Introduction

Harry Lee

January 8, 2018

CEE 696

Table of Contents

Course Organization

Course description

- Optimization involves finding the “best” solution according to specific criteria
- Any engineering problem requires the optimization to make optimal use of resources with the least cost while minimizing failure and risk
- Examples in groundwater engineering:
    - maximize groundwater supply
    - minimize remediation cost
    - minimize the risk of aquifer deletion or saltwater intrusion

Course Objectives

- Learn how to solve various optimization problems
- Learn how to use tools
  - Python programming
  - MODFLOW simulation with Python interface (flopy)
- Use LaTeX to submit homework, midterm, and project report

Prerequisites

No formal ones, but

- undergraduate/graduate level class in linear algebra
- experience in script languages (e.g., MATLAB, R, PYTHON, Julia)

- Project: use optimization to do something cool!
- proposal, milestone, final paper
- Final presentation : Mon May 7 or Wed May 11

Course Schedule

- $4 \sim 5$˜HWs including Project proposal
- 2 Midterms for Project progress reports
- Project: use optimization to do something cool!
- proposal, milestone, final presentation, final paper

Materials

Lecture slides and suggested readings will be uploaded in

https://www2.hawaii.edu/~jonghyun/classes/S18/CEE696/index.html

https://www2.hawaii.edu/~jonghyun/classes/S18/CEE696/schedule.html

Tools

- Python Distribution : Anaconda
- Python Editor : PyCharm
- Document : LaTeX(using Overleaf)

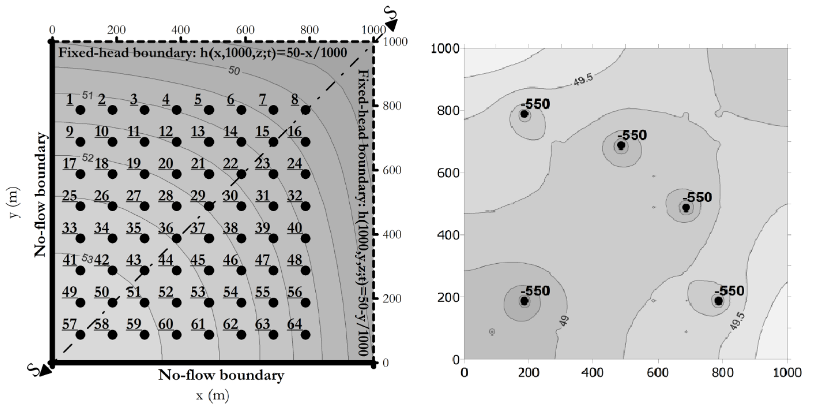
Office Hours

- 4-5 PM TR
- Holmes 336

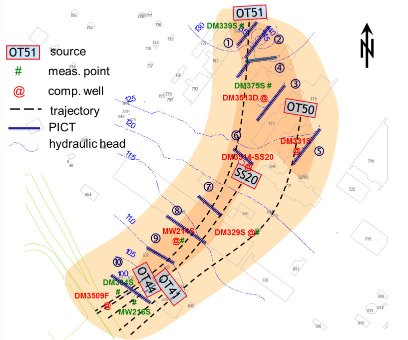
Lastly..

- Enjoy the class project!

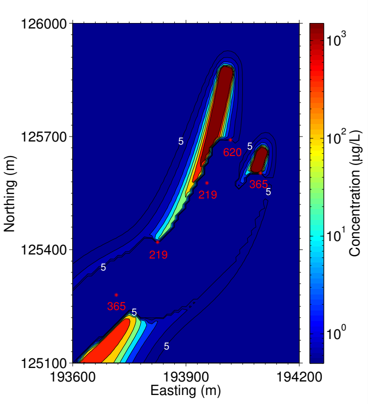
Examples



Maximize groundwater supply while not too much aquifer drawdown.



(a) Dover Air Force Base in Delaware



(b) Optimized bioremediation strategy

Minimize bioremediation cost while contaminant concentration below MCL at the compliance wells

Model Calibration

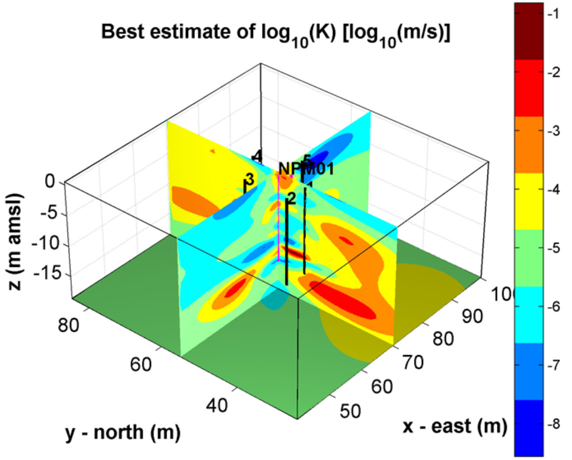


Figure 2: Hydraulic tomography [Hochstetler et al., 2016]

Minimize the difference between simulation model outputs and available observations

Optimization Problem

$$\begin{aligned} \underset{x}{\text{minimize}} \quad & f_0(x) \\ \text{subject to} \quad & f_i(x) \leq b_i, \; i = 1, \ldots, m. \end{aligned}$$

$f_0(x)$ is called objective function

$f_i(x)$ are constraints that the optimization problem should satisfy

Classification

- Continuous vs. Discrete Optimization
- Constrained vs. Unconstrained Optimization
- Single-objective vs. Multi-objective optimization
- Local vs. Global Optimization
    - convex optimization
    - meta-heuristic methods

Tentative Topics

- Python programming
- MODFLOW-Flopy modeling
- 1D optimization
- Local optimization
- Global optimization
    - convex optimization
    - stochastic search/evolutionary algorithm
- Multi-objective optimization
- Response matrix approach