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Interval Technology
Forte Developer Tools

Interval Arithmetic in Computational Biology

Molecular Revolution is Here!

- Including:
 - Computational Chemist
 - Lasers
 - Genomics
 - Robotics
 - Proteomics
 - Nanotechnology
- Computing: The "Engine" and "Glue"



Apollo 13 astronaut Jim Lovell:

"Houston. We have a

problem!" Floating-Point *Disconnect* with:

- Science
- Engineering
- Mathematics
- **No** Accuracy Information
- **No** Accuracy Requirements
- **No** Ability to Reliably Extrapolate

"Apollo 13. We have a Solution!" @ Sun Connect

Computing to the World!

- An interval's width represents error
- Arithmetic on intervals produces mathematical bounds on the set of all possible results
- Interval algorithms solve otherwise numerically unsolvable problems:
 - Nonlinear systems of equations
 - Nonlinear *global* optimization
 - ODE integration

Interval Solvers Work By

- Deleting Solutions Proved to be Impossible Using
- The Fundamental Theorem of Interval Arithmetic:

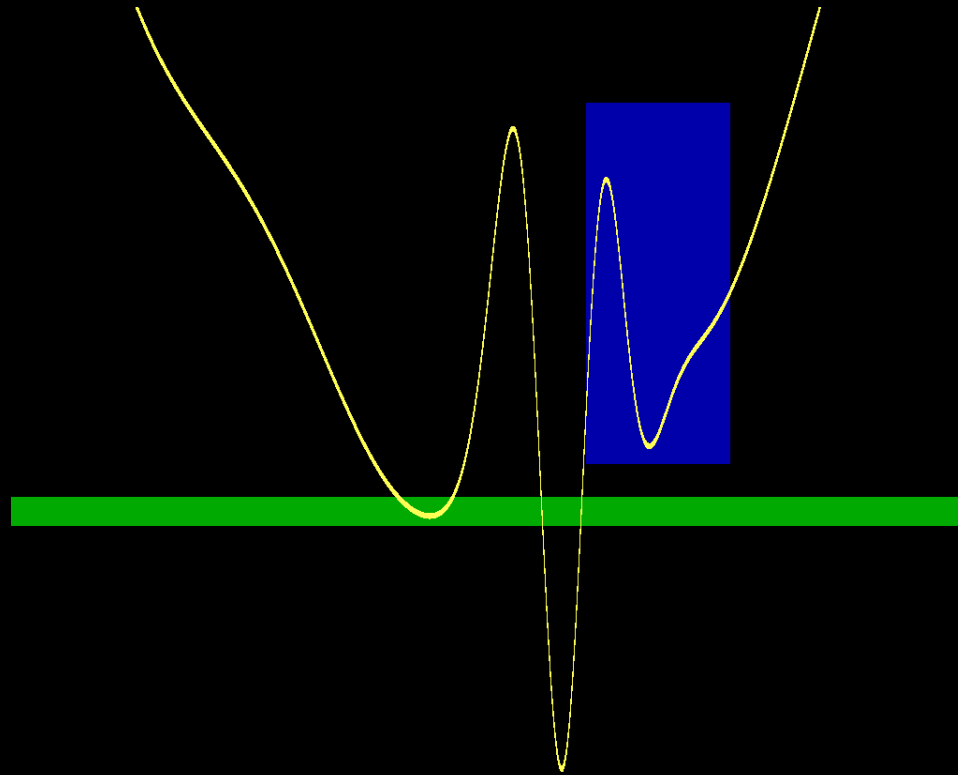
Given an expression $f(\mathbf{x})$,
then $F(\mathbf{x}^I) \supseteq \{f(\mathbf{x}) \mid \mathbf{x} \in \mathbf{x}^I\}$

- For Example,

$$\bar{f} < F(\mathbf{x}^I) \Rightarrow \mathbf{x}^* \notin \mathbf{x}^I$$

Interval Global Optimization

- Example



Interval Solvers Are

- Generic
 - Not vertical-market or application specific
- Massively or "Embarrassingly" Parallel
 - Yield linear (or even super-linear) speedup "forever"

Interval Solvers Are

- As large a "stretch" for you as genomics and proteomics are for me
- Mathematics is our best common language in which to define problems

To Learn More

- Visit:
 - `www.sun.com/forte/info/features/`
`intervals.html`
 - and links contained therein

To Use Interval Solvers

- Provide a mathematical problem description
 - Nonlinear parametric model
 - Optimization objective function and constraints
 - Clinical trial business value statements
- As domain-specific apps get written, less will be required of users.
 - Example: Neural Network coefficient solvers

Non-Genomic Examples

- Prove whether or not a room is "square"
 - See introduction handout
- Calibrate and produce operational location bounds for a GPS system
 - See GPS handout

Conclusion:

- Intervals will provide computing power in the form required by the Revolution in Computational Biology



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