```
data = readmatrix('HW6_Ligament_Data.xlsx');

parallel_stretch = data(:,1);
parallel_stress = data(:,2);
transverse_stretch = data(1:30,3);
transverse_stress = data(1:30,4);
```

NH Transverse

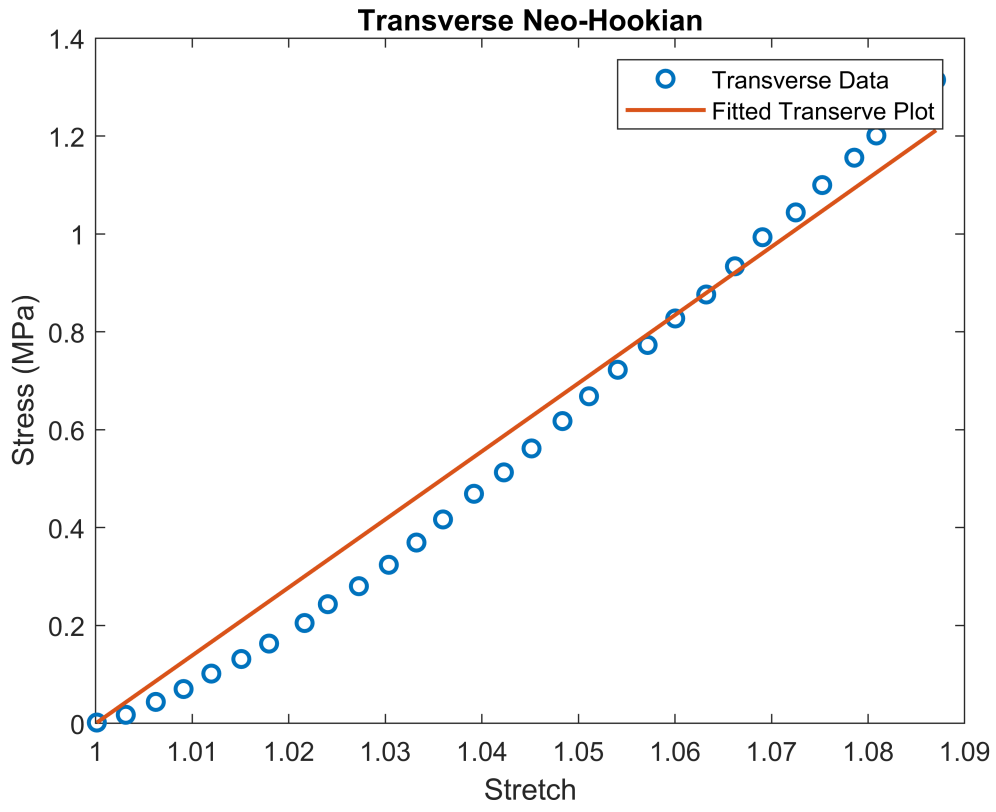
```
F = @(u,transverse_stretch)((u.*(transverse_stretch.^2))-(u./transverse_stretch))
```

```
F = function_handle with value:
    @(u,transverse_stretch)((u.*(transverse_stretch.^2))-(u./transverse_stretch))
```

```
u = lsqcurvefit(F, [1], transverse_stretch, transverse_stress)
```

```
Local minimum found.

Optimization completed because the size of the gradient is less than
the value of the optimality tolerance.

<stopping criteria details>
u = 4.6297
```

```
figure(1)
plot (transverse_stretch, transverse_stress, 'o', 'Linewidth', 1.5)
hold on
plot(transverse_stretch,(u.*(transverse_stretch.^2))-(u./transverse_stretch), 'Linewidth', 1.5)
xlabel('Stretch')
ylabel('Stress (MPa)')
title ('Transverse Neo-Hookian')
legend('Transverse Data', 'Fitted Transerve Plot');
```



NH Parallel

```
lambda = 1.035;
u = 4.6297;
syms c5;
clear x;


toe_region = parallel_stretch(1:19);
toe_stress = parallel_stress(1:19);
linear_region = parallel_stretch(18:end);
linear_stress = parallel_stress(18:end);

Toe = @(x,lambda)(u.*(lambda).^2)+ x(1)*(exp(x(2)*(lambda-1))-1) - u*(lambda.^-1);
x = lsqcurvefit(Toe, [1,1], toe_region, toe_stress);
```

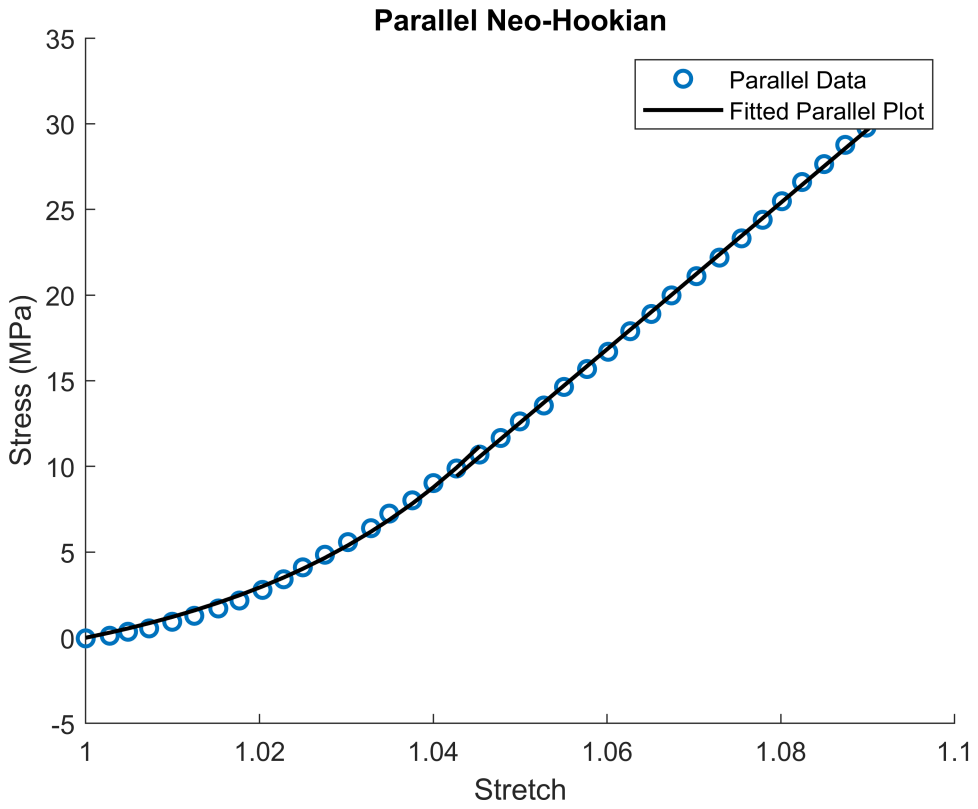
```
Local minimum found.

Optimization completed because the size of the gradient is less than
the value of the optimality tolerance.

<stopping criteria details>
```

```
Linear = @(w,lambdaLin)(u*(lambdaLin.^2))+(w(1)*lambdaLin)+w(2)-(u*(lambdaLin.^(-1)));
```

```
w=lsqcurvefit(Linear, [1,1], linear_region, linear_stress)
```

```
Local minimum found.

Optimization completed because the size of the gradient is less than
the value of the optimality tolerance.

<stopping criteria details>
w = 1×2
  413.7863 -422.6086
```

```
%c6 = c3c4(1).*(exp(c3c4(2).*(1.04-1))-1)-c5(1)*1.04


figure;
hold on;
plot(parallel_stretch,parallel_stress, 'o', 'Linewidth', 1.5)
plot(toe_region,Toe(x, toe_region),'k','Linewidth', 1.5)
plot(linear_region,Linear(w, linear_region),'k','Linewidth', 1.5)
xlabel('Stretch')
ylabel('Stress (MPa)')
title ('Parallel Neo-Hookian')
legend('Parallel Data', 'Fitted Parallel Plot');
```



Verona Transverse

```
clear all

syms x  c1 c2 c3 c4 c5 c6 ;

data = readmatrix('HW6_Ligament_Data.xlsx');

parallel_stretch = data(:,1);
parallel_stress = data(:,2);
transverse_stretch = data(1:30,3);
transverse_stress = data(1:30,4);

toe_region = parallel_stretch(1:19);
toe_stress = parallel_stress(1:19);
linear_region = parallel_stretch(19:end);
linear_stress = parallel_stress(19:end);

I1 = x.^2 + (2/x);
w1 = c1*c2*(exp(c2*(I1-3)))
```

w1 =

$$c_1\, c_2\, \mathrm{e}^{c_2\left(\frac{2}{x}+x^2-3\right)}$$

```
w2 = -c1*c2/2
```

w2 =

$$-\frac{c_1\, c_2}{2}$$

```
p = simplify(2*(((w1+(w2*I1))/x) - (w2/x.^2)))
```

p =

$$-\frac{c_1\, c_2\left(x^3-2\,x\,\mathrm{e}^{\frac{c_2\,(x-1)^2\,(x+2)}{x}}+1\right)}{x^2}$$

```
%B33 = 1/x;
%Verona33= 2*(B33*(w1+w2*I1)-B33^2*w2)+p; % T22 and T33
%solved_p = solve(Verona33==0,p)

%B11= x.^2;
%Veronda11= 2*(B11*(w1+w2*I1)-B11^2*w2)+solved_p
%simplify(Veronda11)

F_trans = @(c,transverse_stretch)((c(1).*c(2).*(2.*transverse_stretch.*exp((c(2).*(transverse_s
c = lsqcurvefit(F_trans,[1,1],transverse_stretch,transverse_stress)
```

```
Local minimum found.

Optimization completed because the size of the gradient is less than
the value of the optimality tolerance.
```

```
<stopping criteria details>
c = 1×2
    0.4958    7.3404
```

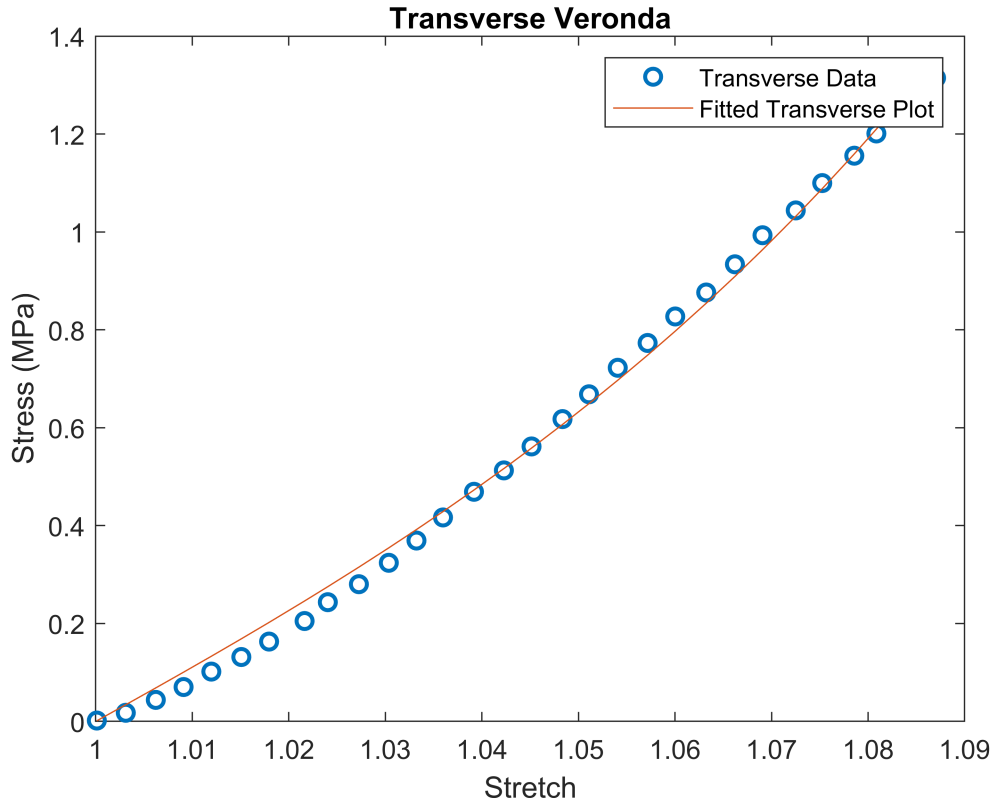
```
F_toe = @(k,toe_region)((c(1).*c(2) - k(1).*toe_region.^2 + k(1).*toe_region.^2.*exp((k(2).*(to
k = lsqcurvefit(F_toe,[1,1],toe_region,toe_stress)
```

```
Local minimum possible.

lsqcurvefit stopped because the final change in the sum of squares relative to
its initial value is less than the value of the function tolerance.

<stopping criteria details>
k = 1×2
    2.5126   36.4761
```

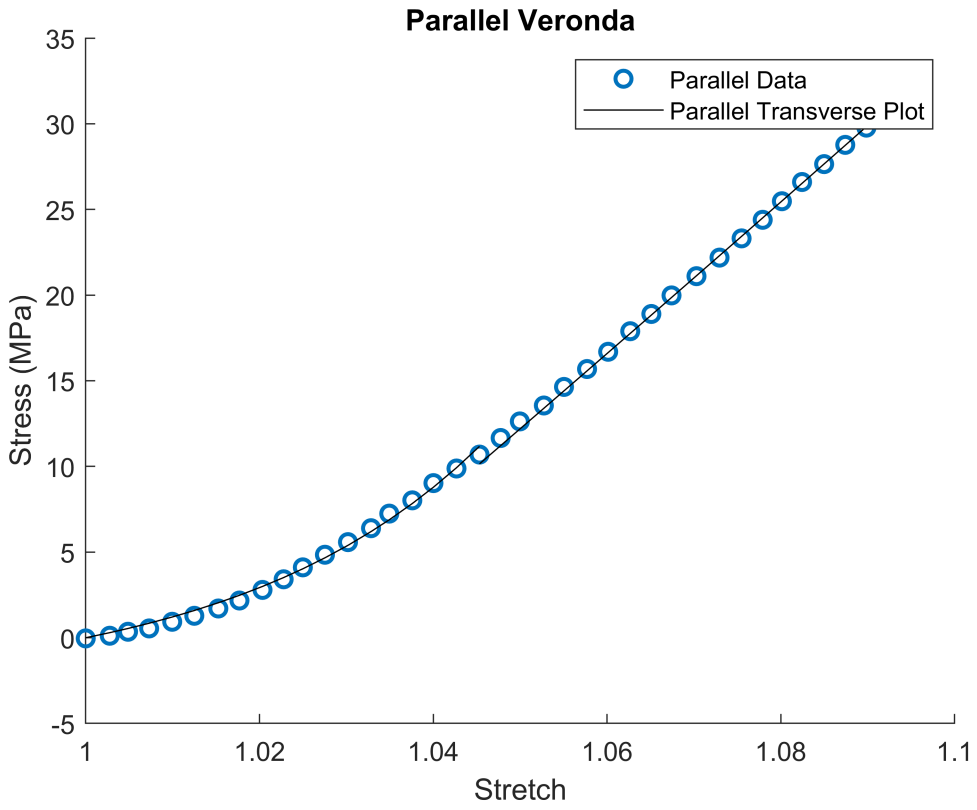
```
F_linear = @(v,linear_region)((c(1).*c(2) + v(1).*linear_region.^3 + (7.3403 - (1.04.*v(1))).*l
v = lsqcurvefit(F_linear,1,linear_region,linear_stress)
```

```
Local minimum found.

Optimization completed because the size of the gradient is less than
the value of the optimality tolerance.

<stopping criteria details>
v = 422.6825
```

```
figure
plot (transverse_stretch, transverse_stress, 'o', 'Linewidth', 1.5)
hold on
plot(transverse_stretch,(c(1).*c(2).*(2.*transverse_stretch.*exp((c(2).*(transverse_stretch - 1
xlabel('Stretch')
ylabel('Stress (MPa)')
title ('Transverse Veronda')
legend('Transverse Data', 'Fitted Transverse Plot');
```




```
figure;
hold on;
plot(parallel_stretch,parallel_stress, 'o', 'Linewidth', 1.5)
plot(toe_region,F_toe(k, toe_region),'k')
plot(linear_region,F_linear(v, linear_region),'k')
xlabel('Stretch')
ylabel('Stress (MPa)')
title ('Parallel Veronda')
legend('Parallel Data', 'Parallel Transverse Plot');
```



Problem 2 Shear

```
clear all;
kdata = [0;0.01;0.03;0.04;0.06;0.07;0.08;0.09;0.11;0.12;0.14;0.15;0.16;0.17;0.19;0.2;0.22;0.23;
% k = tan(theta)
Rxn_F_Data = [2;5;5;7;8;10;10;12;13;14;19;21;26;29;34;39;46;56;64;76;89;103;124;147;173;203;238

area = 0.000016 %[m]
```

```
area = 1.6000e-05
```

```
PK = (Rxn_F_Data ./ area ) *10.^-6 %[Mpa]
```

```
PK = 31×1
    0.1250
    0.3125
    0.3125
    0.4375
    0.5000
    0.6250
    0.6250
    0.7500
    0.8125
    0.8750
     ⋮
```

```
F_k = @(u,kdata)((u.*(kdata)))
```

```
F_k = function_handle with value:
    @(u,kdata)((u.*(kdata)))
```

```
u = lsqcurvefit(F_k, [1],kdata, PK)
```

```
Local minimum found.

Optimization completed because the size of the gradient is less than
the value of the optimality tolerance.

<stopping criteria details>
u = 36.0222
```

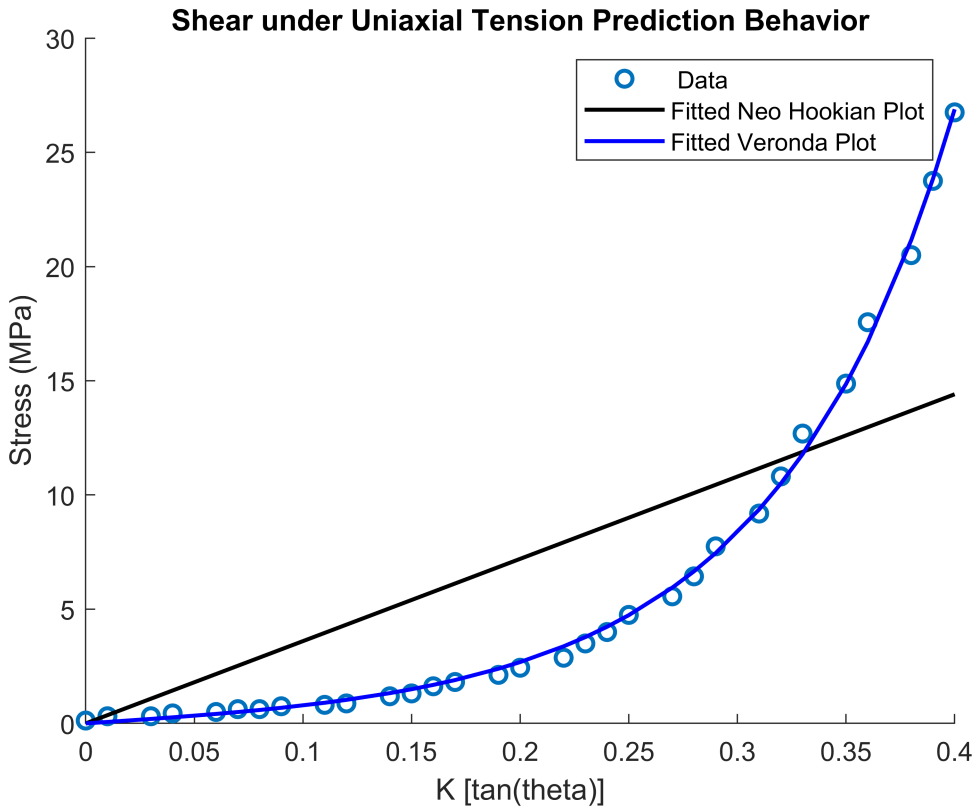
```
F_VW  = @(c,kdata)((2.*kdata.*c(1).*c(2).*exp(c(2).*kdata.^2))-((c(1).*c(2).*kdata).*((kdata.^2
```

```
F_VW = function_handle with value:
    @(c,kdata)((2.*kdata.*c(1).*c(2).*exp(c(2).*kdata.^2))-((c(1).*c(2).*kdata).*((kdata.^2)+3))+((c(1).*c(2)).*(kda
```

```
c = lsqcurvefit(F_VW, [1,1],kdata, PK)
```

```
Local minimum possible.

lsqcurvefit stopped because the final change in the sum of squares relative to
its initial value is less than the value of the function tolerance.

<stopping criteria details>
c = 1×2
    0.5860   10.9294
```

```
figure
hold on
plot (kdata, PK, 'o', 'Linewidth', 1.5)
plot(kdata,F_k (u, kdata),'k','Linewidth', 1.5)
plot(kdata,F_VW (c, kdata),'b','Linewidth', 1.5)
xlabel('K [tan(theta)]')
ylabel('Stress (MPa)')
title ('Shear under Uniaxial Tension Prediction Behavior')
legend(' Data', 'Fitted Neo Hookian Plot', 'Fitted Veronda Plot');
```


Shear under Uniaxial Tension Prediction Behavior
Data
Fitted Neo Hookian Plot
Fitted Veronda Plot
Stress (MPa)
K [tan(theta)]
0
5
10
15
20
25
30
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4