Metaheuristic Projects

– What would you like to do ?

Thomas Stidsen

thst@man.dtu.dk

DTU-Management

Technical University of Denmark

DTU

Outline

- Set Cover
- Quadratic Knapsack Problem
- Open Shop
- Cutting Stock
- Turbine Balancing Problem
- TSP problem
- Your own optimization problem ....

Set Cover Problem

- Given a set of elements, a set of sub-sets, cover the elements in the set.
- Each element has a corresponding row.
- Each set has a positive price ...

Formulation

objective: minimise

$$\sum_i c_i \cdot x_i$$

s.t.

$$\sum_i a_i^j \cdot x_i \geq 1 \qquad \forall j$$

$$x_i \in \{0, 1\}$$

Data and Inspiration

- Data: “http://people.brunel.ac.uk/ mas-tjjb/jeb/orlib/scpinfo.html”
- Inspiration: “A genetic algorithm for the set covering problem” J.E. Beasley & P.E. Chu
- ... and many others ...

Quadratic Knapsack Problem

A more complex version of the knapsack problem ...

- Still only one constraint (which is good, constraints are difficult to handle ...)
- ... but a quadratic objective ...

Formulation

objective: maximize

$$\sum_{i,j} p_{ij} \cdot x_i \cdot x_j$$

s.t.

$$\sum_{j} w_j \cdot x_j \leq c$$

$$x_i \in \{0, 1\}$$

Data and Inspiration

- “http://www.diku.dk/ pisinger/heuristics/”
- Inspiration ? I could not find any metaheuristics for the problem ...

Open Shop

Given a number of jobs (items ...) and a set of machines:

- Each job needs to be performed on each machine
- For each job and each machine there is a processing time ...
- Minimize the time required before ALL the jobs have been performed

Data and Inspiration

- “http://ina.eivd.ch/Collaborateurs/etd/problemes.dir/ordonnancement.dir/ordonnancement.html”
- “Benchmarks for basic scheduling problems”, E. Taillard (I will have that article in a couple of days ...)
- “A tabu search algorithm for the open shop scheduling problem”, C-F. Liaw

Cutting Stock

Assume you own a sawmill:

- You receive logs of one size ...
- You receive customer orders of many different (smaller) sizes ....
- Satisfy the customer demand with as few log's as possible ...

1. Version

You have no further information ...

1. Version formulation

objective: minimise

$$\sum_j y_j$$

s.t.

$$\sum_j x_{i,j} \geq D_i \quad \forall i$$

$$\sum_i L_i \cdot x_{i,j} \leq L \cdot y_j \quad \forall j$$

$$x_i \in N_0, y_i \in \{0,1\}$$

2. Version

You have cutting patterns (and a lowerbound):

- Select which cutting patterns and how many to use in order to satisfy customers
- A somewhat more complex version of set-cover
  ...

The cutting patterns and lowerbound comes from a column generation algorithm (more on that later in course)

Formulation

objective: minimise

$$\sum_j x_j$$

s.t.

$$\sum_j a_{i,j} \cdot x_j \geq D_i \quad \forall i$$

$$x_i \in N_0, a_{i,j}, D_i \in N_0$$

Data

- Generated by GAMS program CuttingStock.gms
- Also generates lower bounds !

Turbine Balancing

Given a turbine, the center of mass should coincide or be as close as possible to the geometric center.

- The blades have different masses ....
- Where to put the blades ?

Formulation

objective: minimise

$$\sum_i \sum_j \sum_k \sum_l M_i M_k \cdot cos(\theta_j - \theta_l) x_{ij} x_{kil}$$

s.t.

$$\sum_i x_{ij} = 1 \quad \forall j$$

$$\sum_j x_{ij} = 1 \quad \forall i$$

$$x_{ij} \in \{0, 1\}$$

Data

We do not have access to data for the problem, but a description of how they should be generated: “Balancing hydraulic turbine runners: A quadratic assignment problem”, G. Laporte & H. Mercure

TSP

You can do TSP as a problem, but:

- TSP is very well researched ...
- ... so don't expect to get world class performance ...
- Be inspired by others .... best material: D.S. Johnson and L.A. McGeoch ...
- Data from TSPLIB

Your Own Problem !

I will be **happy** if any of you decide to work on your own problem ...