.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;} >

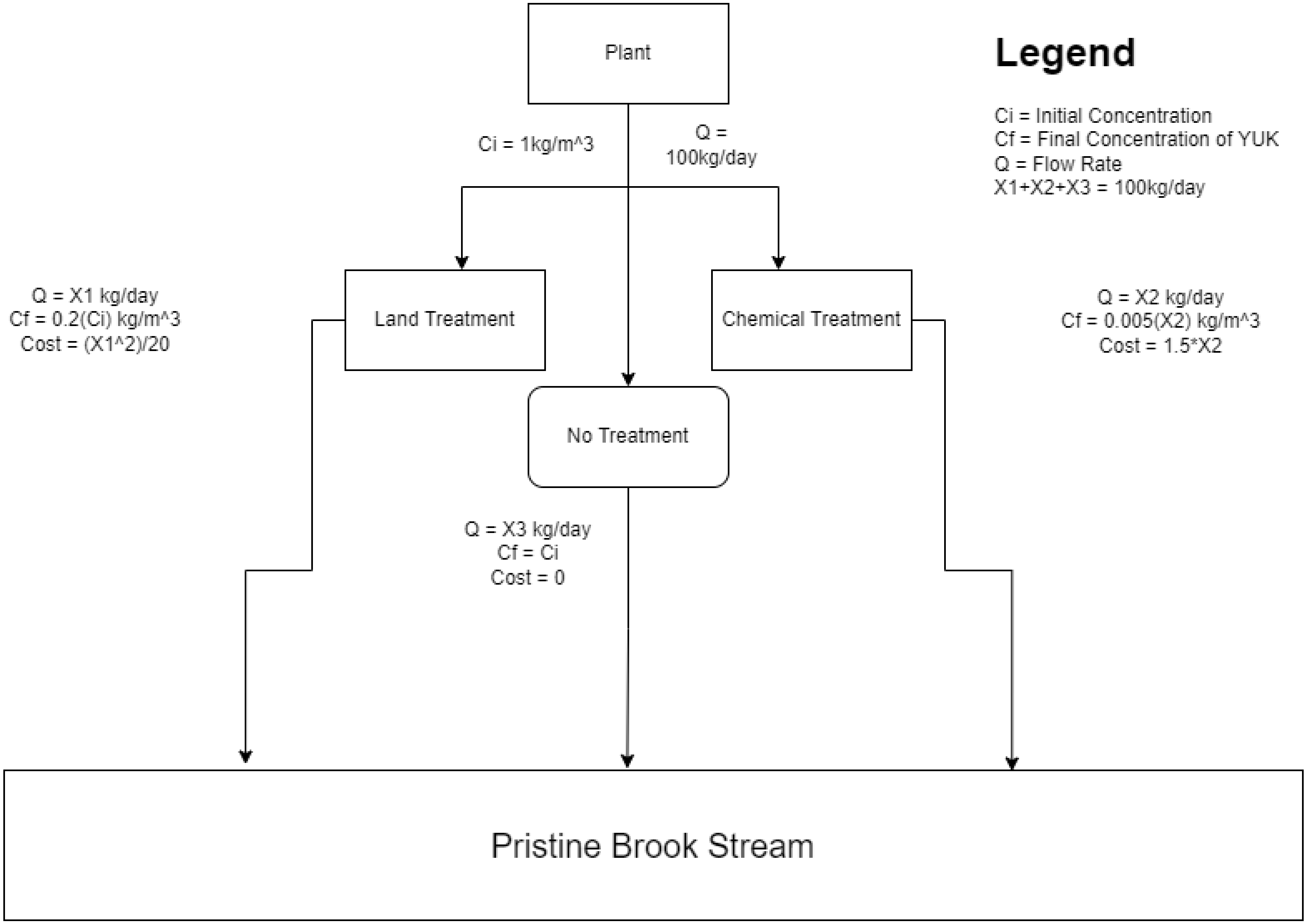
BEE 4750/5750 Homework 1

Sonjay Lake (SVL24)

2022-09-14

Problem 1

Problem 1.1



The figure above details the three possible pathways for treating the wastewater emitted by the factory. This includes land treatment, chemical treatment, and no treatment. All three flows end up in the Pristine Brook Stream.

Problem 1.2

There are many possible methods for treating the 100 $\frac{kg}{day}$ of wastewater released by the plant.
Creating a model for this scenario would involve taking into account a combination of the three different treatment paths.
First, one would have to take into the account the constraint indicated by the diagram:

$$X_1 + X_2 + X3 = 100$$

which is the conservation of mass between all three treatment methods.

This concept can be extended to the YUK concentration after each method as well. 0

$$(C_{i,1} * X_1) + (C_{i,2} * X_2) + (C_{i,3} * X_3) = C_f$$

As an example, a treatment plan using solely land treatment would have a final concentration:

$$C_f = C_{i,1} * X_1$$

with $X_1 = \ 100\frac{kg}{day}$.

The cost would be computed similarly using the equations in the diagram.

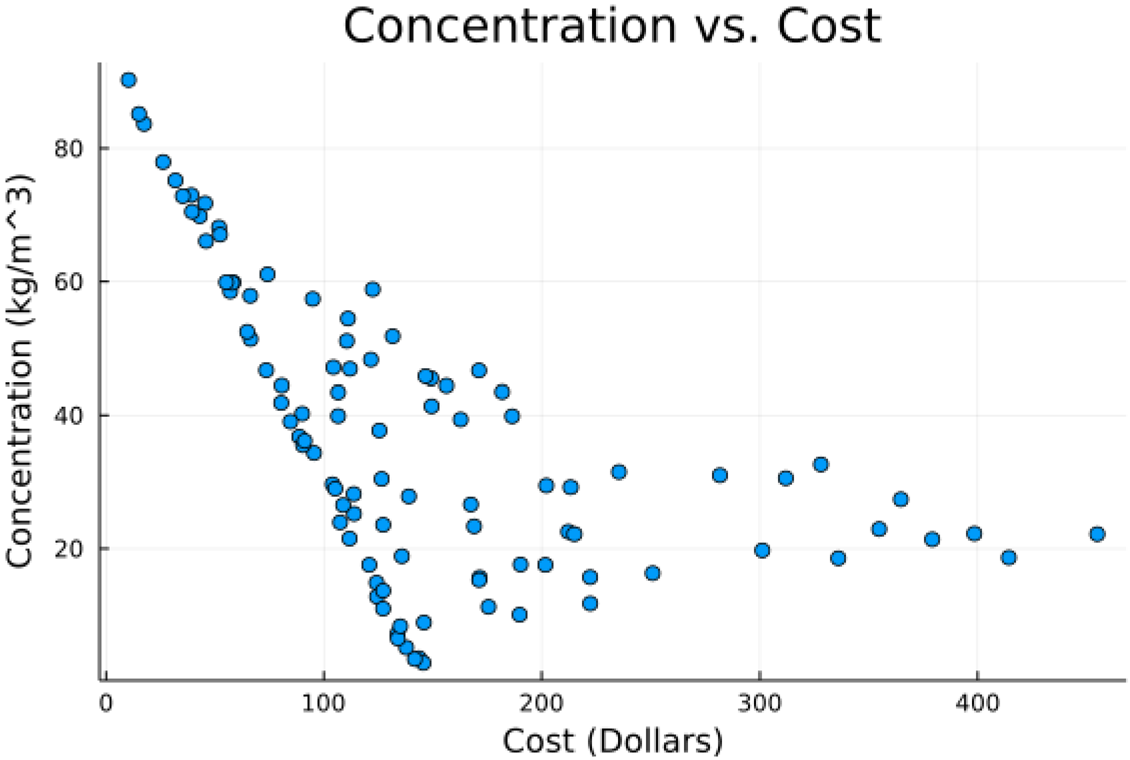
Problem 1.3

```
julia> function model(x1,x2,x3)
       #Function that computes the final YUK concentration given the following input variables:
       #=
       x1 = wastewater allocated to land treatment
       x2 = wasteater allocated to chemical treatment
       x3 = wastewawter allocated to no treatment
       x1+x2+x3 must sum to 100
       =#
```

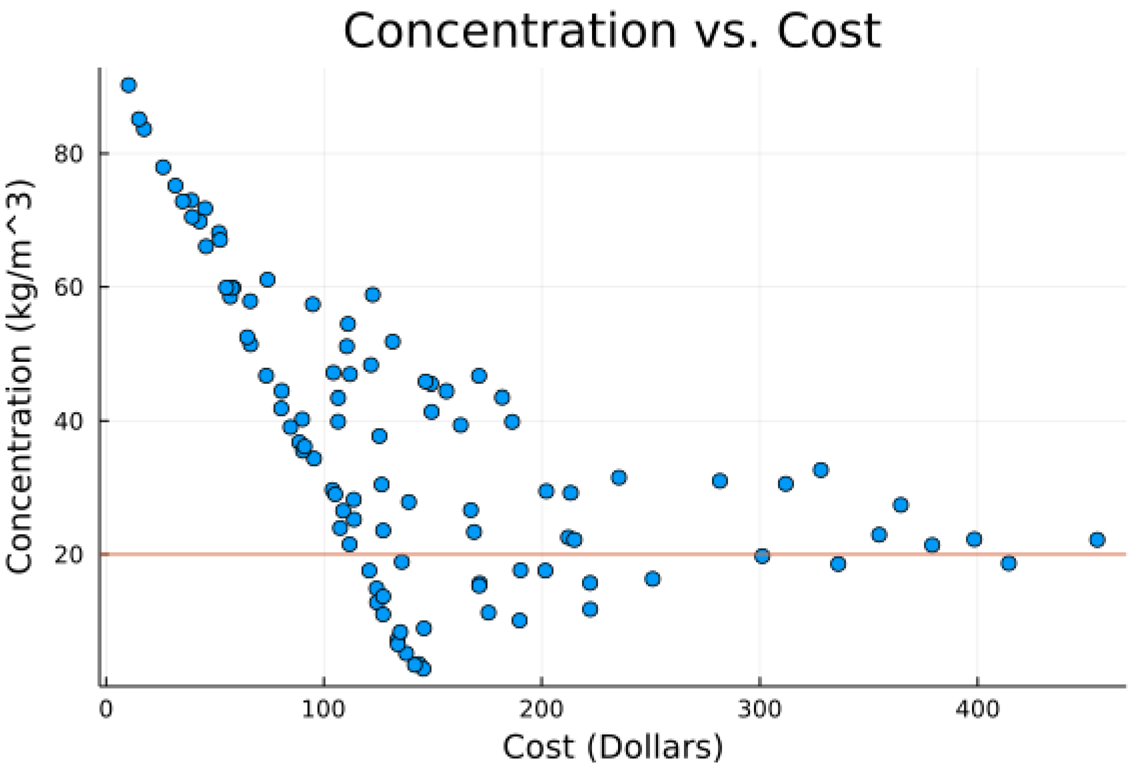
```
           c1 = x1*0.2
           c2 = x2*0.005
           c3 = x3
           cf = c1 + c2 + c3

           cost = ((x1^2)/20) + (1.5*x2)
           return cost, cf

       end
model (generic function with 1 method)
```

Problem 1.4

```
julia> using Distributions

julia> using Plots

julia> #X = cost, y = concentration


       x = []
Any[]

julia> y = []
Any[]

julia> for k in 1:100
           values = rand(Dirichlet(3,1)) * 100
           cost_val, conc = model(values[1],values[2],values[3])
           append!(x,cost_val); append!(y,conc)

       end

julia> scatter(x,y,legend=false,xlabel="Cost (Dollars)" ,ylabel="Concentration (kg/m^3)",plot_title="Concentration vs. Cost" )
```




```
julia> hline!([20])
```



From the plot above we can see that the cost for treatment that meets the standard (under 20 $\frac{kg}{m^3}$ 0 is generally at least 100 dollars.

Problem 1.5

I would select a treatment plan that meets the criteria while minimizing the cost. This would mean I would be looking for points below the horiziontal line and as far to the left as possible. This plan could reflect the interests of different parties because of the fact that it considers both cost and YUK concentration. Factory owners may want to maximize profit and look forward to barely meeting the treatment standards if it means a lower price. On the other hand, environmental and public agencies may be fine with not optimizing price in favor of lowering pollution concentration as much as possible (similar to the public). The plot in problem 1.4 presents both of these scenarios, as well as ones where they overlap.

0

The design from problem 1.4 sought to use a variety of combinations. However, this is restricted because it only has 100 data points. A design model that uses preset combinations of x1, x2, and x3 would also be restricted, but its data points would be static and allow for consistent analysis. Overall, I think that the numerical setup from the previous problem allowed me to properly analyze the correlation between cost and concentration so that a reasonable decision could be made. A different experimental design may have changed the outcome only slightly since the values for how much flow is going into each treatment plant was effectively selected at random with certain constaints.

Problem 1.6

The model can be improved by adding more detail. One example of this could be investigating the YUK pollutants reactions in the environment. Perhaps the YUK compound has a decay rate that makes method 3 (no treatment) more viable than it really seems. One assumption was that the system was closed. It is possible that some of the wastewater is lost to the environment, altering the volume of flow and concentration of YUK that ultimately ends up in the stream. These results only apply to a perfectly closed system without reaction of YUK in the environment.

0

References

Stackoverflow and juliadiscourse forums
