

“Evolution of Algorithms and their effect on prene dynamics and outcomes”

Nilkanth Patel

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USC

Outline

- Genes, Memes and Cenes
 - Who/what decides the outcome?
- Evolution of Algorithms
- Examples
- Conclusion

The determinant component

- **Genes**

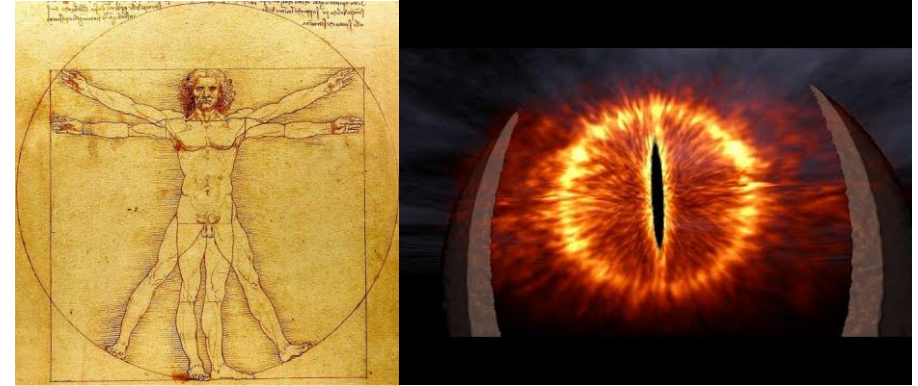
- Physical attributes (phenotypes)
 - Height
 - Color of eye
 - Predisposition to a disease

- **Memes**

- Human “behavior” or leanings
 - Political
 - Societal
 - Religious

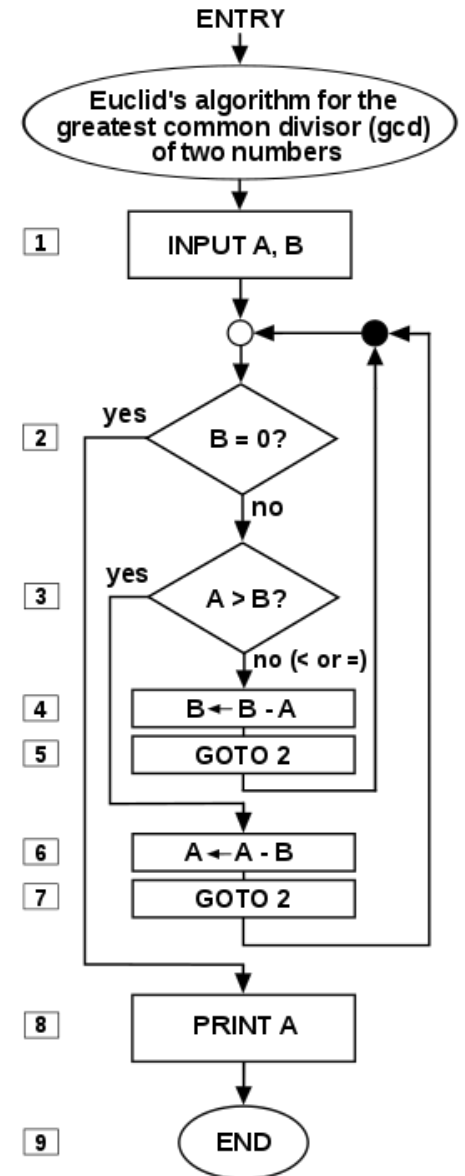
- **Cenes**

- Prediction and analysis from complex data
 - Weather
 - Trades















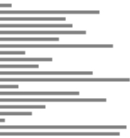







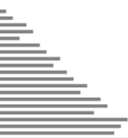
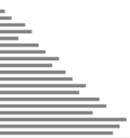
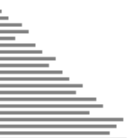
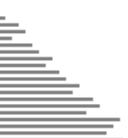

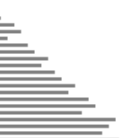


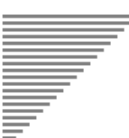
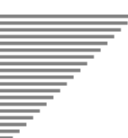
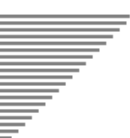
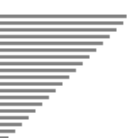
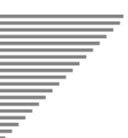
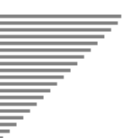
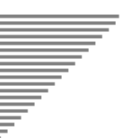
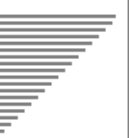

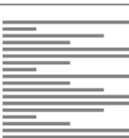
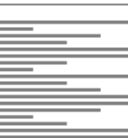
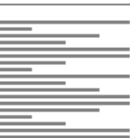
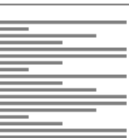
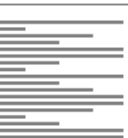
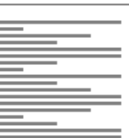

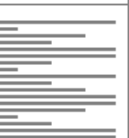
Algorithms

- It is a pre-defined, self-constrained steps/instructions required to execute diverse functions
- Named after 9th Century Persian mathematician Muhammad Ibn Musa al-Khwarizmi
- An example of one of the earliest known algorithms
 - Euclid's Algorithm for GCD of two numbers



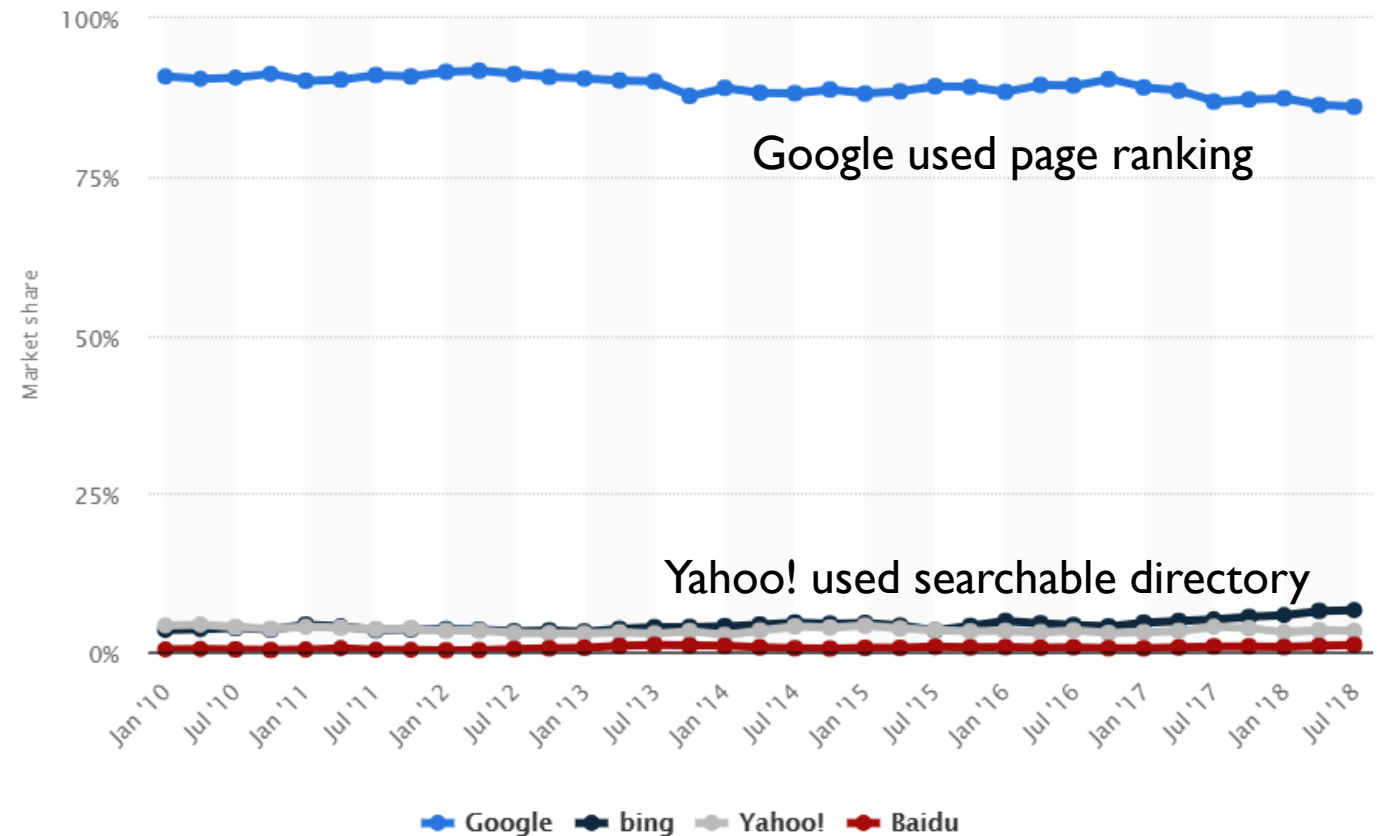
Algorithms and Prene theory

- Mutate, evolve, compete for their survival
- Example: Sorting algorithms

												
					Insertion	Selection	Bubble	Shell	Merge	Heap	Quick	Quick3
Year	Name	Time	Space	 Random								
1945	Merge Sort	$O(n \log n)$	$O(n)$									
1954	Radix Sort	$O(nk)$	$O(n+k)$	 Nearly Sorted								
1959	Shell Sort	$O(n (\log n)^2)$	$O(1)$									
1962	Quick Sort	$O(n^2)$	$O(\log n)$	 Reversed								
1964	Heap Sort	$O(n \log n)$	$O(1)$	 Few Unique								

Example I: Evolution of search engines

Year	Event
1957	Advanced Research Project Agency
1960	Hypertext and Hyperlink
1980	Concept of WWW
1989	Archie (a query form)
1991	WWW goes online
1992	Web Wanderer
1993	Aliweb
1994	Yahoo! , Lycos
1995	Altavista, Excite
1997-98	Google, MSN
2000	Baidu
2009	Bing

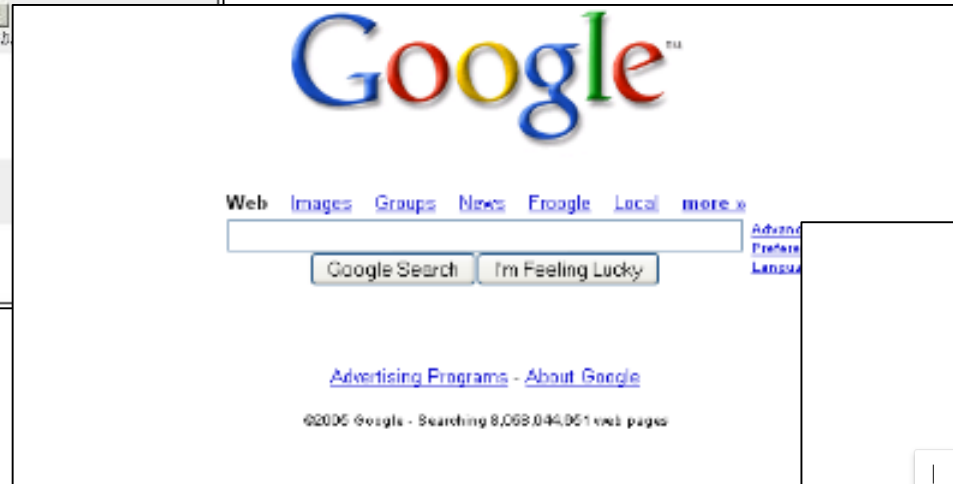


Google has > **90%** of search market share

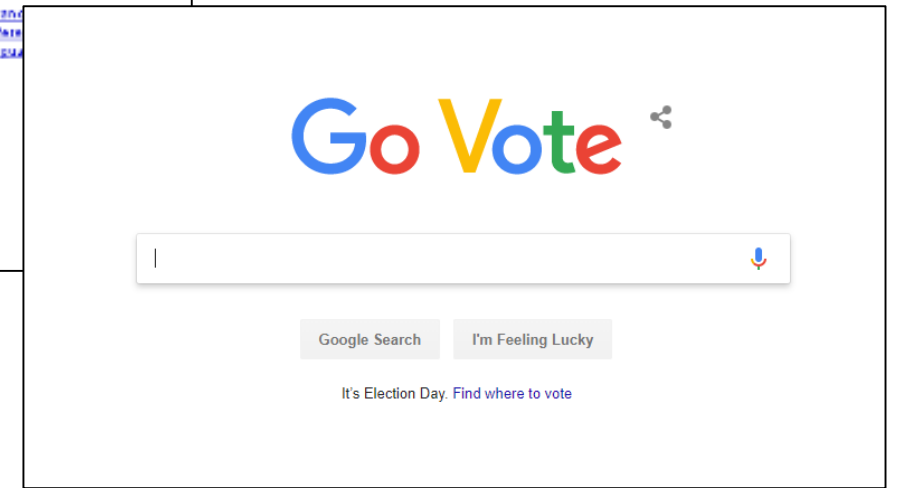
Google has evolved...



1998

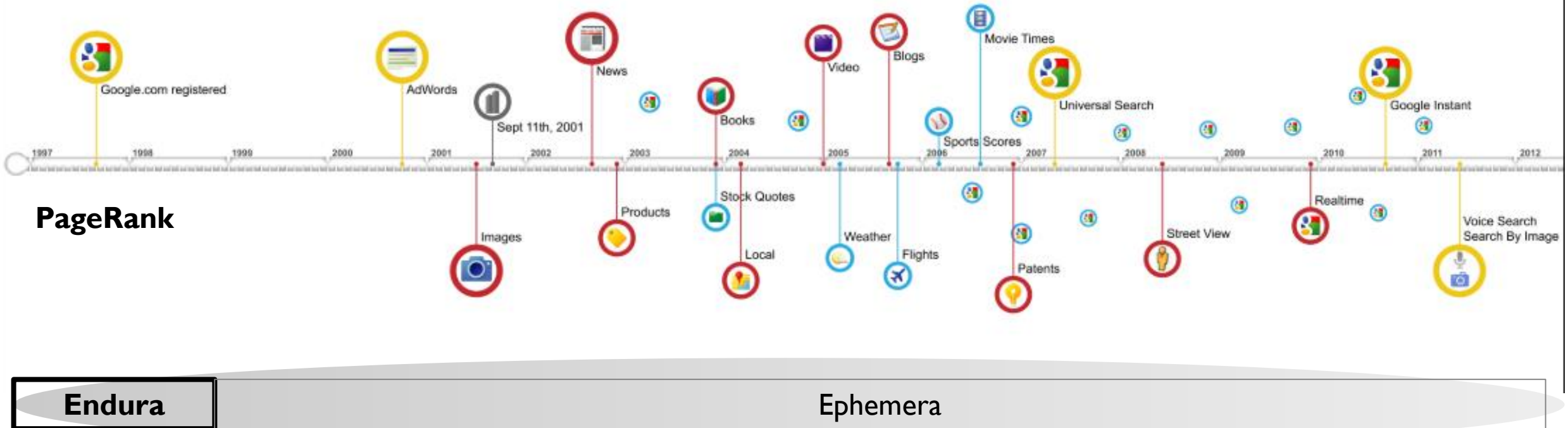


2005



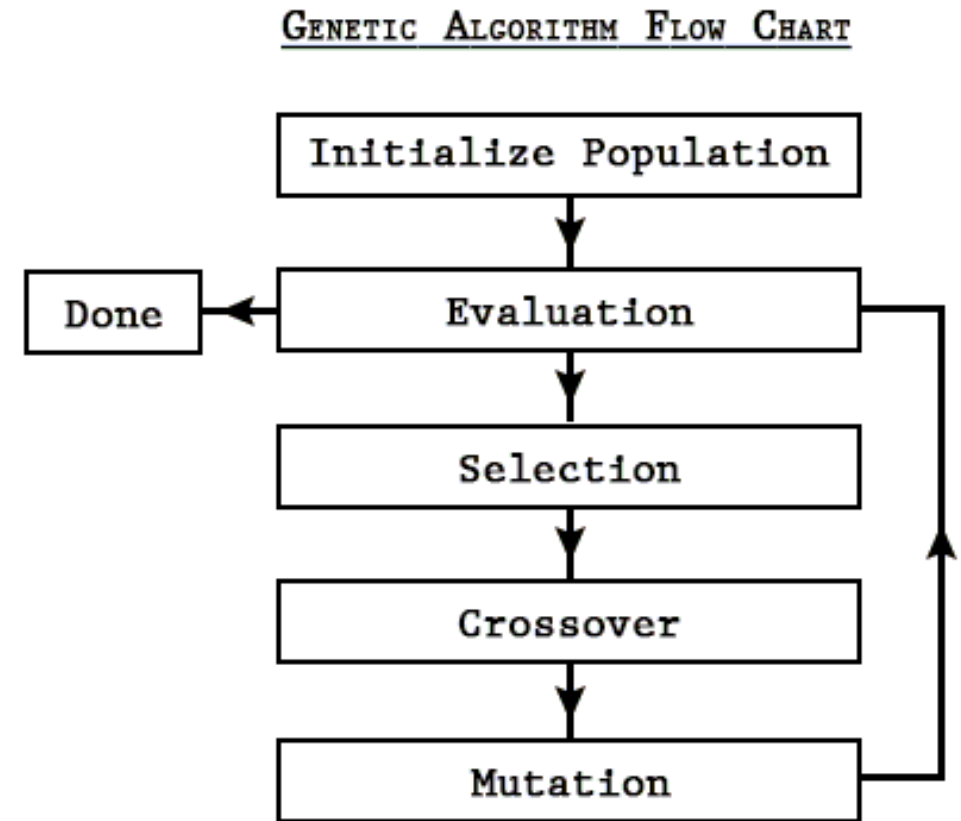
2018

Google prene-set has evolved...



Example 2: Genetic Algorithm

- Introduced in 1960s by John Holland
- Based on the Darwin's theory of evolution
- GA Has 3 key steps
 - Selection
 - Cross-over
 - Mutation



Applications of Genetic algorithm

- Natural sciences, Mathematics, Computer science
 - Power electronics design
 - Chemical kinetics
 - Artificial creativity
- Earth sciences
 - Modeling global temperature changes and estimation of heat flux
- Biological sciences
 - Protein ligand docking and drug design
-



ST5 spacecraft antenna
“Evolved” to create best
radiation pattern.

Genetic algorithm has found new avenues



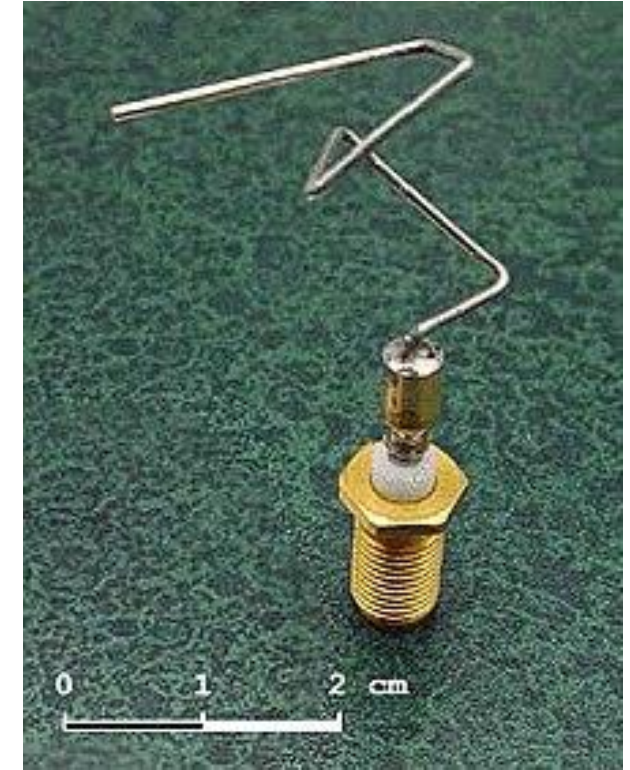
GA existed only in the
Genes

3.7 billion years



Recognized by Memes

since 1960s



Adopted into Memes and
Cenes

since 1980s

Some observations

- Has recent splash in the computing and data science formed a new environment to allow rapid mutations and spread of algorithms?
 - Machine Learning & AI
- Physical mechanisms bound by the laws of universe – Are they a treasure trove of advanced algorithms?
 - Protein folding
- Is the determinant component the one where the algorithm resides?

? / . / !