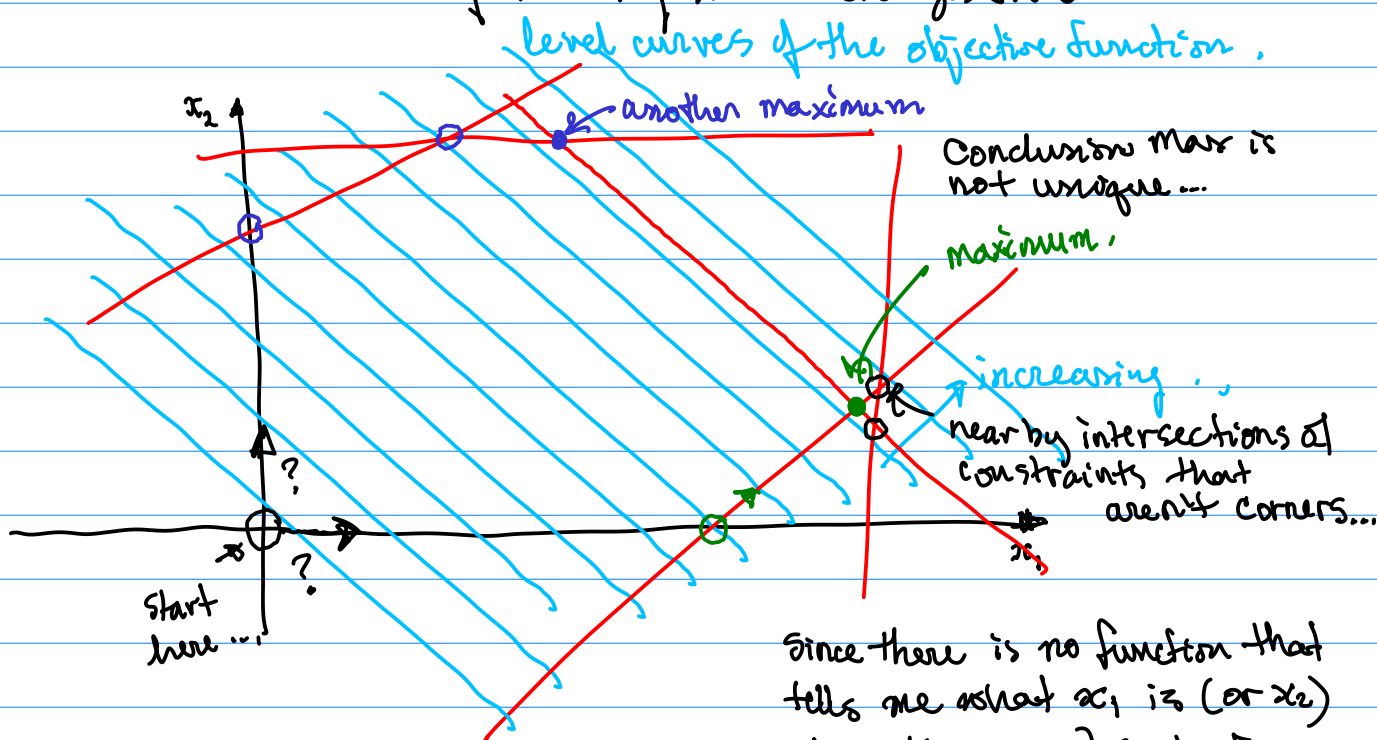


Quiz 4 extended deadline March 2.

Hints: • Since problem is nonlinear use Newton's method to solve for the derivative equal zero to find the optimal time

• Use implicit differentiation to find the sensitivity or the idea of making small changes from the text.



since there is no function that tells me what x_1 is (or x_2) then it's impossible to find

$$\frac{dx_1}{d?} \leftarrow \text{other modeling parameter...}$$

So $S(y, ?)$ is okay.

but $S(x_1, ?)$ is a problem in this case...

on the other hand the max itself is unique and well defined so

$$\frac{dy}{d?}$$

makes sense...

```
using JuMP
using HiGHS
```

```
y(x1,x2,x3)=400*x1+200*x2+250*x3
l(x1,x2,x3)=0.8*x1+0.2*x2+0.3*x3
w(x1,x2,x3)=3.0*x1+1.0*x2+1.5*x3
a(x1,x2,x3)=x1+x2+x3
```

```
model=Model(HiGHS.Optimizer)
@variable(model,x1>=0)
@variable(model,x2>=0)
@variable(model,x3>=0)
@objective(model,Max,y(x1,x2,x3))
@constraint(model,c1,l(x1,x2,x3)<=300)
@constraint(model,c2,w(x1,x2,x3)<=1000)
@constraint(model,c3,a(x1,x2,x3)<=625)
print(model)
```

```
optimize!(model)
```

```
julia> objective_value(model)
162500.0
```

```
julia> myx1=value(x1)
41.666666666666664
```

```
julia> myx2=value(x2)
0.0
```

```
julia> myx3=value(x3)
583.3333333333334
```

```
julia> myX=[myx1,myx2,myx3]
3-element Vector{Float64}:
 41.666666666666664
  0.0
 583.3333333333334
```

```
julia> bookX=[187.5,437.5,0.0]
3-element Vector{Float64}:
 187.5
 437.5
  0.0
```

```
julia> y(myX...)
162500.0
```

```
julia> y(bookX...)
162500.0
```

```

julia> X(theta)=theta*myX+(1-theta)*bookX
X (generic function with 1 method)

julia> X(0.5)
3-element Vector{Float64}:
 114.58333333333333
 218.75
 291.6666666666667

julia> y(X(0.5)...)
162500.0

julia> X(0.25)
3-element Vector{Float64}:
 151.04166666666666
 328.125
 145.83333333333334

julia> y(X(0.25)...)
162500.0

```

interpolate between the two planting plans and the yield is the same along the line connecting the two maximums...

Example 3.5. A large construction firm is currently excavating at three sites. Meanwhile, they are also building at four additional sites, where they require fill dirt. The excavations at sites 1, 2, and 3 produce 150, 400, and 325 cubic yards of dirt per day. The building sites A, B, C, and D require 175, 125, 225, and 450 cubic yards of dirt per day. Additional fill dirt can also be obtained from site 4 at a cost of 5 dollars per cubic yard. The cost of shipping fill dirt is about 20 dollars per mile for one truckload, and a truck carries 10 cubic yards of dirt. Table 3.3 gives the distance between sites in miles. Find the transportation plan that minimizes the cost to the company.

Excavation site	Site to receive fill dirt			
	A	B	C	D
1	5	2	6	10
2	4	5	7	5
3	7	6	4	4
4	9	10	6	2

distances between excavation and fill sites...

age data for the dirt problem of Example 3.5

```
julia> D=[5 2 6 10;
          4 5 7 5;
          7 6 4 4;
          9 10 6 2]
```

← distance matrix

Excavation

```
4×4 Matrix{Int64}:
```

```
1  5  2  6 10
```

```
2  4  5  7  5
```

```
3  7  6  4  4
```

```
4  9 10  6  2
```

A B C D

All site

c_{ij} = cost of shipping dirt from site i to site j (\$/cubic yard)

d_{ij} = distance from site i to site j (miles)

```
julia> C=2*D
```

```
4×4 Matrix{Int64}:
```

```
10  4 12 20
```

```
 8 10 14 10
```

```
14 12  8  8
```

```
18 20 12  4
```

Cost is 2D

```
julia> C[4,:].+=5
```

```
4-element view(::Matrix{Int64}, 4, :)
```

```
23
```

```
25
```

```
17
```

```
 9
```

← add in additional cost for the extra dirt

```
julia> C
```

```
4×4 Matrix{Int64}:
```

```
10  4 12 20
```

```
 8 10 14 10
```

```
14 12  8  8
```

```
23 25 17  9
```

Note: in the Pluto environment it is not allowed to change an existing variable like this because it is tracking dependencies..

we'll use Pluto next time and see how to get around this...