

Real-World Applications





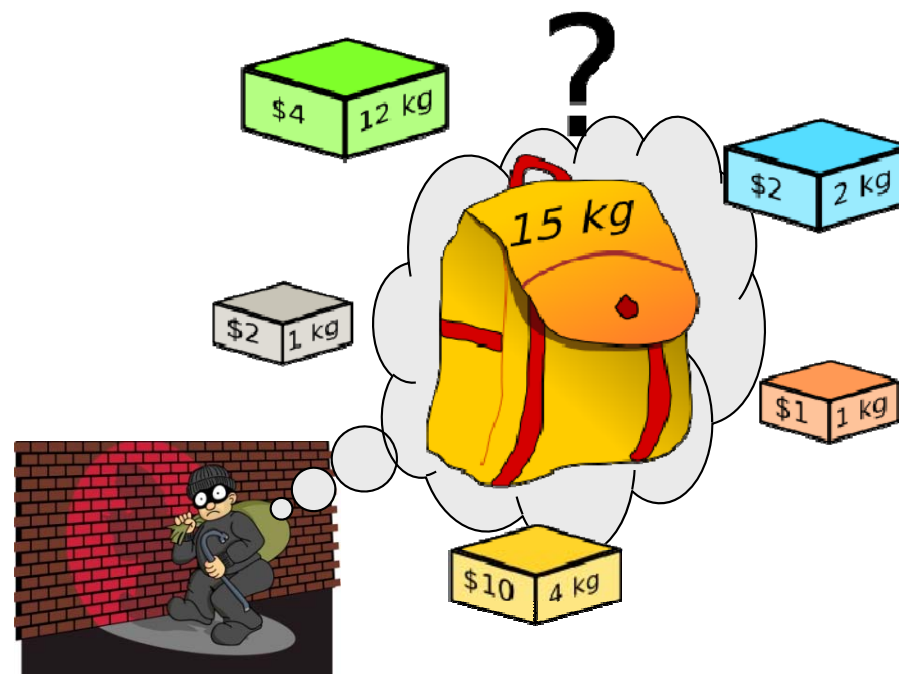
Classical Combinatorial Problems



Traveling Salesman Problem



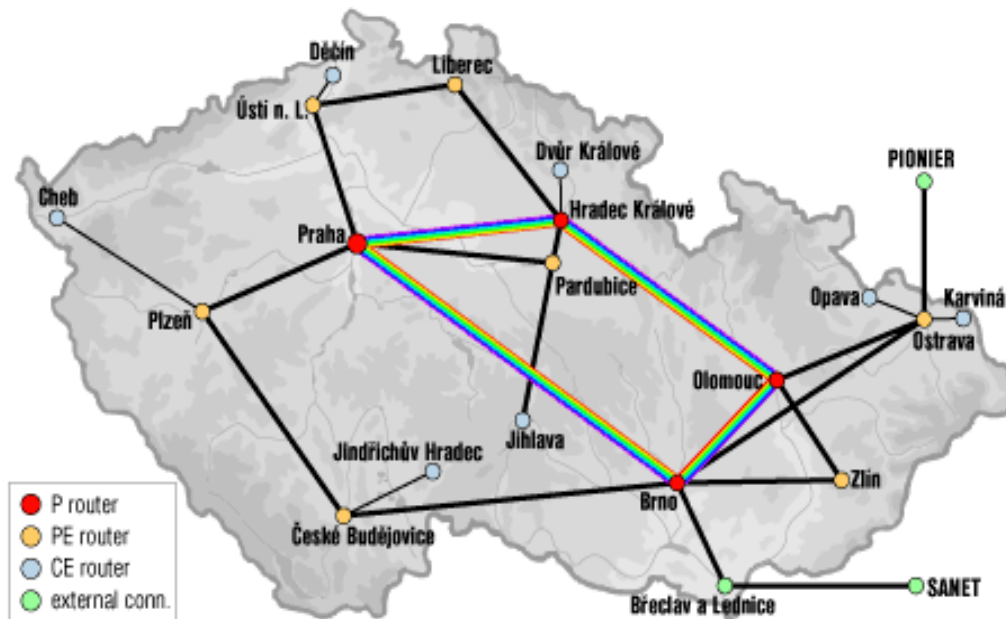
Knapsack Problem



- Maximize the amount of profits (e.g., money) while still keeping the overall weight under or equal to a given limit!

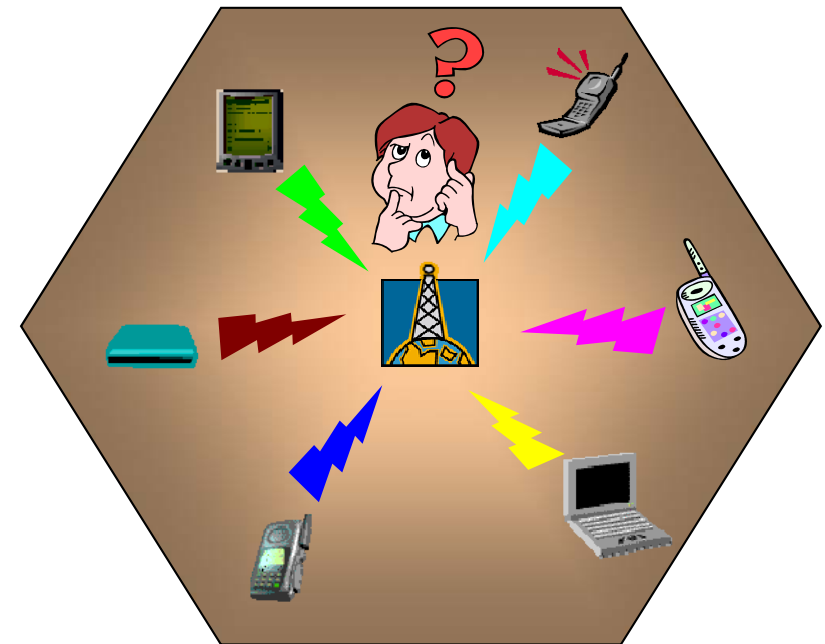


Multicast Routing



- Minimize the cost of multicast tree while satisfying delay and bandwidth constraints

Resource Allocation

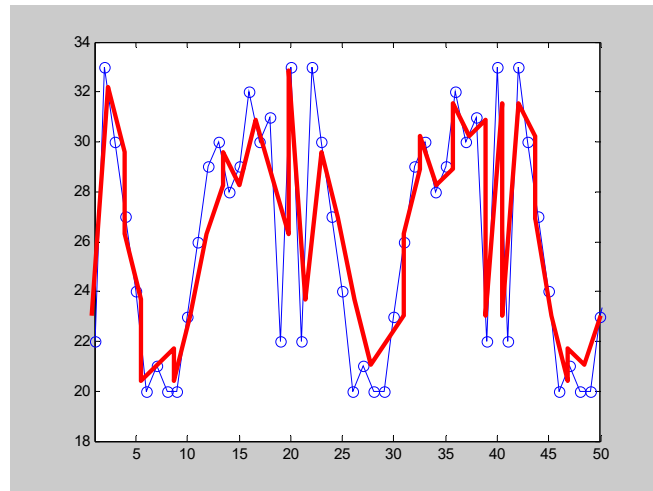
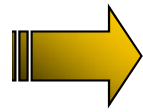
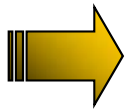


- Maximize resource utilization by fairly distributing wireless resources among the connections



Time-Series Forecasting

CRC40	6 380	18H01	➡ + 1,86%
SBF120	4 315	18H01	➡ + 1,69%
SBF 250	4 042	18H01	➡ + 1,55%
INDEX CAC	2 667	18H01	➡ + 0,10%
INDEX FTSE	4 450	18H01	➡ - 0,66%



- Predicting some future outcomes from a set of historical events
- Stock prediction, Weather forecasting, etc.

Decision in Dilemma



- Choosing a decision in conflict objectives
- Prisoner's dilemma, Game theory, etc.



Game

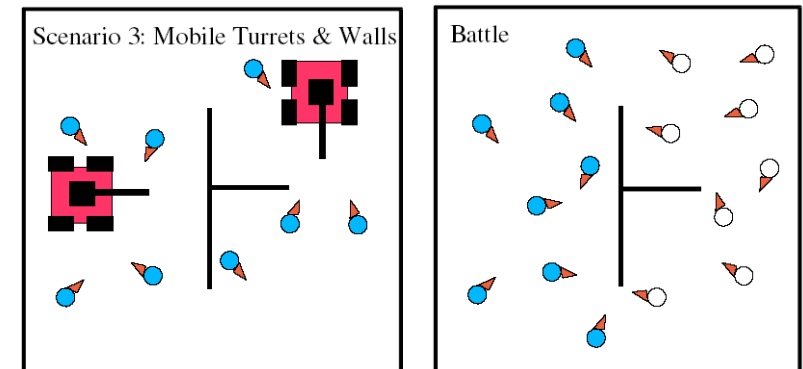
● Evolutionary Checker

- 8X8 board, 12 checkers for each player
 - Diagonal moves, Jumps are forced, etc.
- **Neural Networks + Evolutionary Prog.**
 - Checkerboards are evaluated by NNs
 - NNs and King value are evolved with EP
- Almost **the expert level without knowledge**



● Video Game: NERO

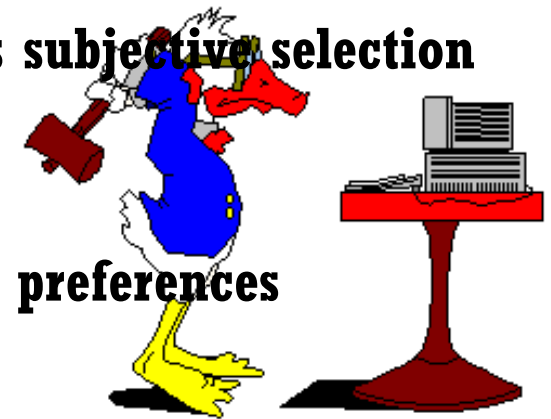
- Univ. of Texas at Austin
- Player's role
 - Train agents for competition
- **No prepackaged or scripted agents**
- **Evolve in real-time**



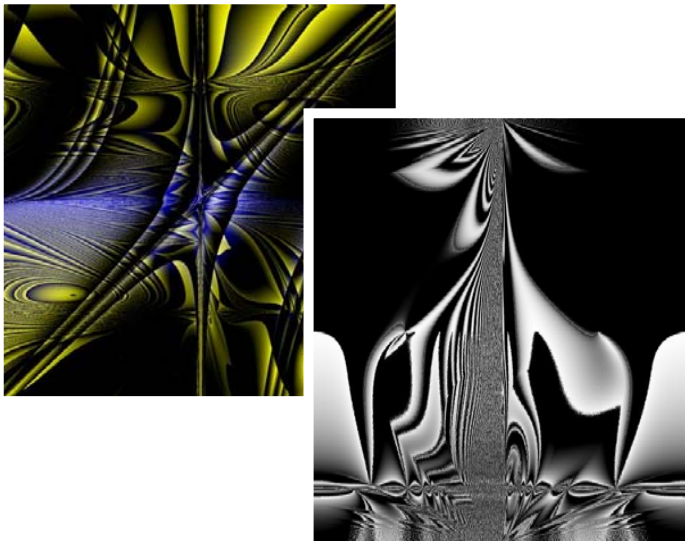


● What's Evolutionary Art?

- Technically, it is creating pieces of art through human-computer interaction
- Computer runs evolutionary algorithms and human applies subjective selection
 - Role of computers: offer choices and create diversity
 - Role of human: make (subjective) choices and reduce diversity
- Selection (aesthetic/subjective) steers towards implicit user preferences



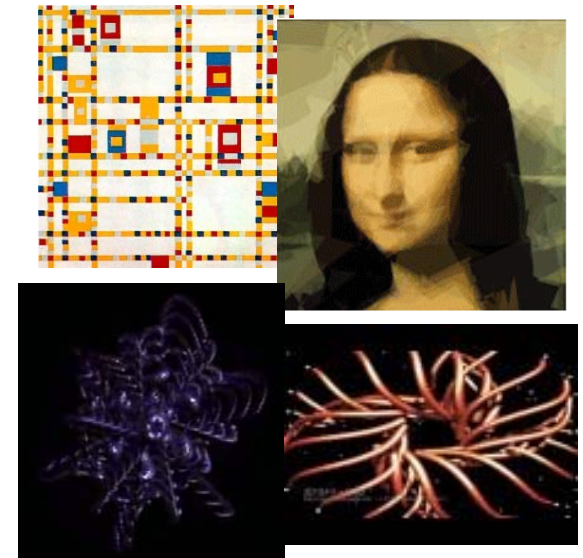
Evol. Art by Kleiweg



Galapagos by Karl Sims



Other Examples





Music

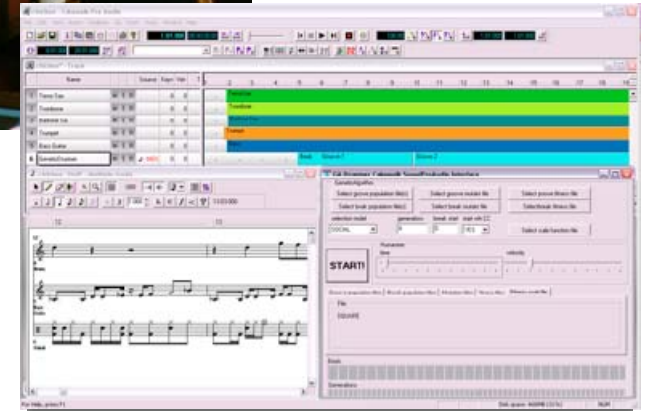


● GenJam (Genetic Jammer)

- Developed in 1993~94 by Prof. John Al Biles
- Interactive GA that learns to play jazz solos
- GenJam's repertoire: Over 250 jazz-style tunes
- Evolving by special fitness operators;
e.g., rhythm conformity
- What can it be done?
 - ✓ Playing full-chorus improvised solos
 - ✓ Listening to trumpet and responds
interactively when we trade fours
 - ✓ Engaging in collective improvisation;
we both solo simultaneously and GenJam
performs a smart echo of improvisation
 - ✓ Listening to me and play the head of a tune
and breeds my measures



Source:
<http://www.it.rit.edu/~jab/GenJam.html>



Source: <http://phoenix.inf.upol.cz/~dostal/evm.html>



Virtual
quintet

MusiGenesis

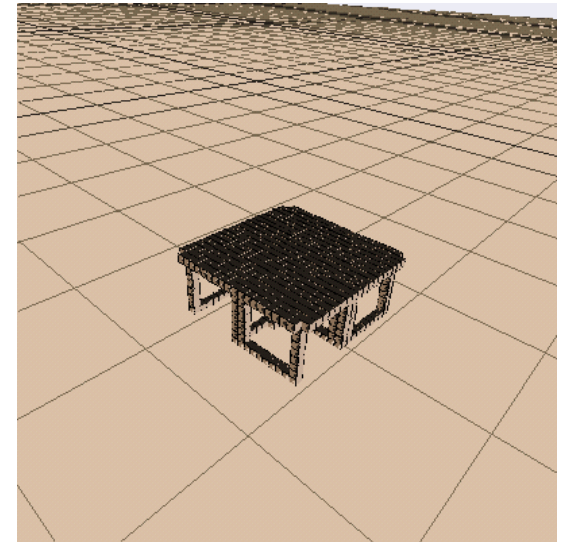




Design

● Structure Design

- Bridge structure optimization
- Building structure design



● Aviation System Design

- Airfoil, wing, and antenna designs
- Space platform structure optimization
- Jet aircraft model optimization



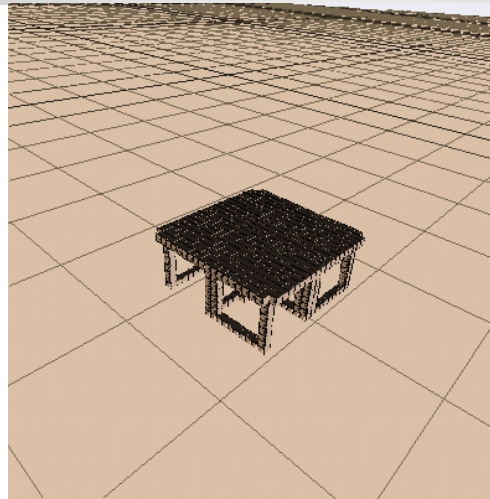


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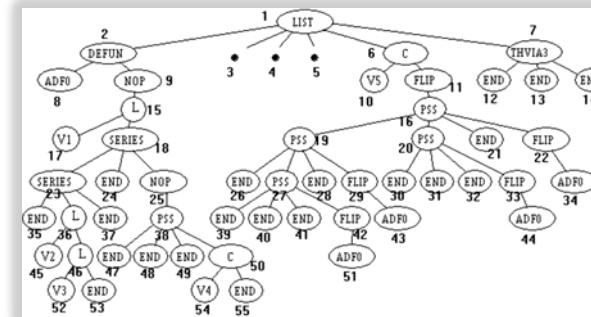
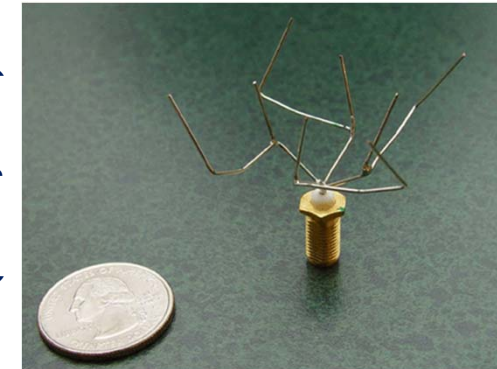
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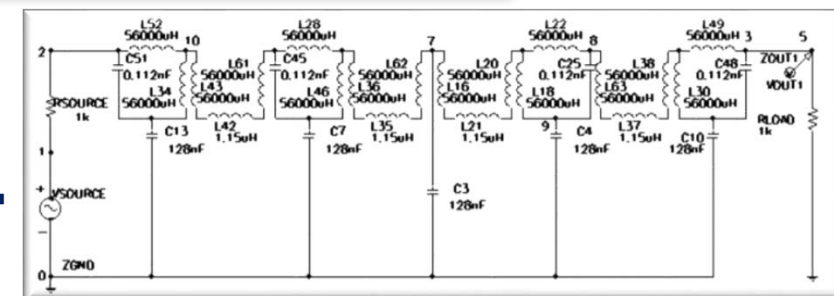
● Circuit Design

- Automatic synthesis of topology & sizing of analog electrical circuits

Evolved antenna
(NASA, 2004)



Lowpass filter



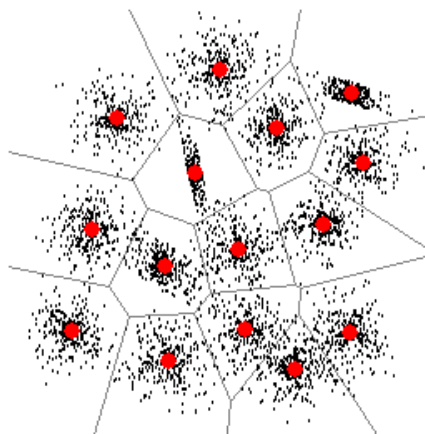


Information Mining



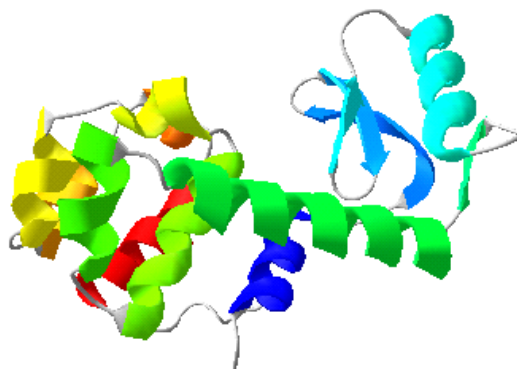
● Clustering

- Data clustering
- Text mining
- Web search



● Bioinformatics

- Drug discovery
- Protein folding
- Cancer diagnosis



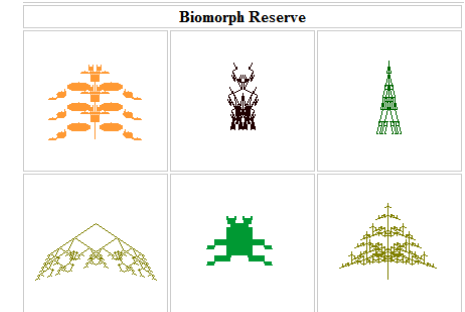
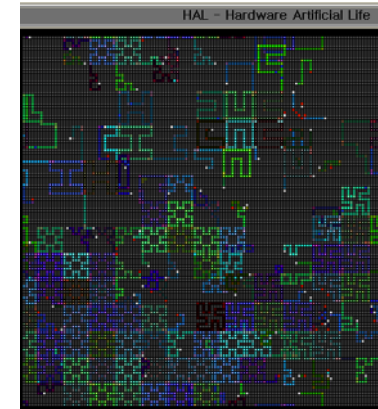
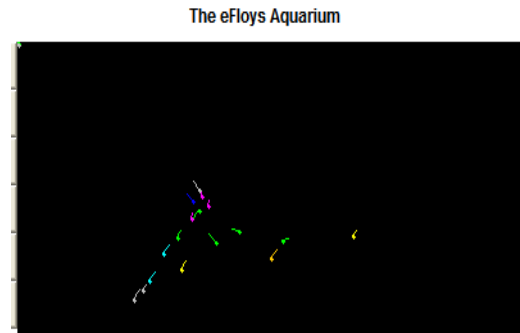


Artificial Creatures & Robotics



● Artificial Creatures

- eFly, Biomorph, HAL,
- Self-replicating Worms
- Gozilla, Solitaire



● Robotics

- Humanoid Robots; e.g., e.g., ASIMO
- Genetic Robots; e.g., Gene
- Others; e.g., Six-Legged Robot
Robot Snake

