```
>> x=[1:1:80];
>> xbar=mean(x)

xbar =

   40.5000

>> C=[ones(1,80)' (x-xbar)'];
>> size(C)

ans =

    80     2

>> y=1+2*x+5*randn(1,80);
>> size(y)

ans =

     1    80

>> b=C\y'

b =

   81.9058
    2.0178

>> mean(y)-b(2)*xbar

ans =

    0.1865

>> CD=[ones(1,80)' x'];
>> b=CD\y'

b =

    0.1865
    2.0178

>> b=C\y';
>> plot(x,y,'*',x,mean(y)+b(2)*(x-xhat))
??? Undefined function or variable 'xhat'.

>> plot(x,y,'*',x,mean(y)+b(2)*(x-xbar))
```

$\bar{x} = 40.5$

$C = \begin{pmatrix} 1 & x_1 - \bar{x} \\ \vdots & \vdots \\ 1 & x_n - \bar{x} \end{pmatrix}$

$\varepsilon_i \in N(0, 25)$ $\quad y_i = 1 + 2x_i + \varepsilon_i \quad i = 1, \ldots, 80$

$\begin{pmatrix} \hat{\alpha} \\ \hat{\beta} \end{pmatrix}$ FINDS for $\quad y_i = \alpha + \beta(x_i - \bar{x}) + \varepsilon_i$

$\text{mean}(y) = \hat{\alpha} = \bar{y}$

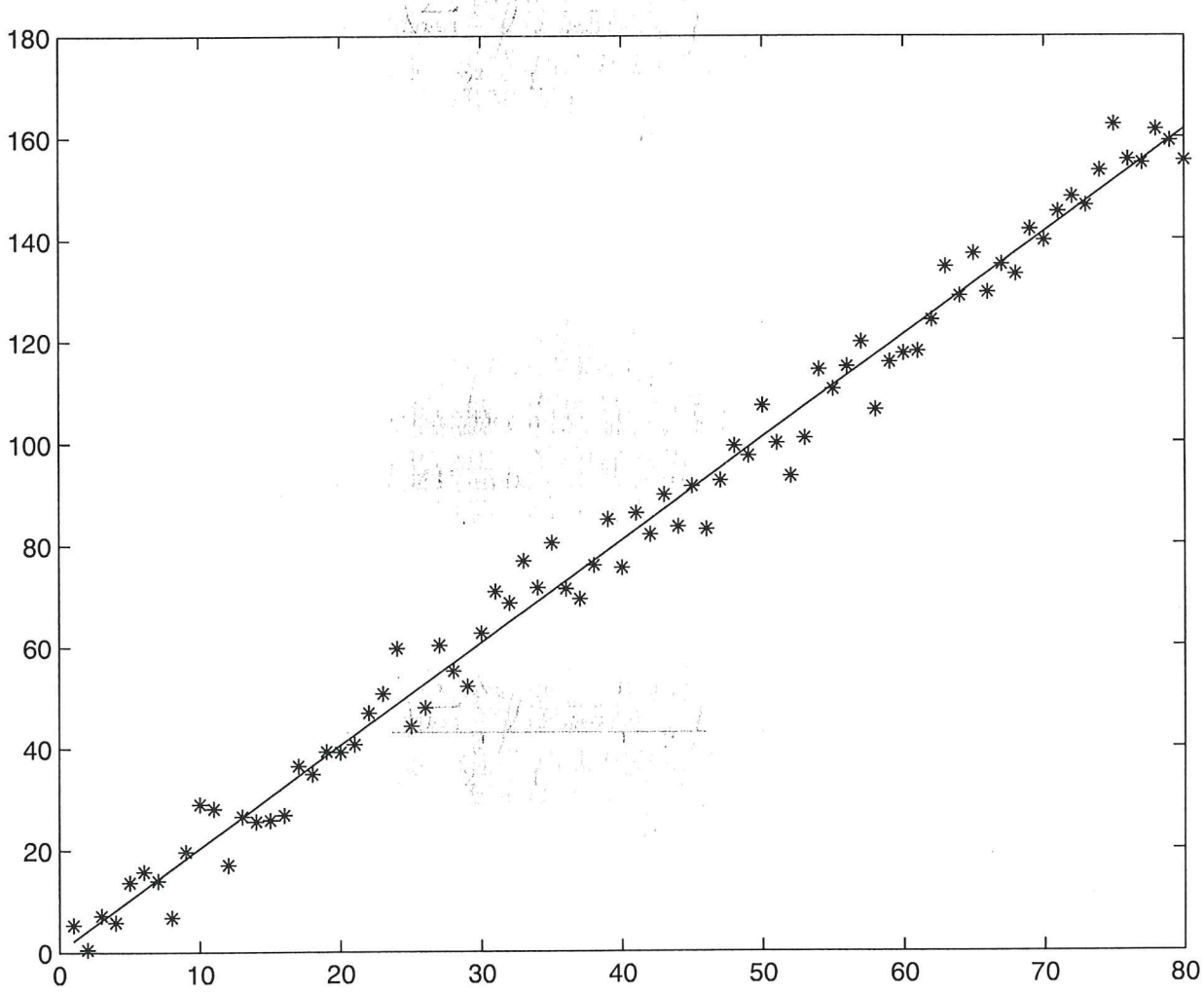
$a = \alpha - \beta\bar{x}$

$\hat{a} = \bar{y} - \beta\bar{x}$

$\begin{pmatrix} 1 & x_1 \\ \vdots & \vdots \\ 1 & x_n \end{pmatrix}$ $\quad y_i = a + bx_i + \varepsilon_i$

PLOT OF $(x_i, y_i)_{i=1}^{80}$ AND THE FITTED

REGRESSION LINE $\hat{\alpha} + \hat{\beta} x = 0.1865 + 2.0178 x$



PAIRWISE BOOTSTRAP FOR $\hat{\beta}$

```
>> x=[1:80];
>> xbar=mean(x)

xbar =

   40.5000

>> y=1+2*x+5*randn(1,80);
>> C=[ones(1,80)', (x-xbar)' ];
>> b=C\y';
>> b

b =

   81.6332
    1.9606

>> X=[y' ones(1,80)' (x-xbar)'];
>> betasample=betastovel(X,1000);
>> std(betasample)

ans =

    0.0253

>> 5/sqrt(sum(x.^(2))-80*xbar^(2))

ans =

    0.0242

>> mean(betasample)

ans =

    1.9600

>> hist(betasample,50)
>>
```

A MATRIX FOR PAIRWISE BOOTSTRAP

1000 BOOTSTRAP SAMPLES

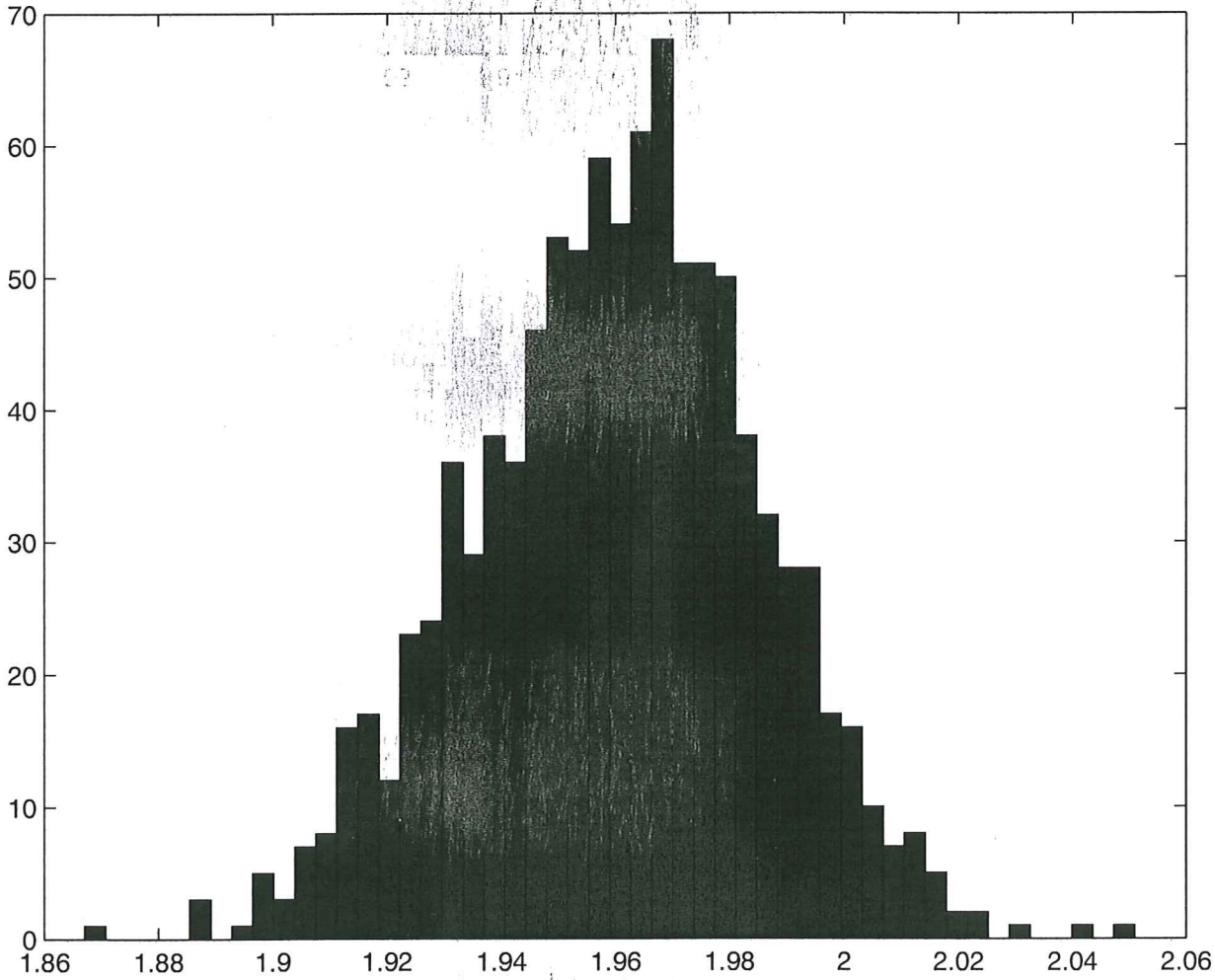
BOOTSTRAP ESTIMATE OF $D(\hat{\beta}_1)$

$\beta \in N\left(2, \frac{5^2}{\sum_{1}^{80}(x_i-\bar{x})^2}\right)$

TRUE VALUE OF $D(\hat{\beta})$

$= \sum_{i=1}^{80} x_i^2 - 80\bar{x}^2$

HISTOGRAM OF PAIRWISE BOOTSTRAPPED $\hat{\beta}^*$



B6

```
>> type betastovel

function  betasample=betastovel(X,m)
betasample=[];
for i=1:m
bssa=stovelstrpair(X);
ysa=bssa(:,1);
onesa=bssa(:,2);
xsa=bssa(:,3);
C=[onesa  xsa];
beta=C\ysa;
betasample=[betasample beta(2)];
end

>> type stovelstrpair

function bssample =stovelstrpair(X)
[n p]=size(X);
z=unidrnd(n,1,n);
bssample =X(z,:);
>>
```

PAIRWISE BOOTSTRAP

```
>> C=[ones(1,80)', x' ];
>> b=C\y';
>> b(1)

ans =

    1.0738

>> b

b =

    1.0738
    2.0013

>> res=y-(b(1)+b(2)*x);
>> betasample=betaresstovel(b(1),b(2),x,res,1000);
>> type  betaresstovel

function  betasample=betaresstovel(a,b,x,res,m)
betasample=[];
 C=[ones(1,length(x))', x' ];
for i=1:m
bsres=stovelstropp(res);
y= a +  b*x+bsres;
beta=C\y';
betasample=[betasample beta(2)];
end

>> std(betasample)

ans =

    0.0217

>> hist(betasample,50)
>>
```

BOOTSTRAP OF RESIDUALS

NEW DATA

$y_i = 1 + 2x + \varepsilon_i$

$\varepsilon_i \in N(0, 2^2)$

RESIDUALS

BOOTSTRAP RESIDUALS

HISTOGRAM FOR β^*
WITH BOOTSTRAPPED RESIDUALS