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sandipan_dey >

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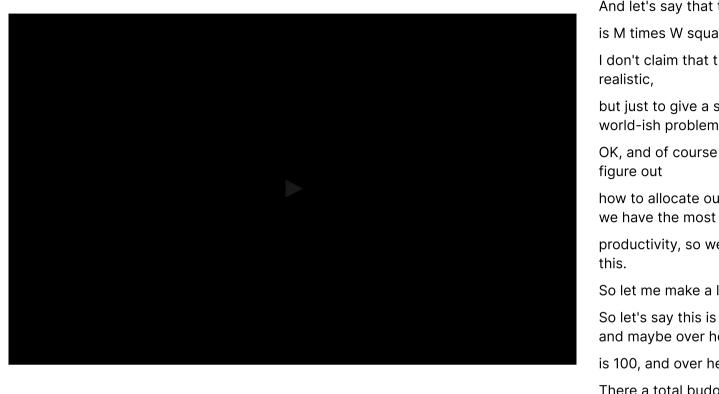
4. Review constrained optimization

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Review

Poll solution, and constrained optimization example



want to spend on machines.

And let's say that the productivity

is M times W squared.

I don't claim that that's actually very

but just to give a sense of a real world-ish problem.

OK, and of course our goal is to

how to allocate our budget so that

productivity, so we want to maximize

So let me make a little picture.

So let's say this is M and this is W, and maybe over here

is 100, and over here is 100.

There a total budget of 100, so our available options

look like that, it's supposed to be a ctraight ling

Video

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6:26 / 6:26

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"

CC

If C is a curve we can describe as the level curve of a function $g\left(x,y
ight)$, and $f\left(x,y
ight)$ is another function that we want to maximize along C, the the maximum occurs where the gradient of f is a multiple of the gradient of g:

$$abla f = \lambda
abla g.$$

▶ 2.0x

Something that can be confusing is understanding which function plays what role. Let's look at an example.

Economics problem

O points possible (ungraded) Suppose we have a factory.

$$W = \text{budget for workers}$$
 (7.52)

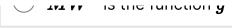
$$M = \text{budget for machines}$$
 (7.53)

We have a total budget of 100. And both M>0 and W>0.

Our goal is to maximize the **productivity** of our factory, which is measured as MW^2 .

In our framework, is MW^2 the function f or the function g?

 $igodelightarrow MW^2$ is the function f



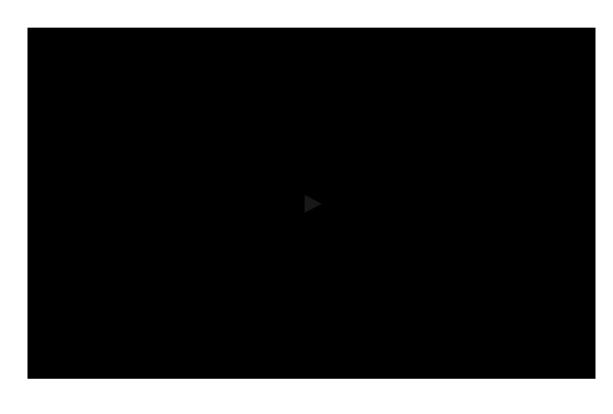


The productivity is the function that we want to maximize, thus it plays the role of the function f in our Lagrange multiplier method.

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1 Answers are displayed within the problem

Question solution



And we're trying to maximize it.

And we're only allowed to choose points on this curve.

Follow-up question, what should be g in this problem?

Is it M times W, or M plus W, or just M?

Thumbs up for M times W, M plus W, that's right.

So what is our constraint?

Our constraint is that our total budget is M plus W.

So this is our curve, and it's a level curve at M plus W, cool.

So hopefully, thinking about a situation like that

will help think of the role of f, and the role of g,

and not get confused between them.



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Find the solution

0 points possible (ungraded)

Our constraint is M+W=100. So the function $g\left(x,y\right) =M+W$.

Find the budget for workers and machines that optimizes the productivity.

$$M = \begin{bmatrix} 100/3 & \text{Answer: } 33.33333 \\ W = \begin{bmatrix} 200/3 & \text{Answer: } 66.6666 \end{bmatrix}$$

Solution:

So let's solve this problem. At the optimal point (M_0,W_0) , we will have



We get the following system:

$$W_0^2 = \lambda \tag{7.57}$$

$$2M_0W_0 = \lambda \tag{7.58}$$

Thus we get $W_0^2=2M_0W_0$. This tells us that $W_0=0$ or $W_0=2M_0$. Let's compare the value of the productivity function in each case.

- If $W_0=0$, then $M_0=100$, and $W_0M_0^2=0$.
- If $W_0=2M_0$, then $W_0+M_0=3M_0=100$, so $M_0=331/3$ and $W_0=662/3$. Thus the productivity is $M_0W_0^2=(33\,1/3)\,(67\,2/3)^2>0$, thus this is the maximum.
- We should also check the boundary M=0 and W=0, but the productivity is equal to zero there, thus the productivity will not achieve the maximum along the boundary.

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Answers are displayed within the problem

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7. [Staff] Typo in solution to finding W and M Solution states that M=331/3 and M=662/3, but it is wrong

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