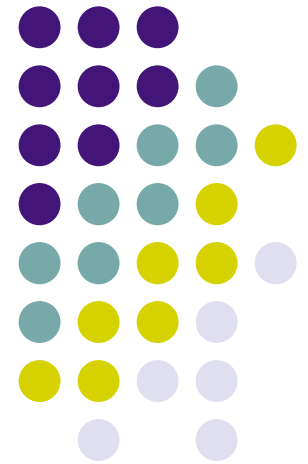


# Computer Simulations of Evolution

Robert C. Newman





# What are we doing here?

- Not a literature search
- Not dealing with origin of life
- Nor with competition & spread of varieties
- Rather a description & investigation of three programs re/ mechanism of evolution:
  - Two described by Dawkins, *Blind Watchmaker*
    - BIOMORPH
    - SHAKES
  - One devised by myself
    - MUNSEL

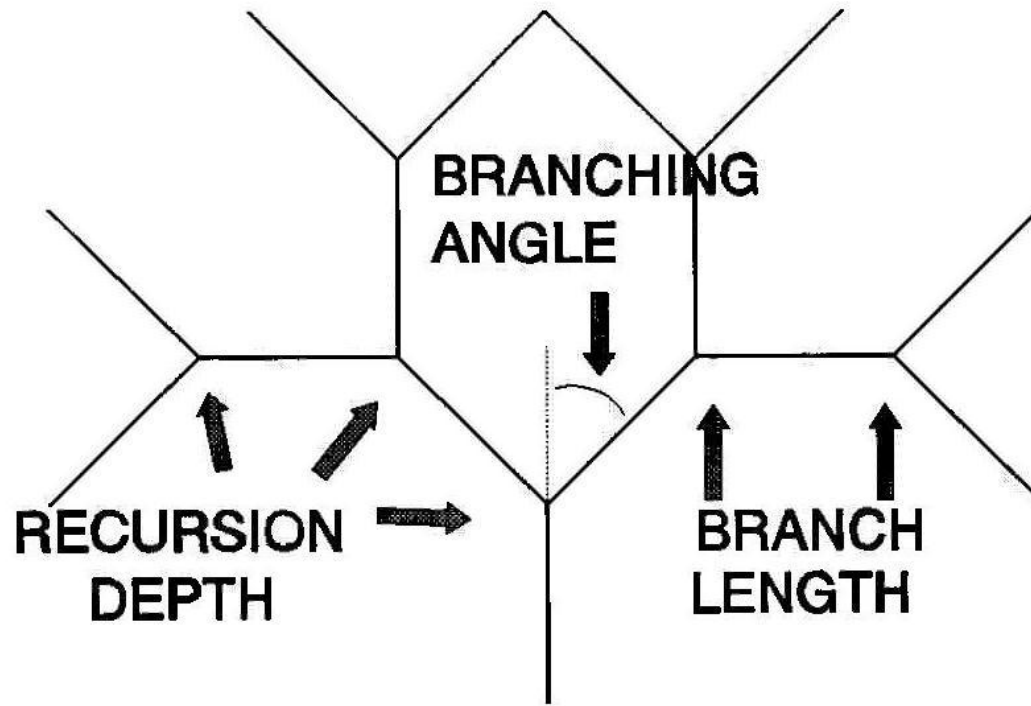


# Program BIOMORPH

- Slightly simplified from Dawkins.
- Building 'organisms' from genetic information, then selecting among mutants.
- Gene is a sequence of eight small integers.
- Integers generate 'tree' by controlling:
  - Branch length
  - Angles
  - Recursion depth (number of levels of branching)



# Sample BIOMORPH Tree

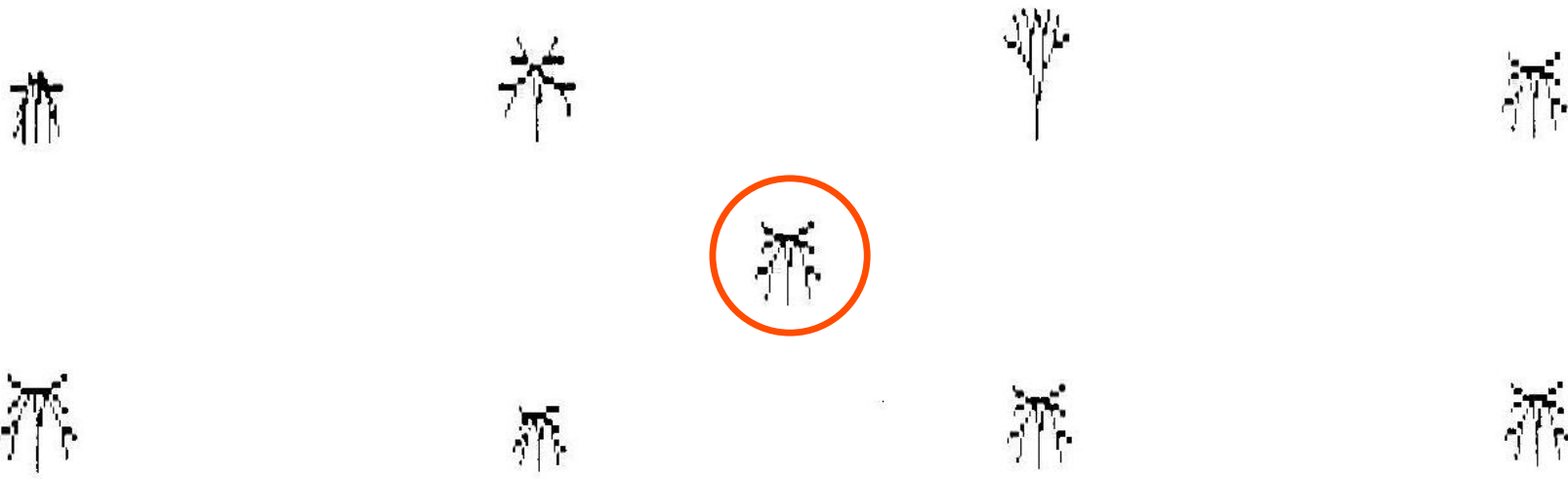




# Program BIOMORPH

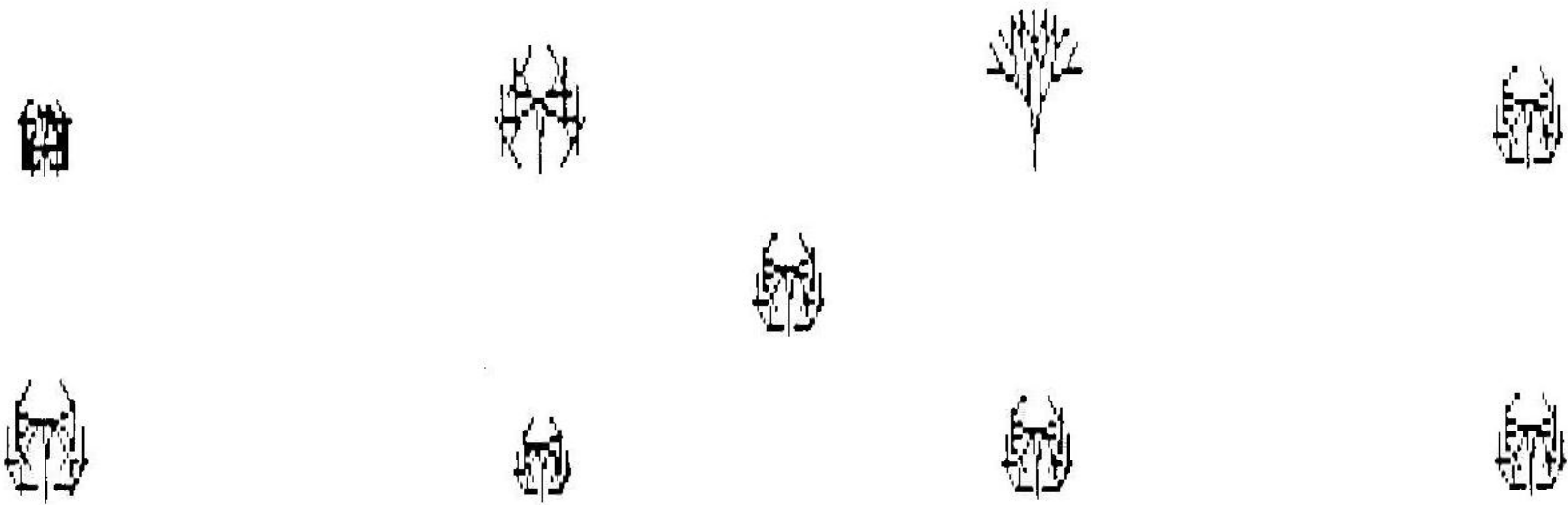
- Trees have mirror symmetry.
- Given a starting gene, program constructs all 'one-step' mutations, displays them on screen.
- Operator selects which mutant will succeed parent.
- Program repeats, using chosen mutant.

# BIOMORPH Output



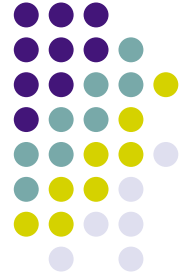
Mother surrounded by next generation of mutant daughters

# BIOMORPH Output



Another mother surrounded by next generation of mutant daughters

# Lessons from BIOMORPH



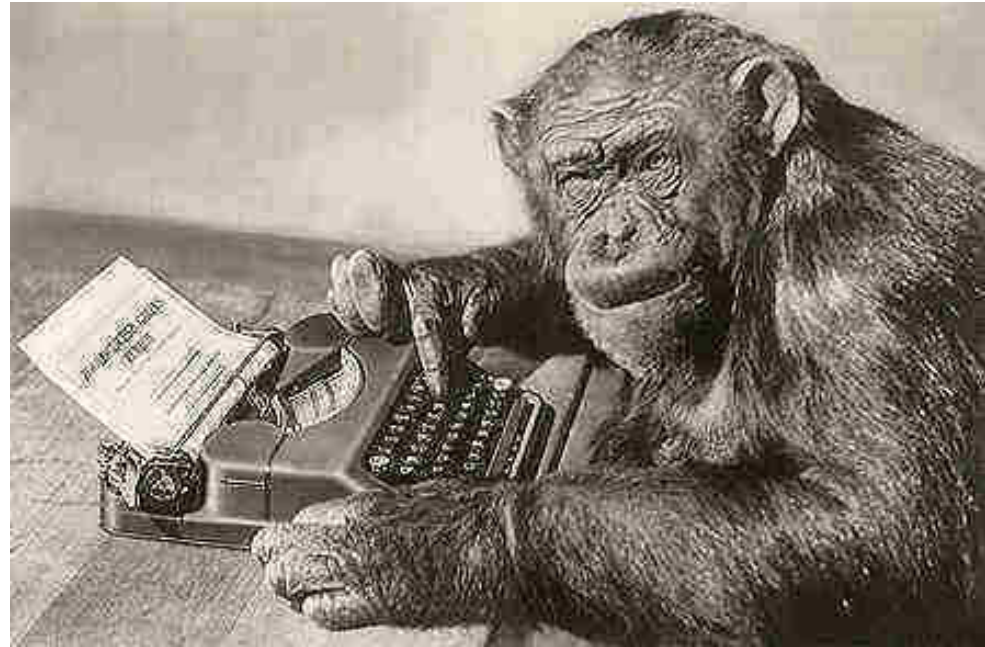
- Shows how:
  - Mutation operates on DNA
  - Selection operates on developed form, not DNA
- We see that:
  - Identical forms can conceal different genetics
  - This leaves room for neutral mutation





# Program SHAKES

Give a few monkeys enough time and they will eventually type out the works of Shakespeare.





# Program SHAKES

- Dawkins in SHAKES seeks to circumvent problem of "monkeys typing Shakespeare" taking an utterly outrageous time to do so.
- Choose a target sentence or phrase, e.g, "METHINKS IT IS LIKE A WEASEL"
- Start with gibberish of same length.
- Mutate gibberish, selecting mutant (if closer to target) as new parent.
- Repeat with new parent.



# Program SHAKES

- Gibberish converges to target to reach goal much faster than if monkeys were typing randomly.
- Dawkins gets convergence in typically 40-70 generations.
- Dawkins doesn't describe his program in detail, so can't tell how he generated mutants, nor how many per generation.



# Sample from Dawkins

(0) Y YVMQKZPFJXWVHGLAWFVCHQXYOPY

(10) Y YVMQKSPFTXWSHLIKEFV WQYSPY

(20) YETHINKSPITXISHLIKEFA WQYSEY

(30) METHINKS IT ISSLIKE A WEFSEY

(40) METHINKS IT ISBLIKE A WEASES

(50) METHINKS IT ISJLIKE A WEASEO

(60) METHNNKS IT IS LIKE A WEASEP

(64) METHINKS IT IS LIKE A WEASEL



# Program SHAKES

- My version: one mutation each generation, randomly chosen for location & type.
- This mutant compared with parent.
- Better of two survives.
- I get much slower convergence than Dawkins does, typically over 1,000 generations.
- So Dawkins is doing something much more favorable than this.



# Program SHAKES

My version:

- Target METHINKS IT IS LIKE A WEASEL not reached in 1,000 generations.
- Target HAPPY BIRTHDAY not reached in 1,000 generations!
- Target QUO VADIS reached in 867 generations.

# Sample from Newman



(0) NEOW KERA  
(50) QVOBUBEGM  
(100) QVOBUAEGS  
(200) QUOAUADHS  
(300) QUO UADHS  
(400) QUO UADIS  
(500) QUO UADIS  
(867) QUO VADIS



# Program SHAKEH

- My version modified: one mutant **at each position** each generation.
- This multi-mutant compared with parent.
- Better of two survives.
- I now get much faster convergence than before, but still slower than Dawkins does.
- So Dawkins is doing something still more favorable than this!



# Sample from Newman



- (0) NEOW KERA
- (20) RSOBVADJQ
- (30) RSOAVADJS
- (40) RUOAVADJS
- (50) RUOAVADIS
- (60) RUOAVADIS
- (70) RUOAVADIS
- (92) QUO VADIS



# Lessons from SHAKES

- Shows that a 'ratchet mechanism' does work.
- This is an important reason why many are convinced evolution must be correct.
- But this is **guided** evolution, i.e., intelligent design!
- This is a considerably more efficient process even than artificial selection (since it has a target) – to say nothing of natural selection!



# Lessons from SHAKES

- This does not solve the time problem.
  - Which of these versions is most realistic?
  - Mutation rate in eukaryotes is  $10^{-8}$  per replication.
  - All these versions ignore time involved for mutant to take over the population.
- All the versions suggest a problem for mutating into complex or optimal structures:
  - Last pieces of puzzle are **highly constrained**
  - Therefore very unlikely!



# Program MUNSEL

- Simulate mutation and natural selection by analogy with human language.
- A letter string is both the gene & organism.
- Mutation is random change in content and/or length.
- Selection is 'naturalized' by requiring that each grouping in the string be an English word.



# A Sample Run of MUNSEL

Start with a single letter:

(0) C

(4) O (first 1-letter word)

(28) LA (first 2-letter word)

(43) FAY (first 3-letter word)

(54) CARE (first 4-letter word)

(61) CARED (first 5-letter word)

(382) WOOED (no 6-letter word yet)



# A Sample Run of MUNSEL

Fix length; start with gibberish:

(0) MWEOOHA OWM H AOE EKEHT QOEN

(11) MWEOOHA CWM Y AFU EO **HI** QOHN

(66) MSEOMD DOWM V **ART** EI **HI** QWTB

(81) MHEHO DOWM W **ART ME HI** IWXY

(98) MH **GO** DZWR W **ART RE HI** ISIY

With 98 generations get four words, longest 3 letters.

# Program MUNSEL



- Current version has operator do selecting, but using a spell-checker would be more objective.
- Program generates words of 1-4 letters rather easily.
- Relative frequency of space character (and nature of selection) tends to keep words short.
- Little success in getting intelligibility in 100s of steps.



# Lessons from MUNSEL

- Complex organisms involve hierarchies of structure, somewhat like intelligible writing.
  - Letters > Words > Phrases > Sentences ...
- Mutation only works at lowest level
  - nucleotides  $\leftrightarrow$  letters
  - So becomes tougher to get anything acceptable as we move up the hierarchy
- Non-selected mutation  $\rightarrow$  gibberish





# Lessons from MUNSEL

- Neutral mutations spread only by random walk.
- Functional isolation seen here
  - Many combinations cannot be reached by single mutations from acceptable smaller groups
  - What is relative size of islands of intelligibility vs oceans of gibberish?
- Can you really get there from here?
  - Complex organs/organisms
  - Crossing higher levels of biological classification

# Computer Simulations of Evolution?



Don't look promising!  
Suggest some sort of  
Intelligent design

