Labwork 5

Linear programming

Exercise 1

Suppose that a gas-processing plant receives a fixed amount of raw gas each week. The raw gas is processed into two grades of heating gas, regular and premium quality. These grades of gas are in high demand (that is, they are guaranteed to sell) and yield different profits to the company. However, their production involves both time and on-site storage constraints. For example, only one of the grades can be produced at a time, and the facility is open for only 80 hr/week. Further, there is limited on-site storage for each of the products. All these factors are listed below (note that a metric ton, or tonne, is equal to 1000 kg):

	Product		
Resource	Regular	Premium	Resource Availability
Raw gas	7 m³/tonne	11 m³/tonne	77 m³/week
Production time	10 hr/tonne	8 hr/tonne	80 hr/week
Storage	9 tonnes	6 tonnes	
Profit	150/tonne	175/tonne	

a. Develop a linear programming formulation to maximize the profits for this operation.
b. Minimization of the problem above using function: *linprog* in Matlab
c. Demonstrate the feasible solution space using the graphical solution of a linear programming problem.
   Hint: use linspace and meshgrid and plot

Numerical Integration

Exercise 2

$$f(x) = 0.2 + 25x - 200x^2 + 675x^3 - 900x^4 + 400x^5$$

a. Use Matlab *trapz* function to estimate the integral above from 0 to 0.8
b. Use the trapezoidal function in Matlab, *cumtrapz*. Compare the difference between two functions
c. Use the simpson function in Matlab, *quad*
d. Use the quadrature function

```
function q = quadadapt(f,a,b,tol,varargin)
% Evaluates definite integral of f(x) from a to b
if nargin < 4 || isempty(tol),tol = 1.e-6;end
c = (a + b)/2;
fa = feval(f,a,varargin{:});
fc = feval(f,c,varargin{:});
fb = feval(f,b,varargin{:});
```

```matlab
q = quadstep(f, a, b, tol, fa, fc, fb, varargin{:});
end
function q = quadstep(f,a,b,tol,fa,fc,fb,varargin)
% Recursive subfunction used by quadadapt.
h = b - a; c = (a + b)/2;
fd = feval(f,(a+c)/2,varargin{:});
fe = feval(f,(c+b)/2,varargin{:});
q1 = h/6 * (fa + 4*fc + fb);
q2 = h/12 * (fa + 4*fd + 2*fc + 4*fe + fb);
if abs(q2 - q1) <= tol
q = q2 + (q2 - q1)/15;
else
qa = quadstep(f, a, c, tol, fa, fd, fc, varargin{:});
qb = quadstep(f, c, b, tol, fc, fe, fb, varargin{:});
q = qa + qb;
end
end
```

Numerical differentiation

Exercise 3

$$f(x) = 0.2 + 25x - 200x^2 + 675x^3 - 900x^4 + 400x^5$$

a. Use Matlab *diff* function to differentiate the function $f(x)$ from
b. Comparison of the exact derivative with numerical estimates
c. Use forward function

```matlab
% y = vector containing function values
% x = vector containing increments
% p = point number where to calculate
% d = derivative of y at point p
function d = forward(y,x,p)
 d = (y(p+1)-y(p))/(x(p+1)-x(p));
end
```
d. Use backward function

```matlab
function d = backward(y,x,p)
 d = (y(p)-y(p-1))/(x(p)-x(p-1));
end
```
e. Use central function

```matlab
function d = central(y,x,p)
 d = (y(p+1)-y(p-1))/(x(p+1)-x(p-1));
end
```