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% Tony Hyun Kim
% CS 224w: PS3, Problem 2
% clear all; close all;
function [alphac, alphad, alphae] = p2b()

% Part b: Generate a dataset of 100,000 values
%-------------------------------------------------------------
N = 1e5;
U = rand(N,1);

xmin = 1;
alpha = 2;

X = xmin*(1-U).^(-1/(alpha-1));

x = xmin:1:1e4;
[h, x] = hist(X,x);
sieve = h>0;
p = h(sieve)/N;
x = x(sieve);

% subplot(121);
% loglog(x,p,'.');
% % grid on;
% xlabel('x');
% ylabel('P(X=x)');
% hold on;

% Theoretical distribution
% p_cont = (alpha-1)/xmin*(x/xmin).^-alpha;
% plot(x,p_cont,'r--');

% Part c: Fit the histogram
%-------------------------------------------------------------
xc = x;
pc = p;

Pc = polyfit(log(xc),log(pc),1);
pc_cont = exp(polyval(Pc,log(xc)));
% plot(xc,pc_cont,'k-','Linewidth',2);

alphac = abs(Pc(1)); % Alpha estimated by linear fit to histogram

% Part d: Fit the CCDF
%-------------------------------------------------------------
ccdf = 1-cumsum(p);

% The last entry point is spurious
xd = x(1:end-1);
ccdf = ccdf(1:end-1);

% subplot(122);
% loglog(xd,ccdf,'.');
% xlabel('x');
% ylabel('CCDF');
% hold on;
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Pd = polyfit(log(xd),log(ccdf),1);
pd_cont = exp(polyval(Pd,log(xd)));
% plot(xd,pd_cont,'k-','Linewidth',2);

alphad = abs(Pd(1)-1); % Alpha estimated by linear fit to CCDF

% Part e: Use the MLE formula
%-------------------------------------------------------------
alphae = 1 + N/sum(log(X/xmin));
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