Group 5

# Goal Programing Overview

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# Goal Programming

- Simple linear programming, in stages
- Goals are determined on priority
- Higher priority handled first
- Lower priority handled while keeping prior goals satisfied

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- Rather than just set equivalency goals, goal programming:
  - Sets goals and then tries to minimize how far above and below that the solution is
  - Is done through multiple iterations, or through weighted objective function
  - Minimizes resources used
  - Is easily changed if goal priorities change

# Chapter 14 Example

Conceptual Products is a computer company that produces the  CP400 and CP500 computers. Many of the components used in the two computer models are produced in abundant supply by the company. However, the memory modules, external hard drives, and cases are bought from suppliers. The CP400 model uses two memory modules and no external hard drive, whereas the CP500 uses one memory module and one external hard drive. Both models use one case.

# Constraints

Suppliers can provide Conceptual Products with 1000 memory modules, 500 external hard drives, and 600 cases on a weekly basis.  It takes one hour to manufacture a CP400 and its profit is $200 and it takes one and one-half hours to manufacture a CP500 and its profit is $500.

# Listed Goals (In order of Priority)

1. Meet a state contract of 200 CP400 machines weekly.
2. Make at least 500 total computers weekly.
3. Make at least $250,000 weekly.
4. Use no more than 400 man-hours per week.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | solver 1 | | | | | | | | | | | |
| 3 | | x1 | x2 | d1- | d1+ | d2- | d2+ | d3- | d3+ | d4- | d4+ | |
| 4 | | 2 | 1 | | | | | | | | | 1000 |
| 5 | | | 1 | | | | | | | | | 500 |
| 6 | | 1 | 1 | | | | | | | | | 600 |
| 7 | | 1 | | 1 | -1 | | | | | | | 200 |
| 8 | | 1 | 1 | | | 1 | -1 | | | | | 500 |
| 9 | | 0.2 | 0.5 | | | | | 1 | -1 | | | 250 |
| 10 | | 1 | 1.5 | | | | | | | 1 | -1 | 400 |
| 11 | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | |
| 13 | solution | 200 | 400 | 0 | 0 | 0 | 100 | 10 | 0 | 0 | 400 | |
| 14 | | | | | | | | | | | | |
| 15 | OF | 0 | | | | | | | | | | |
| 16 | | | | | | | | | | | | |
| 17 | Restraints | 800 | <= | 1000 | | | | | | | | |
| 18 | | 400 | <= | 500 | | | | | | | | |
| 19 | | 600 | <= | 600 | | | | | | | | |
| 20 | | 200 | = | 200 | | | | | | | | |
| 21 | | 500 | = | 500 | | | | | | | | |
| 22 | | 250 | = | 250 | | | | | | | | |
| 23 | | 400 | = | 400 | | | | | | | | |

# Iteration 2

Sets a value for goal 1, now seeks goal 2

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| solution | 200 | 400 | 0 | 0 | 0 | 100 | 10 | 0 | 0 | 400 |
| | | | | | | | | | | |
| OF | 0 | | | | | | | | | |
| | | | | | | | | | | |
| Restraints | 800 | <= | 1000 | | | | | | | |
| | 400 | <= | 500 | | | | | | | |
| | 600 | <= | 600 | | | | | | | |
| | 200 | = | 200 | | | | | | | |
| | 500 | = | 500 | | | | | | | |
| | 250 | = | 250 | | | | | | | |
| | 400 | = | 400 | | | | | | | |
| | 0 | = | 0 | | | | | | | |
| | | | | | | | | | | |

# Iteration 3

Keeps goal 1 value, sets goal 2, seeks goal 3

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| solution | 200 | 400 | 0 | 0 | 0 | 100 | 10 | 0 | 0 | 400 |
| | | | | | | | | | | |
| OF | 10 | | | | | | | | | |
| | | | | | | | | | | |
| Restraints | 800 | <= | 1000 | | | | | | | |
| | 400 | <= | 500 | | | | | | | |
| | 600 | <= | 600 | | | | | | | |
| | 200 | = | 200 | | | | | | | |
| | 500 | = | 500 | | | | | | | |
| | 250 | = | 250 | | | | | | | |
| | 400 | = | 400 | | | | | | | |
| | 0 | = | 0 | | | | | | | |
| | 0 | = | 0 | | | | | | | |

# Iteration 4

Keeps goals 1 & 2 values, sets goal 3, seeks goal 4

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| solution | 200 | 400 | 0 | 0 | 0 | 100 | 10 | 0 | 0 | 400 |
| | | | | | | | | | | |
| OF | 400 | | | | | | | | | |
| | | | | | | | | | | |
| Restraints | 800 | <= | 1000 | | | | | | | |
| | 400 | <= | 500 | | | | | | | |
| | 600 | <= | 600 | | | | | | | |
| | 200 | = | 200 | | | | | | | |
| | 500 | = | 500 | | | | | | | |
| | 250 | = | 250 | | | | | | | |
| | 400 | = | 400 | | | | | | | |
| | 0 | = | 0 | | | | | | | |
| | 0 | = | 0 | | | | | | | |
| | 10 | = | 10 | | | | | | | |

# Final Solution

**Microsoft Excel 15.0 Answer Report**
**Worksheet: [Book1]Sheet1 (4)**
**Report Created: 4/17/2014 3:46:18 PM**
**Result: Solver found a solution. All Constraints and optimality conditions are satisfied.**
**Solver Engine**
Engine: Simplex LP
Solution Time: 0.016 Seconds.
Iterations: 8 Subproblems: 0
**Solver Options**
Max Time Unlimited, Iterations Unlimited, Precision 0.000001, Use Automatic Scaling
Max Subproblems Unlimited, Max Integer Sols Unlimited, Integer Tolerance 1%, Assume NonNegative

Objective Cell (Min)

| Cell | Name | Original Value | Final Value |
|---|---|---|---|
| $B$15 | OF x1 | 400 | 400 |

Variable Cells

| Cell | Name | Original Value | Final Value | Integer |
|---|---|---|---|---|
| $B$13 | solution x1 | 200 | 200 | Contin |
| $C$13 | solution x2 | 400 | 400 | Contin |
| $D$13 | solution d1- | 0 | 0 | Contin |
| $E$13 | solution d1+ | 0 | 0 | Contin |
| $F$13 | solution d2- | 0 | 0 | Contin |
| $G$13 | solution d2+ | 100 | 100 | Contin |
| $H$13 | solution d3- | 10 | 10 | Contin |
| $I$13 | solution d3+ | 0 | 0 | Contin |
| $J$13 | solution d4- | 0 | 0 | Contin |
| $K$13 | solution d4+ | 400 | 400 | Contin |

Constraints

| Cell | Name | Cell Value | Formula | Status | Slack |
|---|---|---|---|---|---|
| $B$17 | Restraints x1 | 800 | $B$17<=$D$17 | Not Binding | 200 |
| $B$18 | x1 | 400 | $B$18<=$D$18 | Not Binding | 100 |
| $B$19 | x1 | 600 | $B$19<=$D$19 | Binding | 0 |
| $B$20 | x1 | 200 | $B$20=$D$20 | Binding | 0 |
| $B$21 | x1 | 500 | $B$21=$D$21 | Binding | 0 |
| $B$22 | x1 | 250 | $B$22=$D$22 | Binding | 0 |
| $B$23 | x1 | 400 | $B$23=$D$23 | Binding | 0 |
| $B$24 | x1 | 0 | $B$24=$D$24 | Binding | 0 |
| $B$25 | x1 | 0 | $B$25=$D$25 | Binding | 0 |
| $B$26 | x1 | 10 | $B$26=$D$26 | Binding | 0 |

# Iteration 3 becomes 1

Still fits all constraints, but OF now 0 rather than 10

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| solution | 166.6667 | 433.3333 | 33.33333 | 0 | 0 | 100 | 0 | 0 | 0 | 416.6667 |
| | | | | | | | | | | |
| OF | 0 | | | | | | | | | |
| | | | | | | | | | | |
| Restraints | 766.6667 | <= | 1000 | | | | | | | |
| | 433.3333 | <= | 500 | | | | | | | |
| | 600 | <= | 600 | | | | | | | |
| | 200 | = | 200 | | | | | | | |
| | 500 | = | 500 | | | | | | | |
| | 250 | = | 250 | | | | | | | |
| | 400 | = | 400 | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |