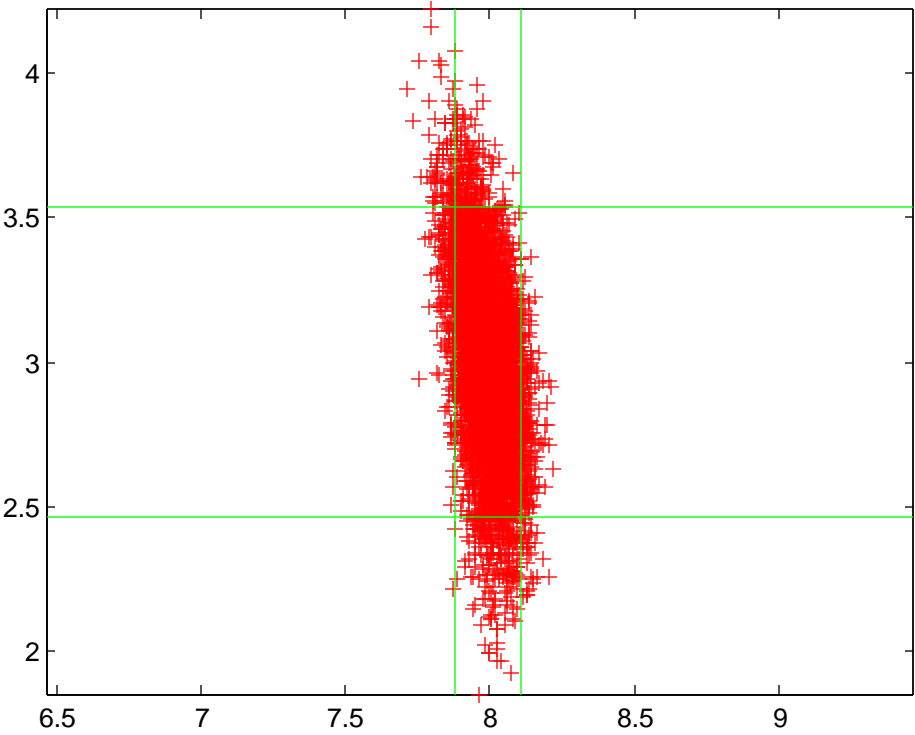


scatterplot of unknown point for HW1_a, 90% limits shown



hw4_1a_res

```
hw4_1a
xbar =
ybar = 7.99207140053659
dx
ans = 3.00049414733908
dy
ans = 0.113154614770481
sx90 = 0.529478101528982
sy90 = 0.11315880612366
rangex = 0.537101889915004
rangey = 0.499713979288321
diary off 2.37232757538579
```

```

% hw4_1a.m.m 15-oct-2015
% monte carlo simulation of 2D range problem

n=3;
n0=2;
r=1;
u=2;
c=3;
x=[1.00;2.00;1.00];
y=[4.00;2.00;1.00];
d1_orig=7.0711;
d2_orig=6.0828;
d3_orig=7.2801;
X=zeros(5000,1);
Y=zeros(5000,1);
rng(47); % seed the rng
for samp=1:5000
    x0=8.00;
    y0=3.00;
    e=randn(3,1)*0.1;
    d1=d1_orig+e(1);
    d2=d2_orig+e(2);
    d3=d3_orig+e(3);
    for iTer=1:6
        B=zeros(c,u);
        f=zeros(c,1);
        D1=sqrt((x0-x(1))^2 + (y0-y(1))^2);
        D2=sqrt((x0-x(2))^2 + (y0-y(2))^2);
        D3=sqrt((x0-x(3))^2 + (y0-y(3))^2);
        B=[-(x0-x(1))/D1 -(y0-y(1))/D1;
           -(x0-x(2))/D2 -(y0-y(2))/D2;
           -(x0-x(3))/D3 -(y0-y(3))/D3];
        F=[d1-D1;
           d2-D2;
           d3-D3];
        f=-F;
        % W=I3
        N=B'*B;
        t=B'*f;
        del=N\t;
        x0=x0+del(1);
        y0=y0+del(2);
        %pause
        end

    %v=f-B*del

    X(samp)=x0;
    Y(samp)=y0;
    end

plot(X,Y,'r+');
axis equal
title('scatterplot of unknown point for HW1_a, 90% limits shown');
hold on

xbar=mean(X)
ybar=mean(Y)
X0=abs(X-xbar);
Y0=abs(Y-ybar);
sX0=sort(X0);
sY0=sort(Y0);
disp('dx');
sX0(4500)
disp('dy');
sY0(4500)
sx90=1.645*std(X)
sy90=1.645*std(Y)
rangex=range(X)
rangey=range(Y)

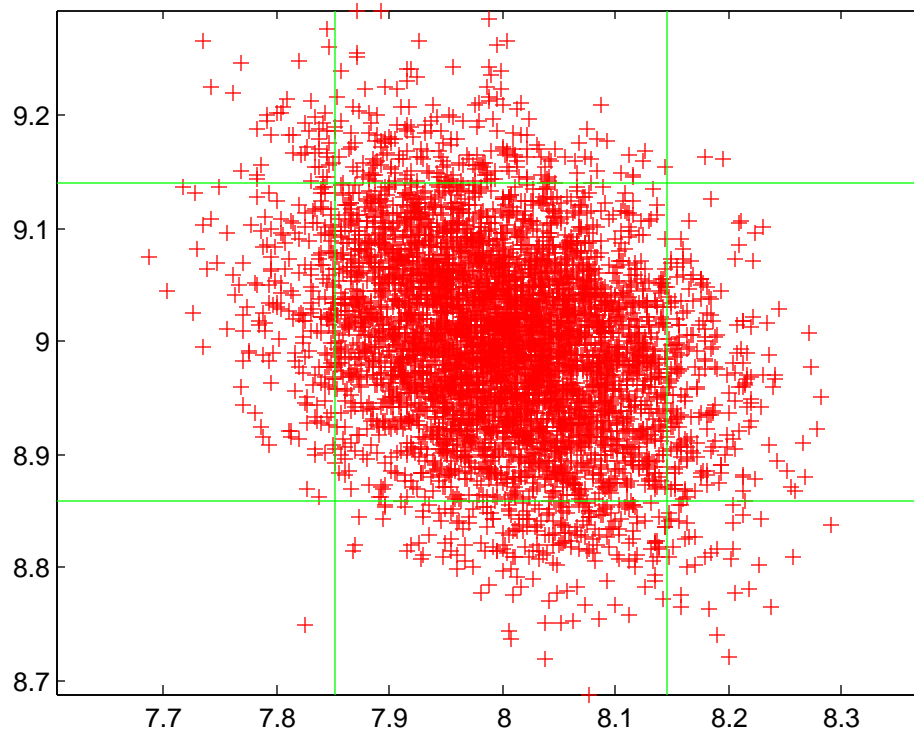
V=axis;
px=[xbar-sx90 xbar-sx90];
py=[V(3) V(4)];
plot(px,py,'-g');
px=[xbar+sx90 xbar+sx90];
py=[V(3) V(4)];
plot(px,py,'-g');
py=[ybar-sy90 ybar-sy90];

```

hw4_1a

```
px=[V(1) V(2)];  
plot(px,py,'-g');  
py=[ybar+sy90 ybar+sy90];  
px=[V(1) V(2)];  
plot(px,py,'-g');
```

scatterplot of unknown point for $HW1_p$, 90% limits shown



hw4_1b_res

```
hw4_1b
xbar =
ybar = 7.99904165000913
      8.99998399081762
dx
ans = 0.147311725281618
dy
ans = 0.141259387038792
sx90 = 0.147562175394328
sy90 = 0.140699159497318
rangex = 0.602158219841878
rangey = 0.605264485142662
diary off
```

```

% hw4_1b.m 15-oct-2015
% monte carlo simulation of 2D range problem

n=3;
n0=2;
r=1;
u=2;
c=3;
x=[1.00;1.00;9.00];
y=[8.00;1.00;2.00];
d1_orig=7.0711;
d2_orig=10.6301;
d3_orig=7.0711;
X=zeros(5000,1);
Y=zeros(5000,1);
rng(47); % seed the rng
for samp=1:5000
    x0=8.00;
    y0=9.00;
    e=randn(3,1)*0.1;
    d1=d1_orig+e(1);
    d2=d2_orig+e(2);
    d3=d3_orig+e(3);
    for iter=1:6
        B=zeros(c,u);
        f=zeros(c,1);
        D1=sqrt((x0-x(1))^2 + (y0-y(1))^2);
        D2=sqrt((x0-x(2))^2 + (y0-y(2))^2);
        D3=sqrt((x0-x(3))^2 + (y0-y(3))^2);
        B=[-(x0-x(1))/D1 -(y0-y(1))/D1;
          -(x0-x(2))/D2 -(y0-y(2))/D2;
          -(x0-x(3))/D3 -(y0-y(3))/D3];
        F=[d1-D1;
          d2-D2;
          d3-D3];
        f=-F;
        % W=I3
        N=B'*B;
        t=B'*f;
        del=N\t;
        x0=x0+del(1);
        y0=y0+del(2);
        %pause
        end

    %v=f-B*del

    X(samp)=x0;
    Y(samp)=y0;
    end

plot(X,Y,'r+');
axis equal
title('scatterplot of unknown point for HW1_b, 90% limits shown');
hold on

xbar=mean(X)
ybar=mean(Y)
X0=abs(X-xbar);
Y0=abs(Y-ybar);
sX0=sort(X0);
sY0=sort(Y0);
disp('dx');
sX0(4500)
disp('dy');
sY0(4500)
sx90=1.645*std(X)
sy90=1.645*std(Y)

V=axis;
px=[xbar-sx90 xbar+sx90];
py=[V(3) V(4)];
plot(px,py,'-g');
px=[xbar+sx90 xbar-sx90];
py=[V(3) V(4)];
plot(px,py,'-g');
py=[ybar-sy90 ybar+sy90];
px=[V(1) V(2)];
plot(px,py,'-g');

```

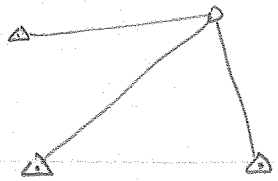
hw4_1b

```
py=[ybar+sy90 ybar+sy90];  
px=[V(1) V(2)];  
plot(px,py,'-g');  
rangex=range(X)  
rangey=range(Y)
```

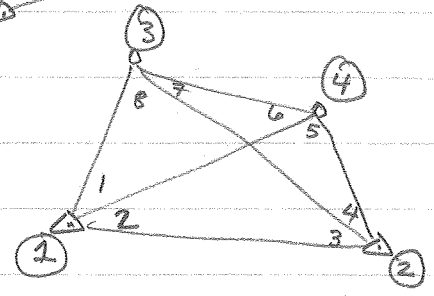

1(a)



1(b)



2(a)



angle	i	j	k	obs	B
1	1	3	4	48.537	$\begin{bmatrix} \times & \times & \times & \times \\ 0 & 0 & \times & \times \\ \times & \times & 0 & 0 \\ \times & \times & \times & \times \\ 0 & 0 & \times & \times \\ \times & \times & \times & \times \\ \times & \times & \times & \times \\ \times & \times & 0 & 0 \end{bmatrix}$
2	1	4	2	37.698	
3	2	1	3	32.158	
4	2	3	4	33.708	
5	4	2	1	76.404	
6	4	1	3	40.145	
7	3	4	2	29.772	
8	3	2	1	61.538	

$$\frac{\partial F_{\theta}}{\partial x_i} = \frac{\Delta y_{ik}}{D_{ik}^2} - \frac{\Delta y_{ij}}{D_{ij}^2}$$

$$\frac{\partial F_{\theta}}{\partial y_i} = -\frac{\Delta x_{ik}}{D_{ik}^2} + \frac{\Delta x_{ij}}{D_{ij}^2}$$

$$\frac{\partial F_{\theta}}{\partial x_j} = \frac{\Delta y_{ij}}{D_{ij}^2}$$

$$\frac{\partial F_{\theta}}{\partial y_j} = -\frac{\Delta x_{ij}}{D_{ij}^2}$$

$$\frac{\partial F_{\theta}}{\partial x_k} = -\frac{\Delta y_{ik}}{D_{ik}^2}$$

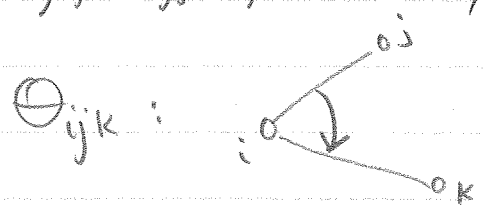
$$\frac{\partial F_{\theta}}{\partial y_k} = \frac{\Delta x_{ik}}{D_{ik}^2}$$

$$\Delta x_{ij} = x_j - x_i$$

$$\Delta x_{ik} = x_k - x_i$$

$$\Delta y_{ij} = y_j - y_i$$

$$\Delta y_{ik} = y_k - y_i$$



confusing table
 hybrid of ↖⁺ and ↗⁺

Table 10-1

$X_j - X_i$	$Y_j - Y_i$	QUADRANT	AZIMUTH $\hat{\alpha}_{ij}$
Positive	Positive	I 0°-90°	γ_u
Positive	Negative	II 90°-180°	$\gamma_u + 180^\circ$
Negative	Negative	III 180°-270°	$\gamma_u + 180^\circ$
Negative	Positive	IV 270°-360°	$\gamma_u + 360^\circ$

↖⁺
 ↗⁺
 prefer below:

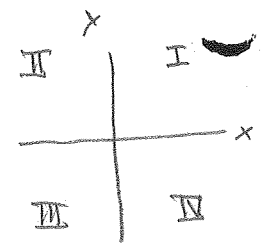
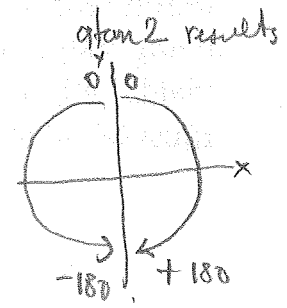
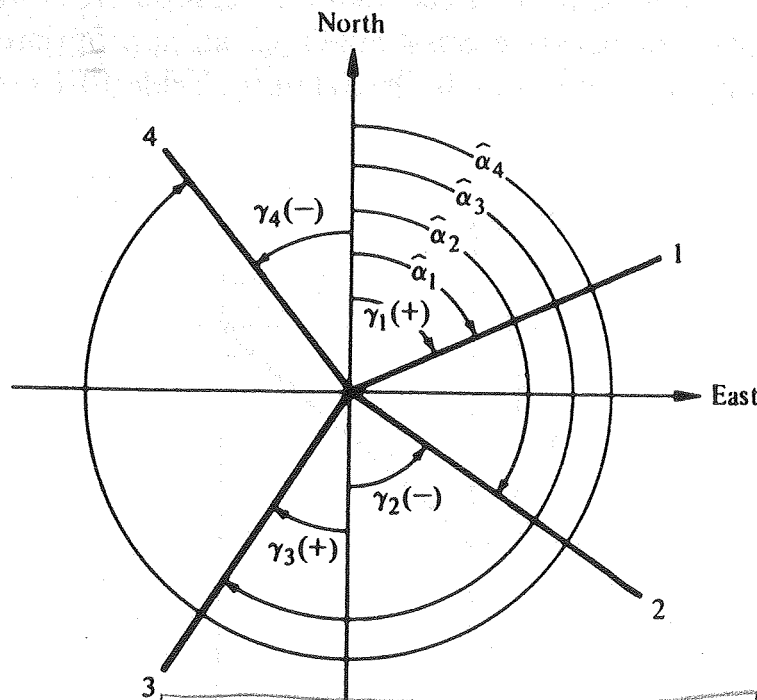
necessary information to ensure that the correct value of $\hat{\alpha}_{ij}$ is obtained. See also Fig. 10-2.

Linearization of Eq. (10-16) yields

$$\hat{\alpha}_{ij} = \alpha_{ij}^0 + \left(\frac{\partial \alpha_{ij}}{\partial X_i}\right) \Delta X_i + \left(\frac{\partial \alpha_{ij}}{\partial Y_i}\right) \Delta Y_i + \left(\frac{\partial \alpha_{ij}}{\partial X_j}\right) \Delta X_j + \left(\frac{\partial \alpha_{ij}}{\partial Y_j}\right) \Delta Y_j, \quad (10-17)$$

where

$$\alpha_{ij}^0 = \arctan \frac{X_j^0 - X_i^0}{Y_j^0 - Y_i^0}. \quad (10-18)$$



fix atan(dx/dy)

Quad	Δx	Δy	$\gamma = \arctan(\frac{\Delta x}{\Delta y})$	transf.	$\text{atan2}(\Delta x, \Delta y)$
I	+	+	γ	→	α
II	-	+	γ	→	α
III	-	-	γ	$\gamma - 180^\circ$	α
IV	+	-	γ	$\gamma + 180^\circ$	α

Fig. 10-2

```

% hw4_2a.m 22-oct-2015
% braced quadrilateral

a=[48.537;37.698;32.158;33.708;76.404;40.145;29.772;61.538];
degrad=180/pi;
ar=a/degrad;
x=[100;200;110;180];
y=[1020;1010;1080;1070];

n=8;
n0=4;
r=n-n0;
c=n;
u=n0;
W=eye(n);

% parameter order x3 y3 x4 y4

for niter=1:10
    B=zeros(c,u);
    f=zeros(c,1);

    row=1;
    i=1;
    j=3;
    k=4;
    dxij=x(j)-x(i);
    dyij=y(j)-y(i);
    dxik=x(k)-x(i);
    dyik=y(k)-y(i);
    D2ij=dxij^2 + dyij^2;
    D2ik=dxik^2 + dyik^2;
    dFdxj=dyik/D2ik - dyij/D2ij;
    dFdxk=dyij/D2ij;
    dFdyi=-dxik/D2ik + dxij/D2ij;
    dFdyj=-dxij/D2ij;
    dFdyk=dxik/D2ik;
    B(row,:)= [dFdxj dFdyj dFdxk dFdyk];
    azik=atan2(dxik,dyik);
    azij=atan2(dxij,dyij);
    cang=azik-azij;
    if(cang < 0)
        cang=cang + 2*pi;
    end
    F=ar(row)-cang;
    f(row)=-F;

    row=2;
    i=1;
    j=4;
    k=2;
    dxij=x(j)-x(i);
    dyij=y(j)-y(i);
    dxik=x(k)-x(i);
    dyik=y(k)-y(i);
    D2ij=dxij^2 + dyij^2;
    D2ik=dxik^2 + dyik^2;
    dFdxj=dyik/D2ik - dyij/D2ij;
    dFdxk=dyij/D2ij;
    dFdyi=-dxik/D2ik + dxij/D2ij;
    dFdyj=-dxij/D2ij;
    dFdyk=dxik/D2ik;
    B(row,:)= [0 0 dFdxj dFdyj];
    azik=atan2(dxik,dyik);
    azij=atan2(dxij,dyij);
    cang=azik-azij;
    if(cang < 0)
        cang=cang + 2*pi;
    end
    F=ar(row)-cang;
    f(row)=-F;

    row=3;
    i=2;
    j=1;
    k=3;

```

```

dxij=x(j)-x(i);
dyij=y(j)-y(i);
dxik=x(k)-x(i);
dyik=y(k)-y(i);
D2ij=dxij^2 + dyij^2;
D2ik=dxik^2 + dyik^2;
dFdxj=dyij/D2ij;
dFdxk=-dyik/D2ik;
dFdyi=-dxik/D2ik + dxij/D2ij;
dFdyj=-dxij/D2ij;
dFdyk=dxik/D2ik;
B(row,:)= [dFdxk dFdyk 0 0];
azik=atan2(dxik,dyik);
azij=atan2(dxij,dyij);
cang=azik-azij;
if(cang < 0)
    cang=cang + 2*pi;
end
F=ar(row)-cang;
f(row)=-F;

row=4;
i=2;
j=3;
k=4;
dxij=x(j)-x(i);
dyij=y(j)-y(i);
dxik=x(k)-x(i);
dyik=y(k)-y(i);
D2ij=dxij^2 + dyij^2;
D2ik=dxik^2 + dyik^2;
dFdxj=dyij/D2ij;
dFdxk=-dyik/D2ik;
dFdyi=-dxik/D2ik + dxij/D2ij;
dFdyj=-dxij/D2ij;
dFdyk=dxik/D2ik;
B(row,:)= [dFdxj dFdyj dFdxk dFdyk];
azik=atan2(dxik,dyik);
azij=atan2(dxij,dyij);
cang=azik-azij;
if(cang < 0)
    cang=cang + 2*pi;
end
F=ar(row)-cang;
f(row)=-F;

row=5;
i=4;
j=2;
k=1;
dxij=x(j)-x(i);
dyij=y(j)-y(i);
dxik=x(k)-x(i);
dyik=y(k)-y(i);
D2ij=dxij^2 + dyij^2;
D2ik=dxik^2 + dyik^2;
dFdxj=dyij/D2ij;
dFdxk=-dyik/D2ik;
dFdyi=-dxik/D2ik + dxij/D2ij;
dFdyj=-dxij/D2ij;
dFdyk=dxik/D2ik;
B(row,:)= [0 0 dFdxj dFdyj];
azik=atan2(dxik,dyik);
azij=atan2(dxij,dyij);
cang=azik-azij;
if(cang < 0)
    cang=cang + 2*pi;
end
F=ar(row)-cang;
f(row)=-F;

row=6;
i=4;
j=1;
k=3;
dxij=x(j)-x(i);

```

```

dyij=y(j)-y(i);
dxik=x(k)-x(i);
dyik=y(k)-y(i);
D2ij=dxij^2 + dyij^2;
D2ik=dxik^2 + dyik^2;
dFdxj=dyik/D2ik - dyij/D2ij;
dFdxk=-dyik/D2ik;
dFdyi=-dxik/D2ik + dxij/D2ij;
dFdyj=-dxij/D2ij;
dFdyk=dxik/D2ik;
B(row,:)= [dFdxk dFdyk dFdxj dFdyi];
azik=atan2(dxik,dyik);
azij=atan2(dxij,dyij);
cang=azik-azij;
if(cang < 0)
    cang=cang + 2*pi;
end
F=ar(row)-cang;
f(row)=-F;

row=7;
i=3;
j=4;
k=2;
dxij=x(j)-x(i);
dyij=y(j)-y(i);
dxik=x(k)-x(i);
dyik=y(k)-y(i);
D2ij=dxij^2 + dyij^2;
D2ik=dxik^2 + dyik^2;
dFdxj=dyik/D2ik - dyij/D2ij;
dFdxk=-dyik/D2ik;
dFdyi=-dxik/D2ik + dxij/D2ij;
dFdyj=-dxij/D2ij;
dFdyk=dxik/D2ik;
B(row,:)= [dFdxj dFdyi dFdxk dFdyk];
azik=atan2(dxik,dyik);
azij=atan2(dxij,dyij);
cang=azik-azij;
if(cang < 0)
    cang=cang + 2*pi;
end
F=ar(row)-cang;
f(row)=-F;

row=8;
i=3;
j=2;
k=1;
dxij=x(j)-x(i);
dyij=y(j)-y(i);
dxik=x(k)-x(i);
dyik=y(k)-y(i);
D2ij=dxij^2 + dyij^2;
D2ik=dxik^2 + dyik^2;
dFdxj=dyik/D2ik - dyij/D2ij;
dFdxk=-dyik/D2ik;
dFdyi=-dxik/D2ik + dxij/D2ij;
dFdyj=-dxij/D2ij;
dFdyk=dxik/D2ik;
B(row,:)= [dFdxj dFdyi 0 0];
azik=atan2(dxik,dyik);
azij=atan2(dxij,dyij);
cang=azik-azij;
if(cang < 0)
    cang=cang + 2*pi;
end
F=ar(row)-cang;
f(row)=-F;

del=inv(B'*W*B)*B'*W*f
x(3)=x(3)+del(1);
y(3)=y(3)+del(2);
x(4)=x(4)+del(3);
y(4)=y(4)+del(4);
end

```

hw4_2a

```
disp('parameters: x3, y3, x4, y4');  
x(3)  
y(3)  
x(4)  
y(4)  
  
v=f-B*del  
vd=v*degrad
```

```

hw4_2a
del =
  -0.0217023548470983
    0.0306486096346326
    0.0192311956733966
    0.0283863821376341
del =
  -8.94189399940591e-06
    1.01332102499319e-05
    5.62695934155184e-06
    1.03667331127497e-05
del =
  4.47927613403398e-10
  -2.09950046931029e-10
  -3.3506961961971e-11
  1.65667826679261e-13
del =
  2.25566093581264e-14
  -7.17984699472041e-14
  1.05037506470396e-15
  -2.20093041014557e-14
del =
  -2.5132673719952e-14
  -5.99390329036886e-14
  -4.98819735517131e-15
  -8.23559970219989e-15
del =
  2.25566093581264e-14
  -7.17984699472041e-14
  1.05037506470396e-15
  -2.20093041014557e-14
del =
  -2.5132673719952e-14
  -5.99390329036886e-14
  -4.98819735517131e-15
  -8.23559970219989e-15
del =
  2.25566093581264e-14
  -7.17984699472041e-14
  1.05037506470396e-15
  -2.20093041014557e-14
del =
  -2.5132673719952e-14
  -5.99390329036886e-14
  -4.98819735517131e-15
  -8.23559970219989e-15
del =
  2.25566093581264e-14
  -7.17984699472041e-14
  1.05037506470396e-15
  -2.20093041014557e-14
parameters: x3, y3, x4, y4
ans =
  109.978288703707
ans =
  1080.03065874264
ans =
  180.019236822599
ans =
  1070.02839674887
v =
  0.000205490155008792
  0.000460877141759371
  0.000206851294409185
  2.20976210247341e-05
  -0.000131320696555339
  -6.91268615343435e-05
  -0.000327795546013642
  0.000331058592698376
vd =
  0.0117737186134928
  0.0264063150968645
  0.0118517061564643
  0.00126610042199682
  -0.0075241216753391
  -0.00396067741690311
  -0.0187813013297681
  0.0189682601331575
diary off

```