Discrete Optimization

Assignments: Knapsack

The Knapsack Problem

The Knapsack Problem

- *n* Items
- Value V_i
- Weight W_i
- X_i take item *i*

$$\text{maximize:} \quad \sum_{i \in 1 \ldots n} v_i x_i$$

$$\text{subject to:} \quad \sum_{i \in 1 \ldots n} w_i x_i \leq K$$

$$x_i \in \{0, 1\} \quad (i \in 1 \ldots n)$$

I/O Format

$$\text{maximize:} \quad \sum_{i \in 1 \ldots n} v_i x_i$$

$$\text{subject to:} \quad \sum_{i \in 1 \ldots n} w_i x_i \leq K$$

$$x_i \in \{0, 1\} \quad (i \in 1 \ldots n)$$

Input

```
n K
v_1 w_1
v_2 w_2
...
v_n w_n
```

Output

```
obj opt
x_1 x_2 x_3 ... x_n
```

An Example

$$\text{maximize:} \quad \sum_{i \in 1 \ldots n} v_i x_i$$

$$\text{subject to:}$$

$$\sum_{i \in 1 \ldots n} w_i x_i \leq K$$

$$x_i \in \{0, 1\} \quad (i \in 1 \ldots n)$$

Input

```
4 11
8 4
10 5
15 8
4 3
```

Output

```
19 0
0 0 1 1
```

Implementing Your solver.py

```
import os

def solveIt(inputData):
    ### Modify this code to run your optimization algorithm
    lines = inputData.split('\n')

    ...

    outputData = str(value)+' '+str(0)+'\n'
    outputData += ' '.join(map(str,taken))
    return outputData
```

Input

```
4 11
8 4
10 5
15 8
4 3
```

Output

```
19 0
0 0 1 1
```

Implementing an External Solver

solverJava.py

```
def solveIt(inputData):
    tmpFileName = 'tmp.data'
    tmpFile = open(tmpFileName,'w')
    tmpFile.write(inputData)
    ...
    ### Runs the command: java Solver -file=tmp.data
    process = Popen(['java','Solver','-file='+tmpFileName], stdout=PIPE)
    (stdout, stderr) = process.communicate()
    ...
    return stdout.strip()
```

Solver.java

```
class Solver {
    public static void main(String[] args) {
        new Solver().run(args);
    }
    public void run(String[] args) {
        ...
        System.out.println(value+" 0");
        for(int i=0; i < items; i++){
            System.out.print(taken[i]+" ");
        }
        System.out.println("");
    }
}
```

Testing Your Solver

```
> python solver.py ./data/ks_4_0
18 0
1 1 0 0

>
```

Grading Your Solver

```
> python submit.pyc
==
== Knapsack Solution Submission
==
Login (Email address):
Submission Password (from the programming assignments page.
This is NOT your own account's password):

== Connecting to Coursera ...
Hello! These are the assignment parts that you can submit:
1) Knapsack Problem 1
2) Knapsack Problem 2
3) Knapsack Problem 3
4) Knapsack Problem 4
5) Knapsack Problem 5
6) Knapsack Problem 6
0) All
Please enter which part(s) you want to submit (0-6):
```

Grading Your Solver

```
== Connecting to Coursera ...
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4) Knapsack Problem 4
5) Knapsack Problem 5
6) Knapsack Problem 6
0) All
Please enter which part(s) you want to submit (0-6):
```

```
Please enter which part(s) you want to submit (0-6): 3
```

```
Please enter which part(s) you want to submit (0-6): 0
```

```
Please enter which part(s) you want to submit (0-6): 4, 6
```

Assignment Tips

- Dynamic Program
  - How much space do you need?

- Branch and Bound
  - What is the fastest way to calculate the relaxation value?

Have Fun!

Citations

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