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Project 09 Report: Minimum Cost Connecting Paths

Brief Result

For $\alpha = 1.5$ and $\beta = 1.0$, the optimal coordinates for the polyhedrons given in the problem are:

i	x_i	y_i
1	$(0.4369, 0.6894)$	$(2.6116, 1.7768)$
2	$(0.1, -1.9)$	$(1.0, -4.0)$
3	$(-1.2, -2.0)$	$(-2, -4)$
4	$(-0.8, 1.6)$	$(-2, 4)$

with a total cost function value of $f = 23.6920$

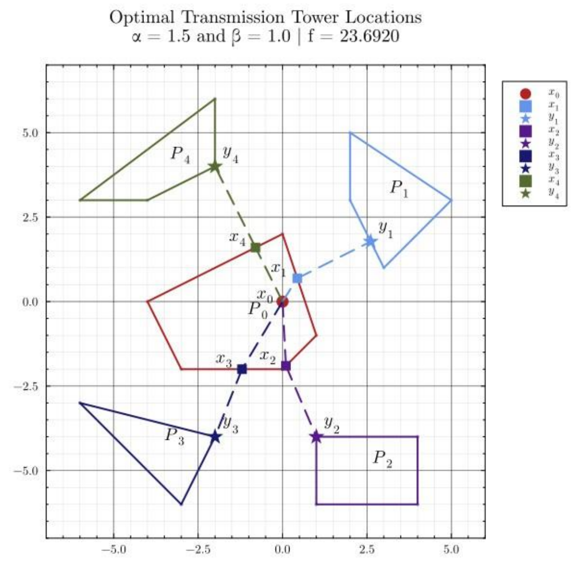

Figure 1 Configuration for $\alpha/\beta = 1.5$ (default problem)

Codebase:
`optimizeASQP.jl` (main solver)
`activeSetQP.jl` (contains all functions required by `optimizeASQP`)
`transmissionLines.jl` (problem statement script)

Problem Description

Incorporate active set quadratic programming method (ASQP) into your solver, which will be able to solve a general QP problem. Use the code to solve for the `transmissionLines` problem with various hyperparameter values (Task 4). Then modify the problem to ensure that equality constraints are solved for correctly as well (Task 5).

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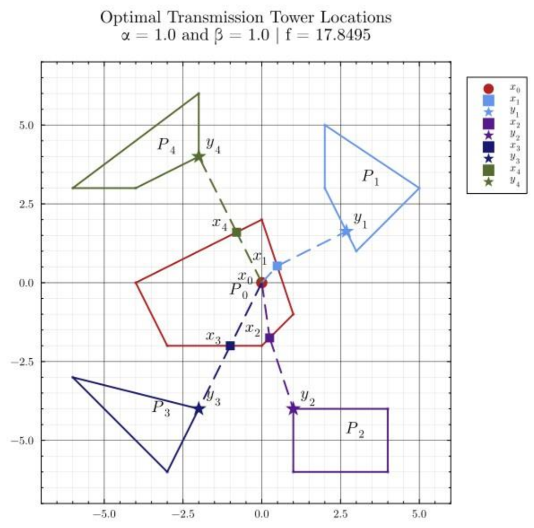
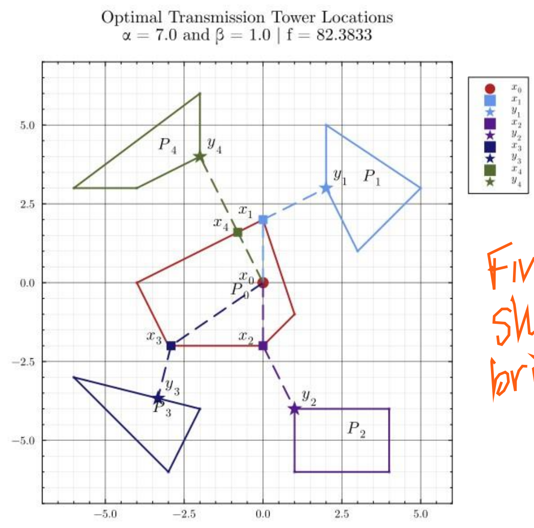
Results and Some Insights

Task 4:

Beyond a critical value of α/β, the optimal placements should remain unchanged (minimizing the length of transmission lines between P_0 and outer regions P_1 to P_4 becomes an increasingly higher priority). In my case, the optimal placements after a factor of $\frac{\alpha}{\beta} \geq 7.0$.





Finds the shortest bridging path!

Figure 2 Configuration for $\alpha/\beta = 1.0$ (default problem)

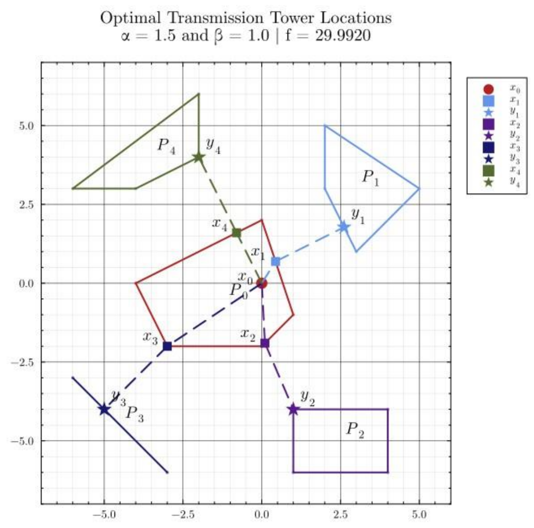
Figure 3 Configuration for $\alpha/\beta = 7.0$ (default problem)

Task 5:

To test equality constraint (making one polyhedron a line segment), I made one change to one of the polyhedrons, specifically as given below:

```
# P3 = [(-2, -4), (-6, -3), (-3, -6)] # problem statement
P3 = [(-6, -3), (-3, -6)] # modification for testing equality constraint
```

And got sensible results, so would assume that my solver holds good for this task too.



I like that you chose a line segment from the "back" of the polyhedron to illustrate the computation

Figure 4 Configuration for $\alpha/\beta = 1.5$ (equality constrained problem)

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Extra:

This problem (`transmissionLines`) was seemingly the first problem in the two courses (MATH 564 and MATH 565) where the problem could be fully decoupled into several problems (one for each outlying polyhedron). This meant that the solver needed to be called multiple times (assuming no parallelized computing is utilized) to solve the full problem, in order to collate the solutions for each polyhedron. Of course, one may just run the solver multiple times and note the results.

Previously, for solving the `dragFunction` in MATH 564 using a warm-start approach, the solver was also called multiple times. But in that case the solver calls were meant to work in a daisy-chain fashion, so only the results of the latest solver run were required.

Methods

Currently I haven't actually created a general constrained optimization function (on similar lines as the `optCQP` function as provided by Tom). Only an `optimizeASQP` problem. `optimizeASQP` of course calls the previously created `optimizeECQP` solver, the `solveLP` solver for finding an initial feasible point for the QP.

that's fine

`solveLP` function is just a wrapper function which utilizes Julia's JuMP modelling language [1] and HiGHS optimization solver [2], for solving the LP problem of finding a feasible point for the QP. ✓

References

1. Introduction · JuMP. (2024, April 18). Retrieved from https://jump.dev/JuMP.jl/stable
2. HiGHS - High-performance parallel linear optimization software. (2024, January 26). Retrieved from https://highs.dev
3. Nocedal, J., & Wright, S. J. . Numerical Optimization. Springer. Retrieved from https://link.springer.com/book/10.1007/978-0-387-40065-5
4. Prof. Tom Asaki's course notes as part of MATH 565 Nonsmooth Analysis and Optimization taught at Washington State University, Spring 2024. Problem Statement retrieved from Project Descriptions: 2024-Spr-MATH-565-PULLM-1-01-03816-Nonsmooth Analy & Optimization. (2024, April 10). Retrieved from https://wsu.instructure.com/courses/1687163