

### **Restricting a Variable to Belong to a Set**

You want to enforce that a variable  $y$  belong to a finite set of specified values, say

$\{1, 2.5, 4.7, 1337.88\}$ .

Model this restriction using IP techniques.

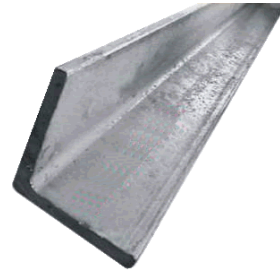
You want to enforce that a variable  $y$  be a nonnegative *even integer*. Model this using IP techniques.

You want to enforce that a variable  $y$  be an integer between 0 and 1000. However, your IP solver does not support general integer variables—but it can handle binary variables. However, you have the student version which only allows 10 binary variables. Can you model this restriction?

## **Cutting stock problems**

Adrian (IE&M, 2011) encountered this problem at his job:

*“Our objective is to find the minimum quantity of raw materials (in this case, angle iron) needed for a product, given two pre-defined input lengths that may be procured. We have a defined output of required quantities and cut lengths that make up the product. Aside from the length, all pieces of angle used in this product are the same dimensions and material.”*



This is an example of a *cutting stock* problem. In these problems, the task is to cut standard-sized pieces of stock material, such as paper rolls or sheet metal, into pieces of specified sizes while minimizing the amount of wasted material.

### **Example**

Suppose the angle iron that Adrian buys comes in 100” or 70” length, and he needs:

- 97 finals of length 45”
- 610 finals of length 36”
- 395 finals of length 31”.

Formulate an IP that meets production needs and minimizes the total length of angle iron bought.