Looking Forward:

What is your mantra?

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- Open source
- High precision
- Massively parallel
- Mixed models
- Mathematics

Open source

- E.g., COIN-OR (**CO**mputational **IN**frastructure for **O**perations **R**esearch)
- Build on previous work
- Mix and match approaches
- Collaboration
  - Open standards 
  - Licenses (e.g., the Common Public License) 

High precision

- High/ultra-high/arbitrary/infinite precision
- Arithmetic – e.g., ARPREC (David Bailey)
- Linear algebra libraries
- Parallel linear algebra libraries
- Polyhedral libraries (e.g., polylib, cdd,…)
- Linear and integer linear programming

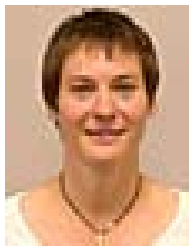
Massively parallel

- Message-passing for distributed systems
- Multithreaded for shared memory (sub)systems (“multi/many core”) 
- E.g., Blue Gene systems, Roadrunner (next-generation peta-flop supercomputer to be built by IBM for DOE at Los Alamos; hybrid design with ~7K AMD Opteron dual-core processors and ~13K Cell Broadband Engine processors)
- Challenges: Hardware design  , programming tools, leverage for mathematical programming 

Mixed models

- Integer (model discrete choices)
- Nonlinear (model static physics, risk,…)
- Stochastic and robust (model uncertainty)
- PDE and dynamical systems (model physical dynamics)
- Derivative free (black box modeling)

Mathematics



- Formulations via systems of polynomial equations in complex variables (rather than the traditional modeling paradigm of linear inequalities in real variables) $\Longrightarrow$ *Hilbert's Nullstellensatz*
- Discrete local search $\Longrightarrow$ Techniques of algebraic geometry (e.g., *Gröbner bases*)
- Using a linear optimization oracle for nonlinear discrete optimization$\Longrightarrow$*Frobenius numbers*
- Using polynomials to enumerate solutions to nonlinear discrete optimization problems on massively-parallel architectures $\Longrightarrow$*Stirling numbers*





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