Bridging Structure and Evolution

Evolutionary Discovery of Molecular Structures

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Micrographs to 3D structures

Images courtesy of Axel Brilot
Wikimedia

Rendering of experimentally-derived ribosome structure

3D reconstruction
Projection Matching Methods
BEADS Evolutionary Automated Discovery of Structures
Our Representation

• Volumes of density as spheres
  – Variable number of spheres
  – Variable radius
Evaluating a candidate model

• Computing fitness of a model
  – Simulate microscope imaging
  – Ray-trace from imaging plane
Mutation

- Mutation randomly perturbs candidate model
Example: Structure Search
Local optima problem

# of models evaluated

Goodness of Fit

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Evolution acts in parallel
• Proteins evolved in parallel
Populations of models

- Individual models may favor different features
Fitness Landscapes

- Fitness landscape describes the distribution of phenotypes by fitness value
- Local optima
- Multiple peaks
- Deceptive optima

Images courtesy of M. Frame
Evolving Structural Models

1. Initialize Population
2. Evaluate fitness of population
3. Reproduce selections with variation
4. Select more fit individuals
5. Continue Evolving?
   - Yes
   - No
Thank you

• Jordan Pollack
• Jeff Gelles and Jane Kondev
• QB program
• Audience
Brevis

- [http://brevis.golemics.org](http://brevis.golemics.org)

- New standalone IDE