Problem 1:

Since $b^2 \gg 4ac$, $\sqrt{b^2 - 4ac}$ will be very close to $|b|$. To get the smaller root, we subtract the $|b|$.

When b is positive, for the x+, the numerator would be close to $-b + (b)$, and subtracting a nearly equal quantity will result in large relative errors.

When b is negative, for the x-, the numerator would be close to $-b - (-b)$, and subtracting a nearly equal quantity will result in large relative errors.

```
%problem 1
function[xp,xm]=solve_quadratic(a,b,c)
if (b >= 0)
    xp = (2*c)/(-b-sqrt(b^2-4*a*c));
    xm = (-b-sqrt(b^2-4*a*c))/(2*a);
else
    xp = (-b+sqrt(b^2-4*a*c))/(2*a);
    xm = (2*c)/(-b+sqrt(b^2-4*a*c));
end
```

$(a)\ x^2 - 10^6 x + 1 = 0$

The x^+ is $1.0 * 10^6$, the x^- is $1.0 * 10^{-6}$.

The error in the smaller root is $-5.0593 * 10^{-11}$

```
>> xp

xp =

   1.0000e+06

>> xm

xm =

   1.0000e-06
```

```
a=1;b=-10^6;c=1;
z = -4*a*c/b^2;
delta = abs(b)*(1+z/2-z^2/4);
x_m = (-b-delta)/(2*a);
x_m =

    9.9995e-07;
```

```
>> x_m - xm

ans =

  -5.0593e-11
```

$(b)\ x^2 + 10^6 x + 1 = 0$ (codes and results are on the next page)

The x^+ is $-1.0 * 10^{-6}$, the x^- is $-1.0 * 10^{+6}$.

The error in the smaller root is 0

```
>> xp

xp =

  -1.0000e-06

>> xm

xm =

  -1.0000e+06
```

```
a=1;b=10^6;c=1;
z = -4*a*c/b^2;
delta = abs(b)*(1+z/2-z^2/4);
x_m = (-b-delta)/(2*a);
x_m =

  -1.0000e+06;
```

```
>> x_m - xm

ans =

     0
```

Problem 2:

```
function[costheta,sintheta]=cos_and_sin(x,y)
costheta = (x/abs(y))/(sqrt((x/y)^2+1));
sintheta = costheta*y/x;
end
```

```
>> cos_and_sin(10^200,10^200)

ans =

    0.7071

>> cos_and_sin(10^(-200),10^(-200))

ans =

    0.7071
```

The answers are 0.7071. By reducing the power of x and y, we prevent the overflow.

Problem 3:

```
function y = mytanh(x)
y = 1 - 2/(exp(2*x)+1);
end

for k=[-2, -1, 0, 1, 2, 3]
x = 10^k
[mytanh(x)]
end
```

The results are on the next page.

k = -2, -1:	k = 0, 1:	k = 2, 3:
x =	x =	x =
0.0100	1	100
ans =	ans =	ans =
0.0100	0.7616	1
x =	x =	x =
0.1000	10	1000
ans =	ans =	ans =
0.0997	1.0000	1

```
for k=[-2, -1, 0, 1, 2, 3]
x = -10^k
[mytanh(x)]
end
```

k = -2, -1:	k = 0, 1:	k = 2, 3:
x =	x =	x =
-0.0100	-1	-100
ans =	ans =	ans =
-0.0100	-0.7616	-1
x =	x =	x =
-0.1000	-10	-1000
ans =	ans =	ans =
-0.0997	-1.0000	-1

Problem 4:

```
%1st
xbar = mean(hw2q4datafile)
n = length(hw2q4datafile)
var_1 = 1/(n-1)*sum((hw2q4datafile-xbar).^2)

%2nd
var_2 = 1/(n-1)*(sum(hw2q4datafile.^2) - n*xbar^2)

var_1 =

    1.2303


var_2 =

  1.3240e+03
```

The second variance = 1.324e^{+03} is more accurate. Since all entries are the same, we expect the variance to be 0. In the first function, we keep adding $(x_i - \bar{x})^2$, the subtracting will lead to a large relative error.