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function [] = affiche_chemin(c,coords)
    n = length(c);
    n1 = n+1;
    plot([coords(1,n1) coords(1,c) coords(1,n1)], [coords(2,n1) coords(2,c) coord
s(2,n1)]);
    for i=1:n1
        text(coords(1,i),coords(2,i),int2str(i))
    end

function [l] = longueur_chemin(c,distances)
    l = 0; n = length(c);
    for i = 1:(n-1)
        l = l + distances(c(i),c(i+1));
    end
    l = l + distances(n+1,c(1)) + distances(c(n),n+1);
function [c,l0] = optim_marche(c,N,coords,distances)
    l0 = zeros(1,N);
    l = longueur_chemin(c,distances);
    for i = 1:N
        c1 = retourne(c);
        l1 = longueur_chemin(c1,distances);
        if l1 < l
            l = l1;
            c = c1;
        end
        l0(i) = l;
    end

function [c,l0] = optim_metropolis(c,N,beta,coords,distances)
    l = longueur_chemin(c,distances);
    l0 = zeros(1,N);
    for i = 1:N
        c1 = retourne(c);
        l1 = longueur_chemin(c1,distances);
        p = min(1,exp((l-l1)/beta));
        if rand() < p
            l = l1;
            c = c1;
        end
        l0(i) = l;
    end

function [c,l0] = optim_recuit(c,N,coords,distances)
    l = longueur_chemin(c,distances);
    beta = 0.05;
    l0 = zeros(1,N);
    for i = 1:N
        beta = beta * 0.997;
        c1 = retourne(c);
        l1 = longueur_chemin(c1,distances);
        p = min(1,exp((l-l1)/beta));
        if rand() < p
            l = l1;
            c = c1;
        end
        l0(i) = l;
    end

function [c] = rchemin(n)
    % Tire un chemin au hasard pour n clients
    c = 1:(n);
    for i=1:(n*3)

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        c = retourne(c);
    end
function [t] = retourne(a)
    n = length(a);
    i0 = ceil(rand()*n);
    j0 = ceil(rand()*n);
    i = min(i0,j0); j = max(i0,j0);
    masque = [1:(i-1) j:-1:i (j+1):n];
    t = a(masque);

function [x] = rmarkov(m,i,n)
    x = i;
    for i = 1:n
        x = rproba(m(x,:));
    end

function [x] = rproba(p)
    cdf = cumsum(p);
    u = rand();
    x = sum(u>cdf)+1;

function [coords,distances] = rprobleme(n)
    % Tire un problÃme alÃatoire
    n1 = n+1;
    coords = rand(2,n1);
    distances = zeros(n1,n1);
    for i = 1:n1
        for j = 1:n1
            distances(i,j) = sqrt(sum((coords(:,i)-coords(:,j)).^2));
        end
    end

function [r] = rpropp(m)
    % Simulation exacte de la loi invariante
    [n a] = size(m);
    r = cumsum(ones(1,n));
    while(sum(abs(r-r(1))) > 0)
        for i = 1:n
            temp(i) = r(rmarkov(m,i,1));
        end
        r = temp;
    end
    r = r(1);

% TP3 : ChaÃnes de Markov

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Algorithme de Propp et Wilson

% test de rproba
p = [0.2 0.4 0.3 0.1]
echantillon = zeros(1,1000);
for i = 1:1000
    echantillon(i) = rproba(p);
end
hist(echantillon)

% test de rmarkov
m = [0.9 0.05 0.05; 0.1 0.4 0.5; 0.1 0.5 0.4]

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echantillon = zeros(1,5000);
for i = 1:5000
    echantillon(i) = rmarkov(m,1,10);
end
hist(echantillon)

% test de rpropp
echantillon = zeros(1,10000);
for i = 1:10000
    echantillon(i) = rpropp(m);
end
loi_p = hist(echantillon,1:3)/10000

% Comparaisons
[a,b] = eig(m');
loi_invar = a(:,1)'/sum(a(:,1))
a = m^15;
loi_15 = a(1,:);
x=1:3;
plot(x,loi_invar,'b',x,loi_15,'r',x,loi_p,'c')
title('Comparaison des lois')
legend('Loi invariante', 'Loi aprÃs 15 itÃrations', 'Loi de Propp-Wilson')

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Voyageur de commerce

[coords distances] = rprobleme(30);
N = 2000

c0 = rchemin(15);
affiche_chemin(c0,coords);
title('Chemin alÃatoire');

[c1,l1] = optim_marche(c0,N,coords,distances);
affiche_chemin(c1,coords);
title('Chemin optimisÃ avec une marche dirigÃe');

[c2,l2] = optim_metropolis(c0,N,0.05,coords,distances);
affiche_chemin(c2,coords);
title('Chemin optimisÃ avec Metropolis');

[c3,l3] = optim_recuit(c0,N,coords,distances);
affiche_chemin(c3,coords);
title('Chemin optimisÃ avec Recuit');

plot(1:N,l1,'r',1:N,l2,'y',1:N,l3,'g')

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