Challenge February 2025
Mr Bates vs The Post Office

A solution with OPL CPLEX by Alex Fleischer
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CPLEX is available within IBM AI platform watsonx.AI
And OPL is a high level modeling language for CPLEX

Let me first address

"Your e-commerce client Mr. Bates sells large comforters of 9,000 cubic inches in volume and wants to make use of this new flat rate if possible. Can you design a box that will be large enough to hold these comforters and that can be sent at a flat rate price?"

```
using CP;

// sizes from larger to smaller
dvar int+ a;
dvar int+ b;
dvar int+ c;

// The "strap measure" of a box is the length of the longest side
// plus two times the sum of the two shorter sides.
dexpr int strap=a+2*(b+c);

subject to
{
  a>=b;
  b>=c;
  // Volume
  a*b*c==9000;
  strap<=100;
}
```

Which gives

Name	Value
Decision variables (3)	
a	40
b	15
c	15
Decision expressions (1)	
strap	100

So yes we can help Mr Bates. Now let's try the original challenge that was maximizing the volume:
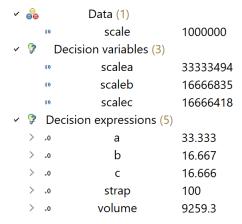
```
using CP;

// sizes from larger to smaller
dvar int+ a;
dvar int+ b;
dvar int+ c;

// The "strap measure" of a box is the length of the longest side
// plus two times the sum of the two shorter sides.
dexpr int strap=a+2*(b+c);
dexpr int volume=a*b*c;
maximize volume;
subject to
{
  a>=b;
  b>=c;

  strap<=100;
}
```

Which gives

Name	Value
∨ ⬦ Decision variables (3)	
⫶⊙ a	34
⫶⊙ b	17
⫶⊙ c	16
∨ ⬦ Decision expressions (2)	
› ⊙ strap	100
› ⊙ volume	9248

Could we do even better if we allow the sizes to be not integer

```
using CP;

execute
{
  cp.param.timelimit=60;
}

 int scale = 1000000;

// sizes from larger to smaller
dvar int+ scalea;
dvar int+ scaleb;
dvar int+ scalec;

dexpr float a=scalea/scale;
dexpr float b=scaleb/scale;
dexpr float c=scalec/scale;

// The "strap measure" of a box is the length of the longest side
// plus two times the sum of the two shorter sides.
dexpr float strap=a+2*(b+c);
dexpr float volume=a*b*c;
maximize volume;
subject to
{
  a>=b;
  b>=c;

  strap<=100;
}
```

Which gives

✓	Data (1)	
	scale	1000000
✓	Decision variables (3)	
	scalea	33333494
	scaleb	16666835
	scalec	16666418
✓	Decision expressions (5)	
>	a	33.333
>	b	16.667
>	c	16.666
>	strap	100
>	volume	9259.3

Many post office rely on optimization and IBM CPLEX to make more profit and I was happy to help Mr Bates to have a small revenge!