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% test least-squares on chronometer errors
%   Date   Chron fast   Diff
%   May  3     4.55     ----
%         5     14.00     9.45
%         8     24.90    20.35
%         9     29.25    24.70
%        12     41.40    36.85
%        14     49.50    44.95

% In days from the first observation
% days  error
%  2    9.45
%  5   20.35
%  6   24.70
%  9   36.85
% 11   44.95

% chron is fast this many seconds
chron0= [ 4.55 14.00 24.90 29.25 41.40 49.50];
dy= [ 3 5 8 9 12 14];

n= dy-dy(1);
n= n(2:end)';           % interval between measurements (days)
m= n(end);             % total number of days
M= [n n.*n./(2*m)]    %
% Error in chronometer in seconds
p= chron0'- chron0(1); p= p(2:end)

% equation to solve is M x = p
xx= inv(M'*M)*M'*p
str= sprintf('Base rate is %5.3f secs, changing %5.3f secs per %d days',...
    xx(1),xx(2),m);
disp(str)
str= sprintf('Rate on May 3rd %5.3f secs, on May 14th %5.3f\n',...
    xx(1),sum(xx)); disp(str);

disp('Estimated gain in secs/day of chronometer:')
pr= [xx(2) xx(1)];     % best fit params
rate= polyval(pr,n/m),

mean_chr= mean(chron0); % mean chron error (sec) over the interval
mean_dy= mean(dy)-dy(1); % days from the start of the interval to mean
r1= polyval(pr,mean_dy/m); % rate

dy2= dy-mean(dy);

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corrns= pr(2).*dy2 + pr(1).*(dy2-mean_dy).*(dy2+mean_dy)./(2*m);
chron1= mean_chr+corrns % corrected times

tsqe= sum((chron0-chron1).^2);

% Shadwell's version
disp('-----Shadwell-----');
A= sum(n); C= sum(n.^2); B= C/(2*m); D= sum(n.^3)/(2*m);
P= sum(p); Q= dot(n,p);
yy(1)= (D*P-B*Q)/(A*D-B*C);
yy(2)= (P-A*yy(1))/B;
YY
corrns2= yy(1).*dy2 + yy(2).*(dy2-mean_dy).*(dy2+mean_dy)./(2*m);
chron2= mean_chr+corrns2 % corrected times, Shadwell
tsqe2= sum((chron0-chron2).^2); % total squared error
str= sprintf('LS error: %5.2f Shadwell: %5.2f',tsqe,tsqe2); disp(str);

figure(1); clf;
plot(dy,chron0,'b.',dy,chron1,'gx',dy,chron2,'rx','MarkerSize',9);
xlabel('Day');
grid on; shg;
legend('orig','LS','Shadwell','Location','NorthWest');
axis([2 15 0 60]);

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M =

2.0000	0.1818
5.0000	1.1364
6.0000	1.6364
9.0000	3.6818
11.0000	5.5000

p =

9.4500
20.3500
24.7000
36.8500
44.9500

xx =

4.2269

-0.3072

Base rate is 4.227 secs, changing -0.307 secs per 11 days
Rate on May 3rd 4.227 secs, on May 14th 3.920

Estimated gain in secs/day of chronometer:

rate =

4.1711
4.0873
4.0594
3.9756
3.9197

chron1 =

4.0185 12.7238 25.5722 29.7991 42.3123 50.5148

-----Shadwell-----

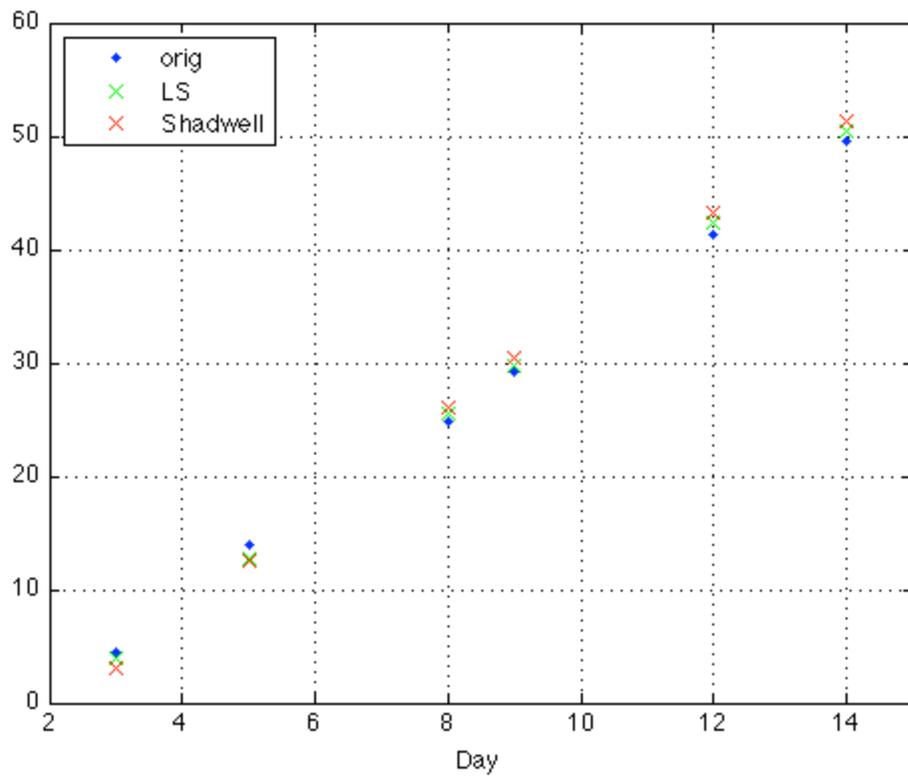
yy =

4.3854 -0.6935

chron2 =

3.1472 12.4853 26.0197 30.4051 43.1829 51.3862

LS error: 4.53 Shadwell: 13.59



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