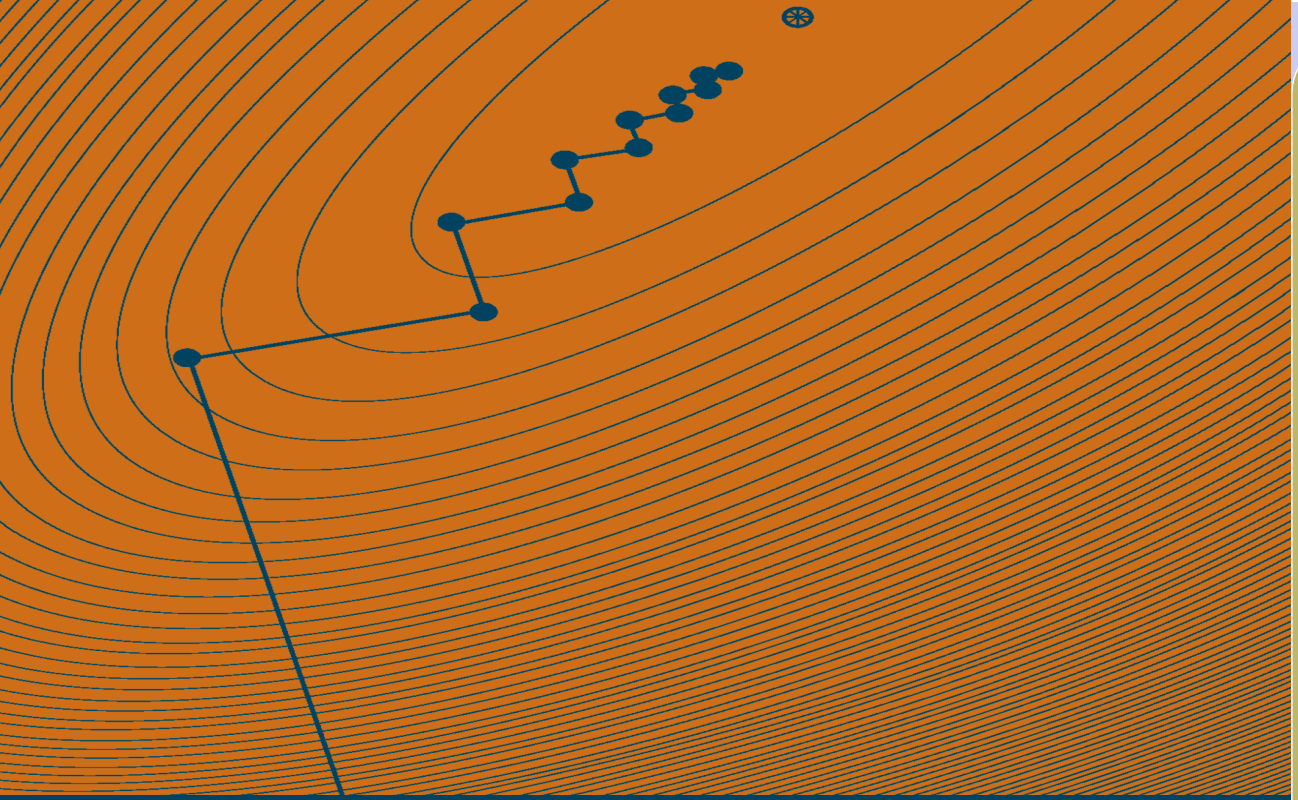

Ross Baldick

Applied Optimization

Formulation and Algorithms for Engineering Systems

CAMBRIDGE

Outline
Why another . . .
Problem classes
Formulation of problems
Case studies
Algorithms
Organization
Level of development
Software
Additional materials
Conclusion

1. Outline

- Why another optimization text?
- Problem classes.
- Formulation of problems.
- Case studies.
- Algorithms.
- Organization.
- Level of development.
- Software.
- Additional materials.
- Conclusion.

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2. Why another optimization text?

- Many texts focus on the design of algorithms.
- Many engineering students are involved with *formulating* a problem:
  - expectation is to utilize existing algorithms and software for solution.
- The "scarce resource" is increasingly in formulation, not hardware or optimization software itself.
- This book focuses on formulation of problems.

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3. Problem classes

- Continuous variables and functions.
- Incrementally defines and discusses:

1. linear systems of equations,
2. non-linear systems of equations,
3. unconstrained optimization,
4. equality-constrained optimization,
5. inequality-constrained optimization.

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4. Formulation of problems

- The book presents engineering applications through a series of fourteen detailed case studies.
- The case studies illustrate:
  - formulation of simultaneous equations and optimization problems,
  - transformation of problem formulations,
  - solution of problems with existing general-purpose software, and
  - incremental development of formulations.
- Simultaneous equations problems are covered in detail since many signal processing and other engineering applications involve the solution of equations.
  - Solution of optimality conditions for optimization problems builds directly on solution of simultaneous equations.

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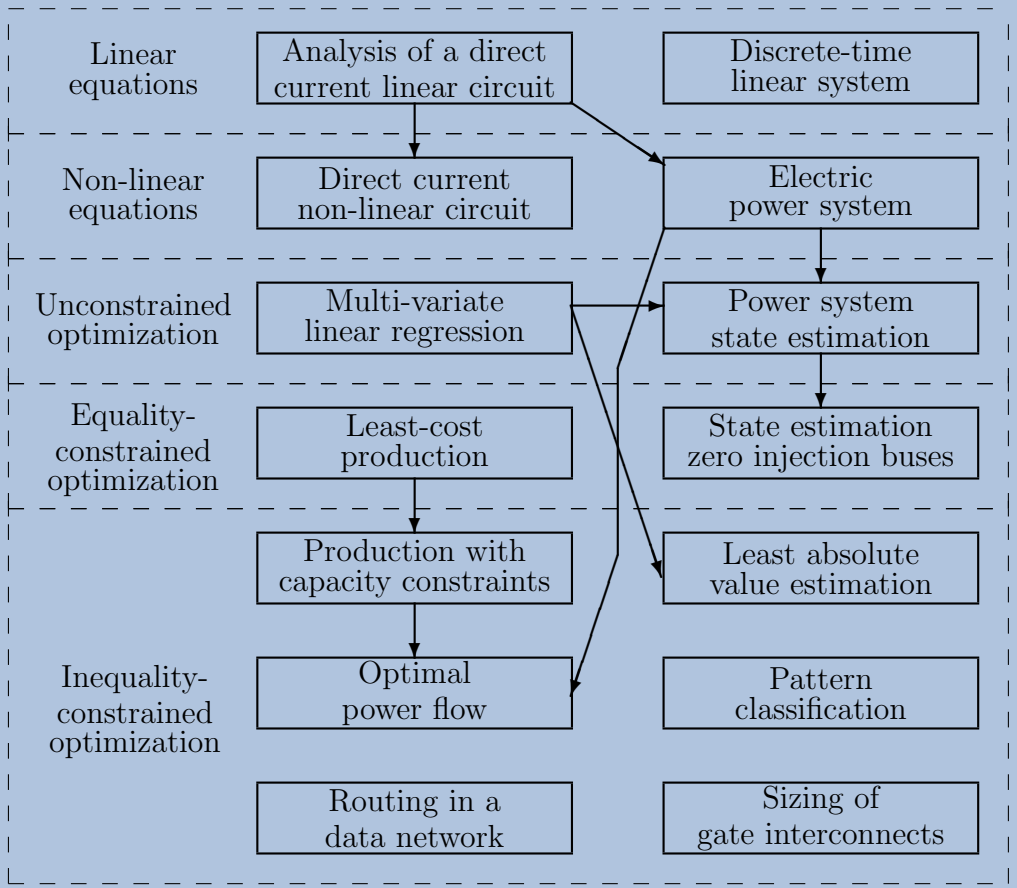
5. Case studies



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6. Algorithms

- One or two exemplar algorithms are introduced for each problem class to illustrate the issues that arise in formulating problems.
- Emphasize:
  - monotonicity,
  - convexity,
  - problem transformations,
  - symmetry, and
  - sparsity.
- Avoid details that are not prominent in problem formulation:
  - variations and extensions introduced briefly.

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7. Organization

- Three introductory chapters outline the problem classes and discuss problem transformations.
- The remaining chapters are organized in five Parts.
- Each Part deals with a problem class and consists of chapters describing:
  - formulation of at least two case studies,
  - algorithms to solve the problem class,
  - sensitivity analysis, and
  - solution of the case studies.
- Each chapter has a number of homework exercises:
  - Over three hundred pages of homework solutions available to instructors.

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8. Level of development

- Aimed at incoming graduate students or senior undergraduates.
- Formal discussion in definition–theorem–proof style.
- Complemented by:
  - considerable discussion,
  - many worked examples, and
  - about 200 figures.

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9. Software

- The MATLAB Optimization Toolbox is used in some of the homework exercises.
- Other frameworks are possibly better suited to formulation and solution of optimization problems.
- MATLAB is used by many engineering students in their research:
  - minimizes the "start-up" costs of learning new packages, and
  - enables direct incorporation of optimization formulations into research projects.

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10. Additional materials

- Available from www.cambridge.org/9780521855648

1. Mathematical background.
2. Proofs of results.
3. Slides that I use in teaching this course.
4. Over four hundred pages of homework solutions available to instructors.

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11. Conclusion

- New book on solving equations and continuous optimization.
- Emphasizes formulation of problems and transformations.
- For ordering information, visit the Home Page, www.cambridge.org/9780521855648

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