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% C. Petersen, H. Werkle, Dynamik der Baukonstruktionen
% 2. Auflage, Springer Vieweg, Wiesbaden, 2018
%
% ML_34_1_Stochastik_1: Spektralanalyse (Mittelwert, Varianz,
% Autokorrelationsfunktion, Autoleistungsspektrum)
%
% Version 1.0, April 2018
% Softwareentwicklung:
% Andrei Firus, M.Eng (andrei.firus@gmail.com)
%
% Aufbau Eingabedatei:
%   - Spalte 1: Zeitvektor des Funktionsverlaufs [s]
%   - Spalte 2: Werte der zu analysierenden Zufallsfunktion
% ANMERKUNG: Dezimaltrennzeichen '.'

% Ausgabedateien:
% Outputdatei_1: Eingaben- und Ergebnisübersicht

%---------------------------- EINGABEBLOCK --------------------------------
% Einlesen des Funktionsverlaufs von der Eingabedatei und Generierung der
% entsprechenden Vektoren
Funktion=dlmread('Inputdatei_1.txt');
t_funk=Funktion(:,1);     % Zeitvektor
x=Funktion(:,2);          % Vektor der Funktionswerte
%------------------------------------------------------------------------
% Eingaben im Quellcode

m=64;                     % Anzahl der Intervalle bis zur maximalen
                          % Korrelationsweite

gamma=1;                  % bezogen auf die Nyquist-Frequenz: jener
                          % Frequenzbereich, für den das
                          % Autoleistungsspektrum berechnet werden soll
%------------------------------------------------------------------------

%--------------------------- BERECHNUNGSBLOCK -----------------------------
T=max(t_funk);  % Dauer der Funktion

% Ermittlung des Mittwertes der Zufallswerte
l=length(x);    % Anzahl der Funktionswerte
xq=sum(x)/l;    % Mittelwert

% Normierung der Funktionswerte auf den Mittelwert
for i=1:1:length(x)
    x(i)=x(i)-xq;
end

% Bestimmung der Varianz (für die auf Mittelwert normierten Daten)
z1=x.^2;        % Hilfsvektor
x2q=sum(z1)/l;  % Varianz

% Zeitschritt
dt=(max(t_funk)-min(t_funk))/(l-1);

% Nyquist-Frequenz
fc=1/(2*dt);
```

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% Definition der Vektoren für die Autokorrelationsfunktion
R=zeros(m,1);
tau=zeros(m,1);

% Berechnung der auf die Varianz normierte Autokorrelationsfunktion
for k=0:1:m
    tau(k+1)=dt*(k);
    z2=0;
    for i=1:1:l-k
        z2=z2+x(i)*x(i+k);
    end
    R(k+1)=(1/((l-k)*x2q))*z2;
end

% Auf die Varianz normiertes Autoleistungsspektrum
S=zeros(m+1,1);
for j=0:1:m
    z3=0;
    for k=1:1:m-1
        z3=z3+R(k+1)*cos(pi*gamma*k*j/m);
    end
    S(j+1)=(R(1)+2*z3+R(m+1)*cos(pi*gamma*j))*dt;
end

f=zeros(m+1,1);
for a=0:1:m
    f(a+1)=a*gamma*fc/m;
end
%--------------------------------------------------------------------------

%------------------------ DARSTELLUNGSBLOCK -----------------------------
% Grafische Darstellung der Ergebnisse
name_fig1 = 'Autoleistungsspektrum einer Zufallsfunktion';
fig1=figure('Name',name_fig1,'NumberTitle','off');
set(fig1,'Position',[1000 50 700 900]);

subplot(3,1,1)
plot(t_funk,x,'MarkerSize',3);
title('Zeitverlauf der Zufallsfunktion');
xlabel('Zeit [s]');
ylabel('x(t)');
grid on; zoom on;

subplot(3,1,2)
plot(tau,R,'-o','MarkerSize',3);
title('Normierte Autokorrelationsfunktion');
xlabel('Zeit [s]');
ylabel('R');
grid on; zoom on;

subplot(3,1,3)
plot(f,S,'-o','MarkerSize',3);
title('Normiertes Autoleistungsspektrum');
xlabel('Frequenz [Hz]');
ylabel('S');
grid on; zoom on;
```

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%--------------------------------------------------------------------------

%---------------------------- AUSGABEBLOCK --------------------------------
% Ausgabe der Ergebnisse in eine Datei
fid = fopen('Outputdatei_1_Allgemein.txt', 'w');
fprintf(fid,...
    '%s\n','C. Petersen, H. Werkle, Dynamik der Baukonstruktionen');
fprintf(fid,...
    '%s\n','2. Auflage, Springer Vieweg, Wiesbaden, 2018');
fprintf(fid,...
    '%s\n','Softwareentwicklung: Andrei Firus (andrei.firus@gmail.com)');
fprintf(fid,'%s\n','Programm ML_34_1: Eingaben- und Ergebnisuebersicht');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,...
    '%s\n','-----------------------------------------------------------');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,...
    '%s\n','EINGABEDATEN:');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Funktionsverlauf: s. Dateiende');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s %s\n','Anzahl der Intervalle bis zur maximalen',...
    'Korrelationsweite:');
fprintf(fid,'%d\n',m);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s %s\n%s\n','Frequenzbereich zur Berechnung des',...
    'Autoleistungsspektrums (bezogen auf','die Nyquistfrequenz):');
fprintf(fid,'%d\n',gamma);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,...
    '%s\n','-----------------------------------------------------------');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,...
    '%s\n','ERGEBNISSE:');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s \n','Anzahl der Funktionswerte:');
fprintf(fid,'%d\n',l);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Dauer der Funktion [s]:');
fprintf(fid,'%d\n',T);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Mittelwert:');
fprintf(fid,'%d\n',xq);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Zeitschrittweite [s]:');
fprintf(fid,'%d\n',dt);
fprintf(fid, '%s\n', ' ');
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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Nyquist-Frequenz [Hz]:');
fprintf(fid,'%d\n',fc);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Varianz:');
fprintf(fid,'%d\n',x2q);
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Autokorrelationsfunktion (normiert auf die Varianz):');
fprintf(fid,'%s \t %s\n','tau [s]','R');
for jj=1:1:length(tau)
    fprintf(fid,'%d \t %d\n',tau(jj),R(jj));
end
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Autoleistungsspektrum (normiert auf die Varianz):');
fprintf(fid,'%s \t %s\n','f [Hz]','S');
for jj=1:1:length(f)
    fprintf(fid,'%d \t %d\n',f(jj),S(jj));
end
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,'%s\n','Funktionsverlauf:');
fprintf(fid,'%s \t %s\n','t [s]','x(t)');
for jj=1:1:length(t_funk)
    fprintf(fid,'%d \t %d\n',t_funk(jj),x(jj)+xq);
end
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fprintf(fid,...
    '%s\n','------------------------------------------------------------');
fprintf(fid, '%s\n', ' ');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
fclose(fid);
%--------------------------------------------------------------------------
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