

# Linear Programming

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## Background

Linear programming involves minimizing linear cost functions subject to linear inequality constraints.

### Illustration:

To illustrate, consider a classic portfolio analysis problem: bonds generate 5% returns, stocks generate 8% returns. The total budget is \$1000. How much of each asset should be bought?

We can translate this problem into a linear programming problem:

$$\max 5b + 8s : b + s \leq 1000, b \geq 0, s \geq 0$$

where  $b, s$  respectively are the amount (in dollars) invested in bonds and stocks.

Any combination of bonds and stocks that satisfies the inequalities:  $b, s \geq 0$  and  $b + s \leq 1000$  is *feasible*. In the problem above, the feasible region is the following triangular region:

```
b <- 0:1000
s <- 1000 - b

ggplot(data.frame(cbind(b, s)), aes(b, s)) +
  geom_line() +
  geom_vline(xintercept = 0) + #vertical line
  geom_hline(yintercept = 0) #horizontal line
```

