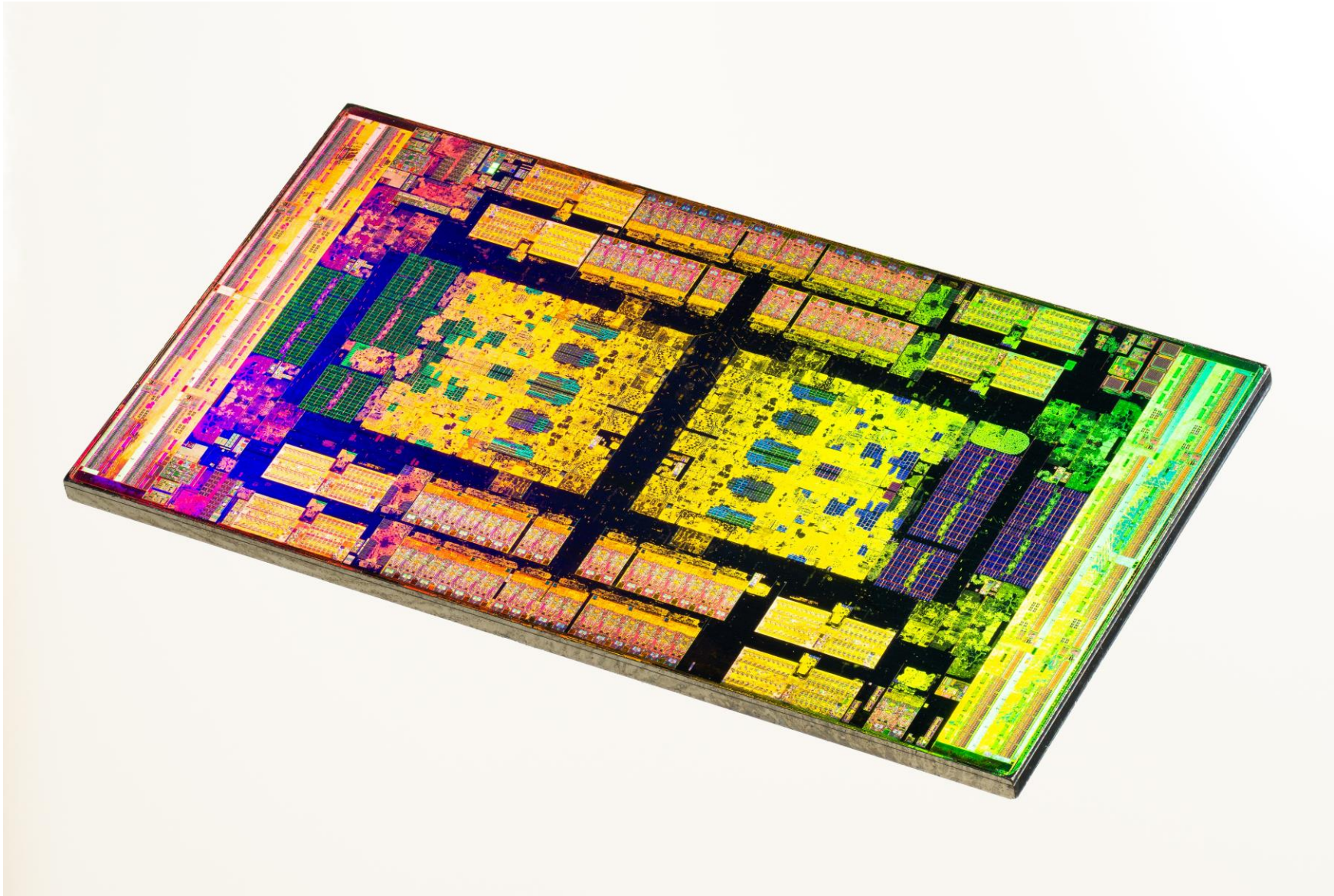
Transistor count



Data source: Wikipedia (wikipedia.org/wiki/Transistor_count)
 OurWorldinData.org – Research and data to make progress against the world's largest problems. Licensed under CC-BY by the authors Hannah Ritchie and Max Roser.







Logički sklopovi

- Ne zanima nas električni dio
- Iznimno kompleksna disciplina
- Pitanje je koliko ljudi stvarno razumije današnje procesore
- Sklopovi su modularni

Tri načina prezentacije

- Booleova algebra
- Shema
- Tablica istinitosti

Prezentacijski modeli

		y	
		0	1
x	0	0	0
	1	0	1

		y	
		0	1
x	0	0	1
	1	1	1

		y	
		0	1
x	0	0	1
	1	0	1

		y	
		0	1
x	0	0	1
	1	1	0

Figure 1. Truth tables

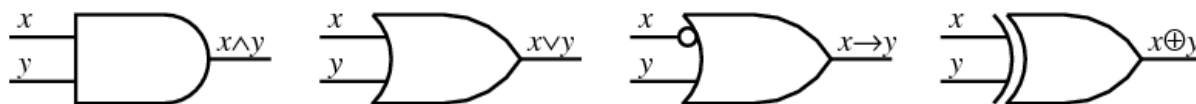


Figure 2. Logic gates

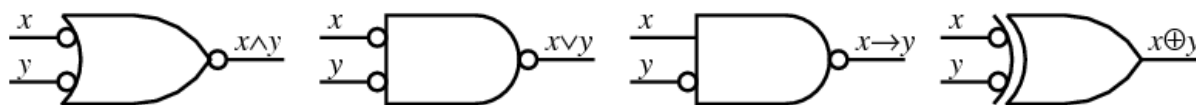


Figure 3. De Morgan equivalents



Figure 4. Venn diagrams

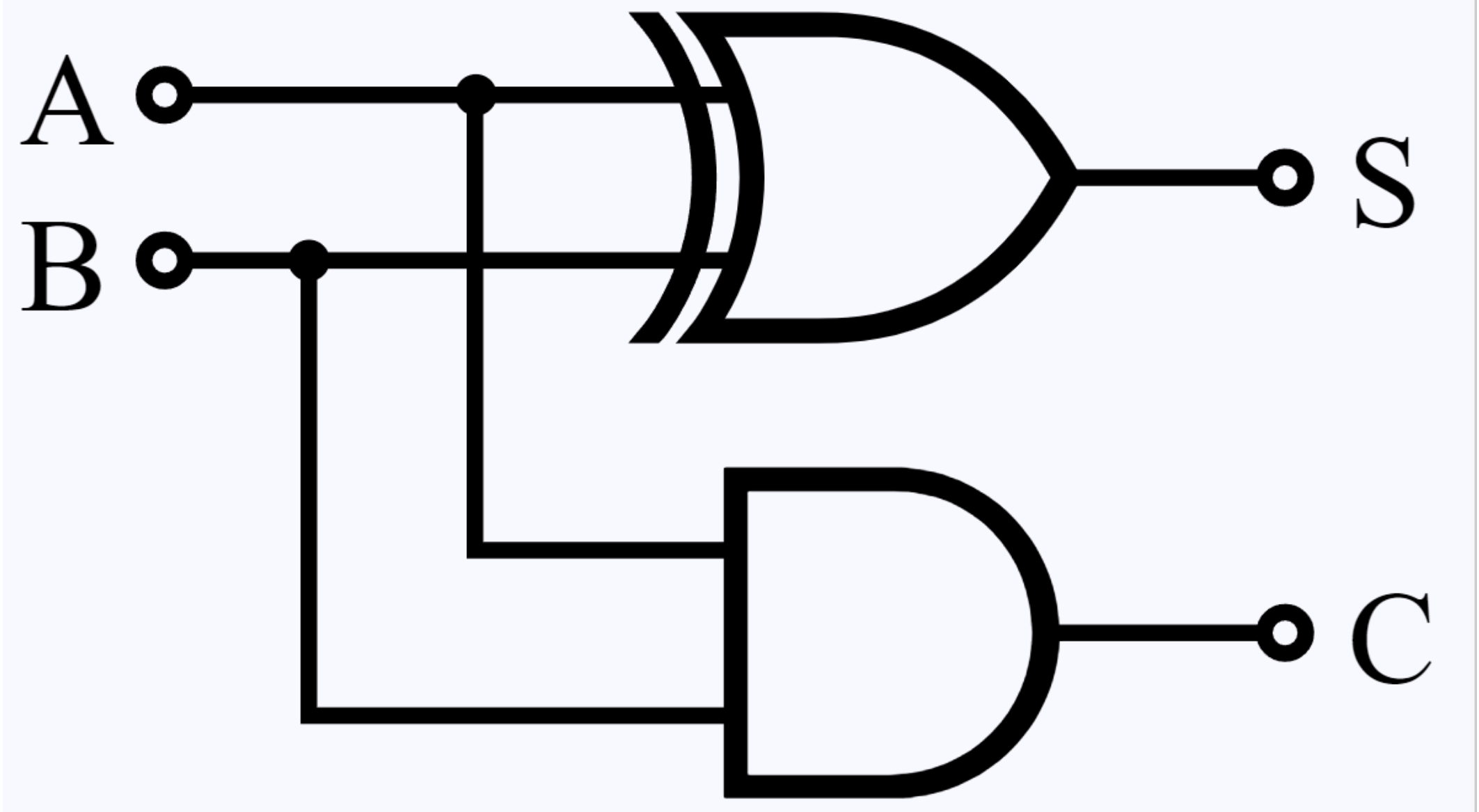
Booleova algebra

Teoremi Booleove algebre		
$\neg\neg A=A$		involutivnost
$A\cdot 0=0$	$A+0=A$	logičko množenje i logičko zbrajanje s nulom
$A\cdot A=A$	$A+A=A$	logičko množenje i logičko zbrajanje varijable sa samom sobom
$A\cdot 1=A$	$A+1=1$	logičko množenje i logičko zbrajanje s jedinicom
$A\cdot\neg A=0$	$A+\neg A=1$	komplementarnost
$A\cdot(A+B)=A$	$A+A\cdot B=A$	apsorpcija
$A\cdot(\neg A+B)=A\cdot B$	$A+\neg A\cdot B=A+B$	
$\neg(A\cdot B)=\neg A+\neg B$	$\neg(A+B)=\neg A\cdot\neg B$	De Morganovo pravilo
$A\cdot B=B\cdot A$	$A+B=B+A$	komutativnost
$A\cdot(B+C)=A\cdot B+A\cdot C$	$A+(B\cdot C)=(A+B)\cdot(A+C)$	distributivnost
$(A+B)\cdot(C+D)=A\cdot C+A\cdot D+B\cdot C+B\cdot D$		

Zbrajalo

- $A+B$
- $0+0=0$
- $1+0=0$
- $0+1=0$
- $1+1=10$

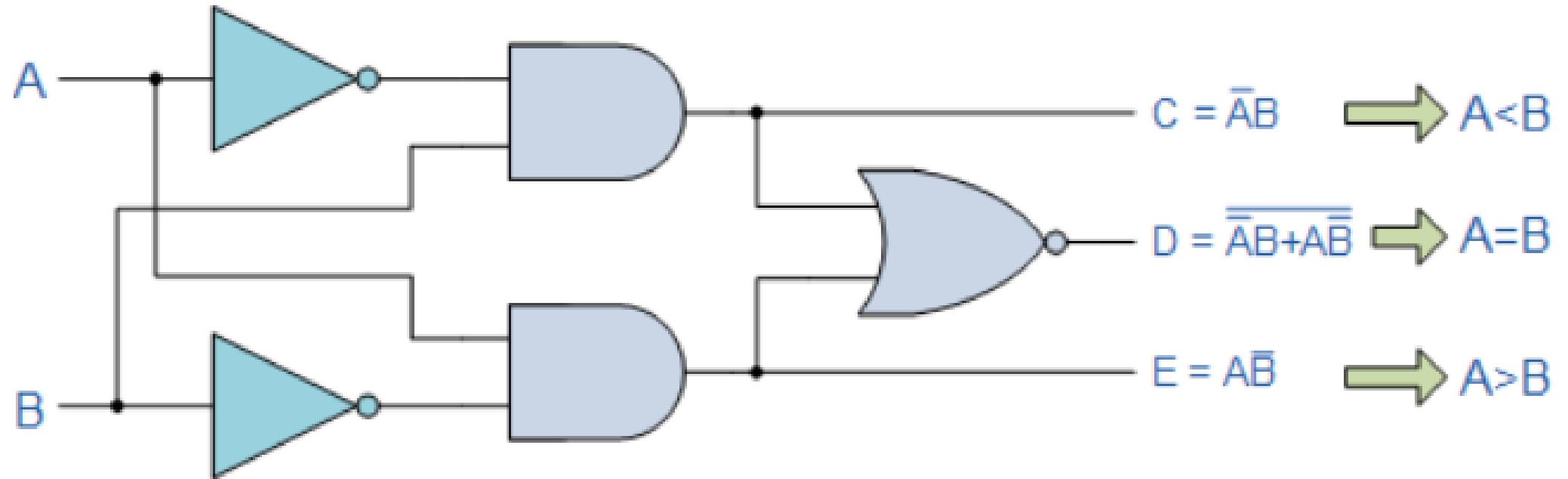
- CARRY



Komparator

- Služi za usporedbu brojeva

Inputs		Outputs		
B	A	$A > B$	$A = B$	$A < B$
0	0	0	1	0
0	1	1	0	0
1	0	0	0	1
1	1	0	1	0



Demo

- Stvarnost je puno kompleksnija
- <http://visual6502.org/JSSim/index.html>



**Hvala na
pažnji!**