.label-body { display: inline-block; margin-left: .5rem; font-weight: normal; } ul { list-style: circle; } ol { list-style: decimal; } ul ul, ul ol, ol ol, ol ul { margin: 1.5rem 0 1.5rem 3rem; font-size: 90%; } li > p {margin : 0;} th, td { padding: 12px 15px; text-align: left; border-bottom: 1px solid #E1E1E1; } th:first-child, td:first-child { padding-left: 0; } th:last-child, td:last-child { padding-right: 0; } button, .button { margin-bottom: 1rem; } input, textarea, select, fieldset { margin-bottom: 1.5rem; } pre, blockquote, dl, figure, table, p, ul, ol, form { margin-bottom: 1.0rem; } .u-full-width { width: 100%; box-sizing: border-box; } .u-max-full-width { max-width: 100%; box-sizing: border-box; } .u-pull-right { float: right; } .u-pull-left { float: left; } hr { margin-top: 3rem; margin-bottom: 3.5rem; border-width: 0; border-top: 1px solid #E1E1E1; } .container:after, .row:after, .u-cf { content: ""; display: table; clear: both; } pre { display: block; padding: 9.5px; margin: 0 0 10px; font-size: 13px; line-height: 1.42857143; word-break: break-all; word-wrap: break-word; border: 1px solid #ccc; border-radius: 4px; } pre.hljl { margin: 0 0 10px; display: block; background: #f5f5f5; border-radius: 4px; padding : 5px; } pre.output { background: #ffffff; } pre.code { background: #ffffff; } pre.julia-error { color : red } code, kbd, pre, samp { font-family: Menlo, Monaco, Consolas, "Courier New", monospace; font-size: 0.9em; } @media (min-width: 400px) {} @media (min-width: 550px) {} @media (min-width: 750px) {} @media (min-width: 1000px) {} @media (min-width: 1200px) {} h1.title {margin-top : 20px} img {max-width : 100%} div.title {text-align: center;} >

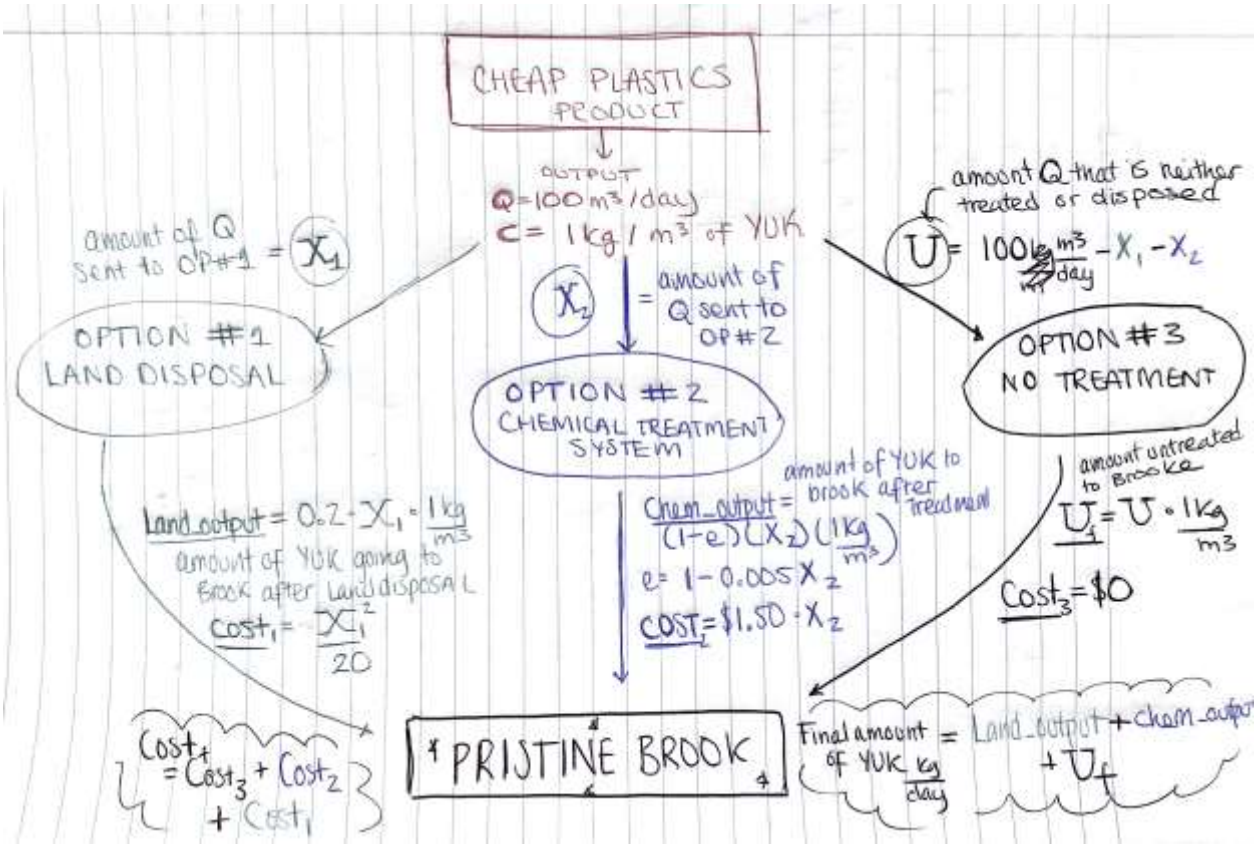
BEE 4750/5750 Homework 1

Audrey Noziere (aln57)

2022-09-14

Problem 1

Problem 1.1



Problem 1.2

Explanation *Given that there is 100 m^3/day of waste being generated (at a concentration of 1kg/m^3) we know that the totality of that waste must be disrtibuted between the three options: Land Disposal, Chemical Treatment, or Untreated*

- X_1 represents the amount of waste disposed on land. 1/5 of that is going to end back in to the brook
- X_2 represents the amount of waste going through chemical treatment, the efficiency will help us find the amount going to brook
- U represents the untreated amount which is going straight to brook

Outline of Constraints

$$X_1 + X_2 + U = 100$$

subject to

$$X_1 \geq 0$$
$$X_1 \leq 100$$
$$X_2 \geq 0$$
$$X_2 \leq 100$$
$$U \geq 0$$
$$U \leq 100$$

The total amount going to Brook:

- This represents the total output from Land Disposal, Chem Treatment, and No Treatment

- To meet EPA standards the output must be less than or equal to 20 kg/day

$$(LandOutput + ChemOoutput + Uoutput) \leq 20 kg/day$$

subject to

$$LandOutput = (0.2X_1) * 1kg/m^3$$
$$ChemOutput = [(1 - e)X_2] * 1kg/m^3$$
$$e = 1 - 0.005X_2$$
$$UOutput = U * 1kg/m^3$$

The total Cost of the output:

- This depends on the amount being sent to each option, but will result in the sum of the costs

$$Costs = CostLand + CostChem + CostU$$

subject to

$$CostLand = (X_1)^2/20$$
$$CostChem = 1.5X_2$$
$$CostU = 0$$

Problem 1.3

Explanation *The function below calculates the amount of YUK going to the water and the cost The inputs are:*

- X_1
- X_2

It returns:

- x final amount in kg/day going into Pristine Brook
- Final Cost
- Amount untreated (U)
- X_1
- X_2

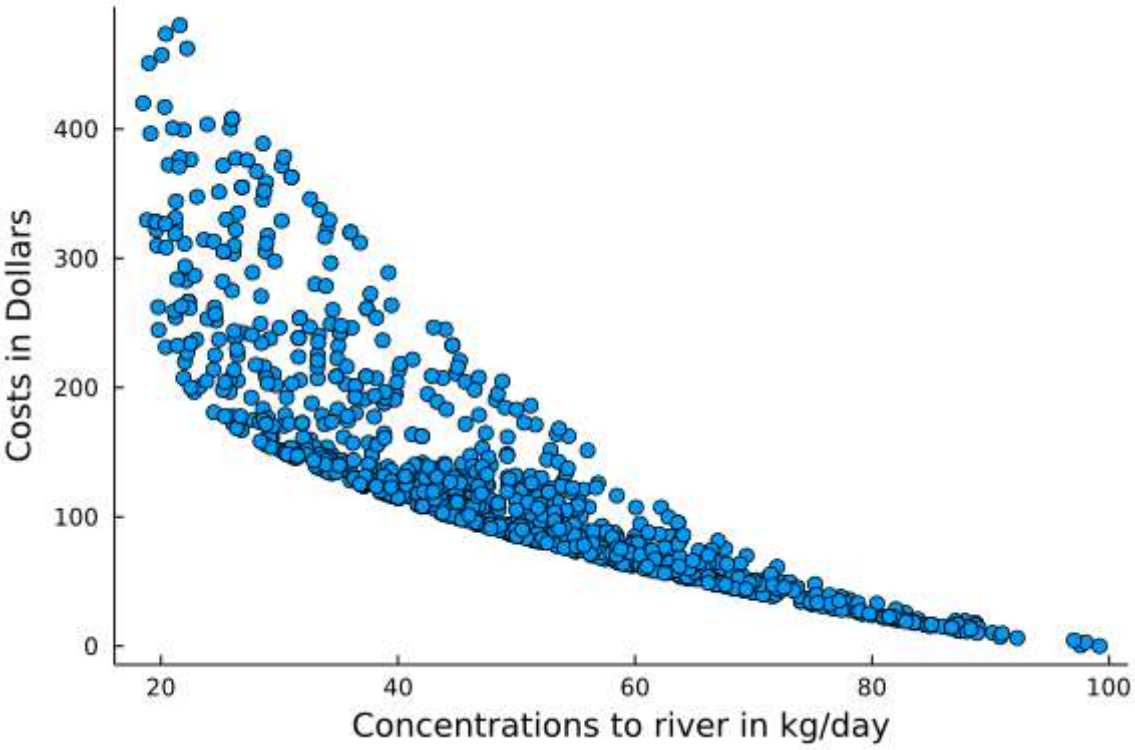
```
julia> function output(X_1, X_2)
           land_output = 0.2*X_1*1
           e = 1 - 0.005*X_2 #efficiency
           chem_output = (1-e)*(X_2)*1
           U = 100 - X_1 - X_2 #untreated amount
           x = land_output + chem_output + U # x is the final output to water
           cost = 1.50*X_2 + (X_1^2)/20
           return x, cost, U, X_1, X_2
       end
output (generic function with 1 method)
```

Problem 1.4

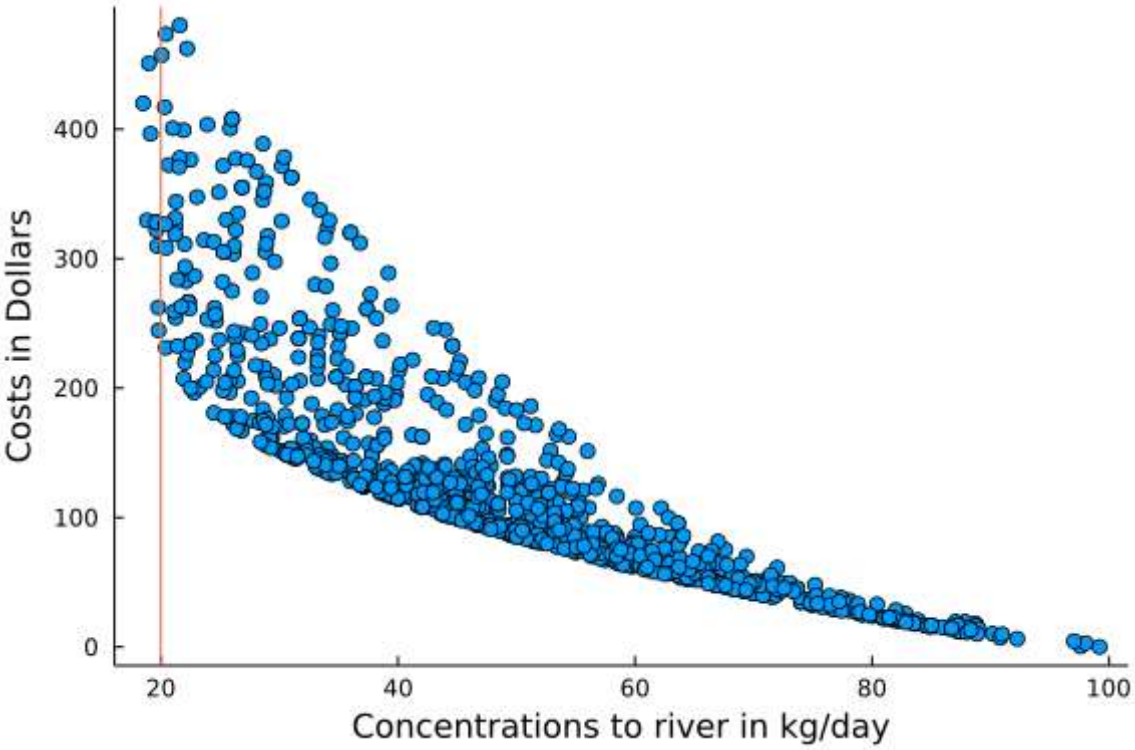
Explanation *Below is the code I used to generate 1000 random samples and plot my findings*

```
julia> treatment_samples = []
Any[]

julia> while length(treatment_samples) < 1000
           a = rand(0.0:100.0)
           b = rand(0.0:100.0)
           if a + b <= 100
               push!(treatment_samples, (a, b))
           end
       end

julia> treatment_output = []
Any[]

julia> for i in treatment_samples
           push!(treatment_output, output(i[1], i[2]))
       end

julia> final_output = [o[1] for o in treatment_output]
1000-element Vector{Float64}:

 71.6
 31.244999999999997
 41.120000000000005
 37.68
 37.805
 70.045
 45.845
 67.68
 53.445
 52.900000000000006
  ⋮
 38.005
 38.045
 25.380000000000003
 61.045
 58.82
 69.7
 52.58
 46.0
 69.38

julia> final_costs = [o[2] for o in treatment_output]
1000-element Vector{Float64}:
  38.45
 145.7
 128.0
 272.45
 147.75
  49.95
 100.5
  45.8
 111.95
  81.45
   ⋮
 177.3
 193.7
 177.8
  61.55
  75.05
  48.8
  79.8
 101.25
  44.0
```

```
julia> scatter(final_output, final_costs, xlabel="Concentrations to river in kg/day", ylabel = "Cos
```




```
julia> plot!([20], seriestype="vline")
```



Problem 1.5

Explanation *I added some code to help me pinpoint the based option in my opinion.

- This would be the lowest cost option after meeting the EPA standard

```
julia> meet_standards = []
Any[]

julia> for i in treatment_output
           if i[1] <= 20
               push!(meet_standards, i)
           end
       end

julia> min_cost = findmin([o[2] for o in meet_standards])
(244.55, 10)

julia> for i in meet_standards
           if i[2] == min_cost[1]
           return i
           end
       end
(19.805000000000003, 244.55, 0.0, 61.0, 39.0)
```

Answers How would you select a treatment plan? How might this plan reflect the perspectives of various interested parties (factory owners, the public, regulatory agencies, etc)?

- Based on the plot, I would immediately illiminate any option that lies beyond the horizontal red line. This line represents the EPA standards of 20kg/day which is allowed to be released into the Pristine Brook. Any point beyond this has exceed this limit. Then I would want to choose the point that is the lowest, so closest to the x axis which would represen the lowest cost. Now there are many points that I could choose and what kind of stakeholder I am will influence what option I choose. In terms of factory owner, I would choose the point that minimizes my cost. Assuming I would get fined if I am over the EPA standards, I would likely choose the cheapest option form the left of the red line. If I was the public and I did not have to pay I would chose the option that minimizes the input to Pristine Brooke which is likely a shared resource, possibly used for drinking water or recreationally. From Regulatory Agency's perspective I would be most interested in choosing a solution that lies to the left of the right line, and if I do not have to bare the price any of those points will do (the lower concentrations the better).

Did how you set up your numerical experiment in Problem 1.5 influence your conclusions?

- I think an important thing to consider is the way in which the variables are chosen. The way my function is set up is that it focuses on X*1 and X*2 and depending on what values are randomized for them, U is chosen. This could have an influence on the solutions that my function outputs. Additionally, X*1 is chosen before X*2 and then U.

- From lookig at the graph, most of the solutions that are found are concnetrated near the center bottom of the graph and there are very few solutions on the left size, this makes me think that my function influenced my solutions by finding more lower cost solutions than low concentration solutions

- The sample size could also have an influence on my conclusions. While I chose 1000 samples, I could increase my sample size and get a better view of all the solutions

Might they have changed with a different experimental design?

- It would be interesting to see the difference in solution if I switch up which varable is randomly chosen first. Finding a way to randomize if X*1 , X*2 or U are chosen first could make my model stronger by elliminating any bias between variables.

- Smaller sample size would give a more limitted view of the solutions, but a large sample size could be more encompasing of all the solutions and particularly finding the best solution.

Problem 1.6

Answer

- Something that could be interesting to investigate more is finding the ideal cost of a Fine from the EPA to the Plastic Company to ensure that they stay below EPA standards. For example, if the Fine is set to 100 dollars for an exceedence, but it cost the company 120 dollars to reduce their output from 22kg/day to 19.9 kg/day they will be incentivized to bare the fine rather than treat the waste. Hence to stengthen the model, we could look into balancing the Fine with the cost of treatment so that the company would always rather treat the waste rather than pay the fine.

Some important assumption that were made in this model :

- is that Cheap Plastic Products is the only source of YUK to Pristine Brook.
- YUK does not degrade with time
- The Land Disposal doesn't runoff into Pristine Brook later on in time
- YUK does not react with elements in Pristine Brook to decompose
- the Costs displayed are only the direct costs of land disposal and chemical disposal but do not incoperate indirect costs of pollution

```

# References


- https://docs.julialang.org/en/v1/base/collections/#Base.findmax
- https://discourse.julialang.org/t/what-is-the-syntax-for-vline-in-plots-jl/1718/8
- https://docs.julialang.org/en/v1/stdlib/Random/
- https://discourse.julialang.org/t/how-to-create-a-random-uniform-distribution-between-but-excluding-0-and-10/21908
- https://docs.julialang.org/en/v1/manual/mathematical-operations/
- https://stackoverflow.com/questions/27827249/julia-concatenate-string-and-integer


---
```