Driven by necessity we have progressed from using fingers to bigger numbers using geometric shapes.

To numerical system (5K YR Ago)

RHIND PAPYRUS
Rhind Papyrus

to tables

M. A. El-Sharkawi, BIA 9

M. A. El-Sharkawi, BIA 11

to abacus

M. A. El-Sharkawi, BIA 11

to mechanical machines

M. A. El-Sharkawi, BIA 11

to slide rules

M. A. El-Sharkawi, BIA 11

to more mechanical machines
M. A. El-Sharkawi, BIA 13

to calculators

M. A. El-Sharkawi, BIA 14

to computers

Konrad Zuse’s Z1 Circa, 1936 Germany.
First Programmable Computer

Atanosoff Berry Computer(ABC), USA, 1939
First Electronic Computer

Harvard Mark I, USA 1944
Largest Electromechanical Calculator

IBM 701 EDPM, 1953
Apple I, 1976

Apple II, 1977

Apple Lisa, 1983

New Wave of Computing

- Moore’s law is still holding
  - computers double their power every 18 month.
- Computationally intensive techniques hard to implement a few years ago are now feasible.
  - Among these techniques are the biologically inspired algorithms (BIA).

Staggering Impact of Modern Computing Power

- Iterative Computation
- Creation of amazingly complex algorithms
- Broad connectivity (e.g. World wide web)
  - Remote engineering and commerce
  - On-demand information
Philosophers argued that with all human achievements in science and engineering, nature still provides the best systems that can ever be fashioned.

This is true even if we compare the most complex machine with the simplest form of a biological cell.

The use of biological processes or behavior as metaphor, inspiration, or enabler in developing new computing technologies.

The field is highly multidisciplinary.
- It includes engineers, computer scientists, molecular biologists, geneticists, mathematicians, physicists, and others.

Observe and study:
- Observe animal and human behaviors and study biological structures

Mimic:
- Acquired knowledge may help us mimic nature and develop better engineering systems and machines.

Observe and study:
- Observe animal and human behaviors and study biological structures

Mimic:
- Acquired knowledge may help us mimic nature and develop better engineering systems and machines.
BIA Systems
- Neural Networks
- Evolutionary Algorithms
- Fuzzy Systems
- Swarm Intelligence
- Boids
- Particle Swarm
- DNA Computing
- Artificial Life
- Intelligent Agents
- ...

Nature is a Powerful Paradigm
- Brain → Neural Networks
- Evolution theory → Evolutionary Algorithms
- Flocking birds → Particle Swarm Optimization, Boids
- Insects → Swarm Intelligence
- ...

Why BIA?
- May require little or no knowledge of the physical system they emulate.
- System is developed by observations and intuition.
- Can find substance in databases through stochastic search.
- Can be self-tuned using raw experiential data.
- Noise tolerant and robust.
- Objectives no longer need to be in restrictive mathematical forms.
- Nonlinearity is no longer a disabling constraint.

The Future

Life Cycle of New Technology
- Interest & Hype
- Backlash
- Serious Developments
- Implementations

A.I.
Music from The Movie Future
ARTIFICIAL INTELLIGENCE
Music Composed and Conducted by JOHN WILLIAMS
Continued Controversy

“(NN, Fuzzy, …) has no place in scientific literature.”

“Already, primitive Intelligent Agents are buzzing around on the internet.”

Remarks

- BIA is the wave of the future.
  - Simplicity and power of BIA
- The key test is in the applications.
- Several industrial applications and consumer products are equipped with BIA based systems.

Real Test

- When safety is a concern, BIA may not be a stand-alone system.
  - Stability, reliability and availability of BIA cannot be verified by a closed form mathematics.
  - If the control breakdown results in safety hazard, or may lead to expensive repair
- For these systems, classical systems is probably the method of choice by most engineers.

Finis