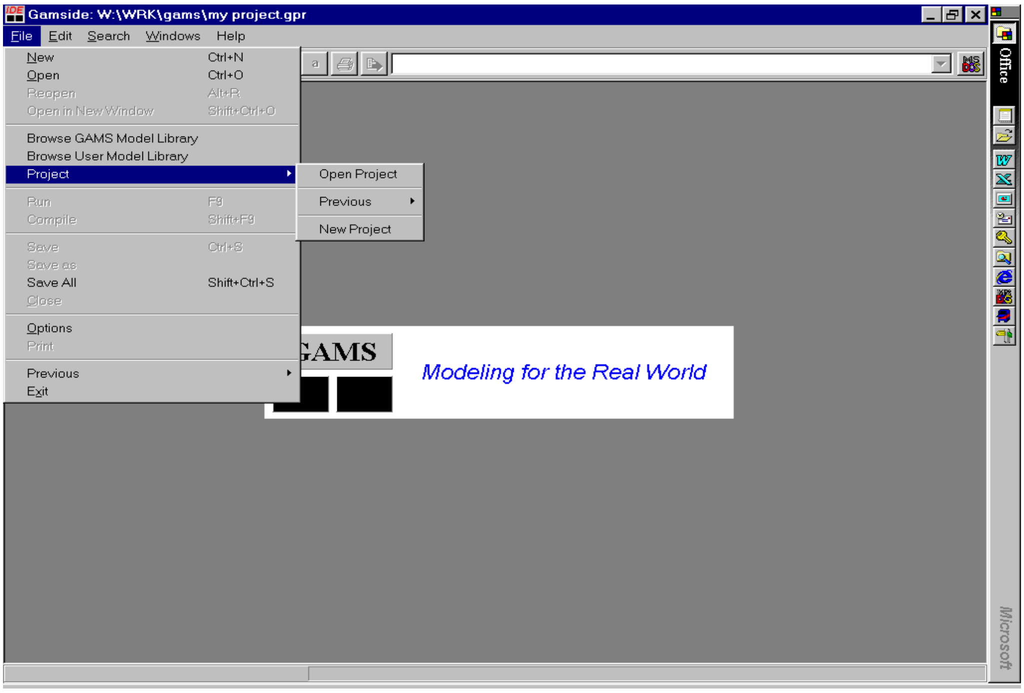
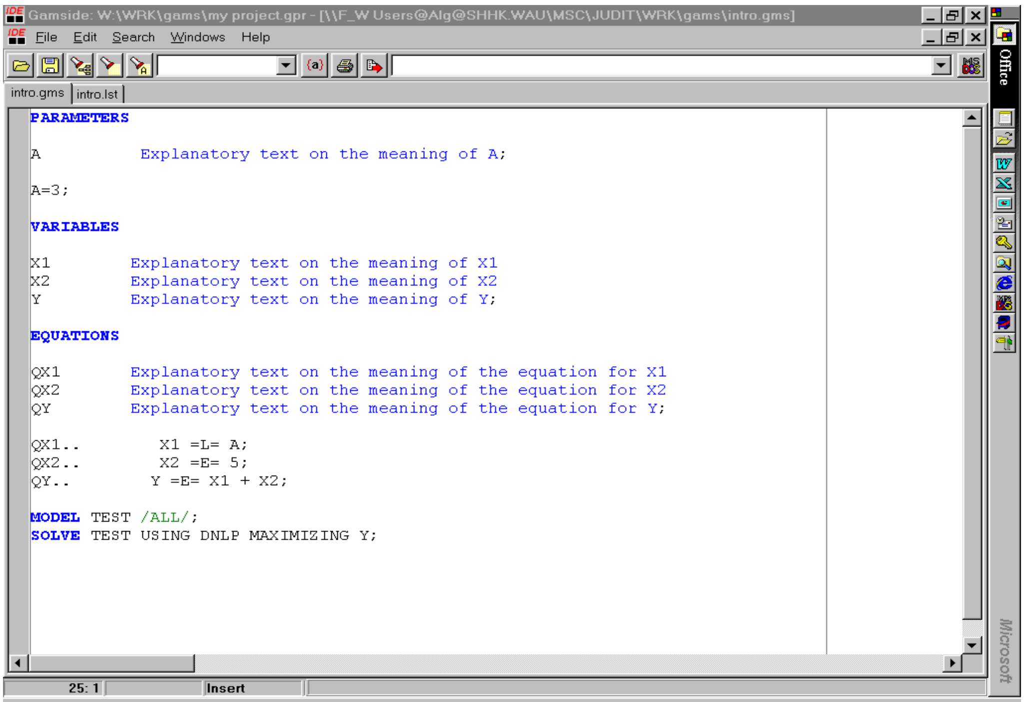
SOLUTION FOR THE EXERCISES 1

Results from 1.1.1.

Your desktop should look similar to this:

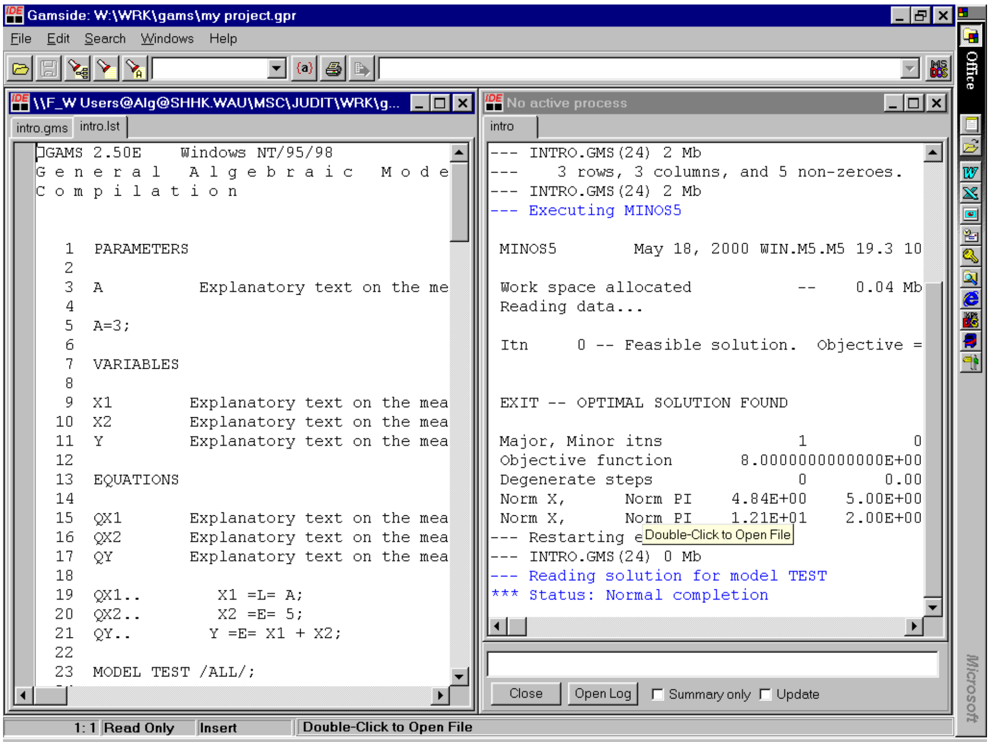


Results from 1.1.2.



Results from 1.1.3.

After running the model, the GAMS-IDE should look similar to this[1]:



Results from 1.1.4.

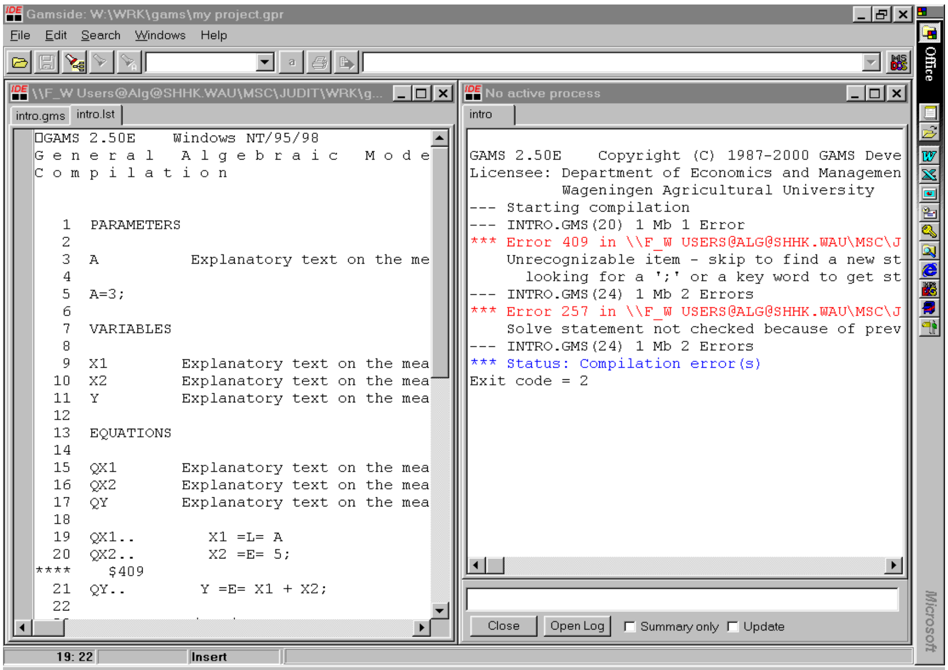
In our simple example, the report on the variables should be as follows :

```
                  LOWER          LEVEL         UPPER          MARGINAL
---- VAR X1       -INF           3.0000        +INF               .
---- VAR X2       -INF           5.0000        +INF               .
---- VAR Y        -INF           8.0000        +INF               .
  X1          Explanatory text on the meaning of X1
  X2          Explanatory text on the meaning of X2
  Y           Explanatory text on the meaning of Y
```

Therefore, the optimal values for variables `X1`, `X2` and `Y` are `3`, `5` and `8` respectively. Note that none of the variables has an lower or upper bound. INF means infinity, so the variables can take infinitely large and small values. The marginal value of all variables is zero, which confirms that the solution found is optimal.

[1] If you use a different solver than Minos, the process window will look different, but the same essential information is displayed.

Results from 1.1.5.



Removing the semi-colon from equation `QX1` results in the following window:
At the end of the listing file the list of errors are explained:

`“409 Unrecognizable item - skip to find a new statement; looking for a ';' or a key word to get started again”` is displayed.

Results from 1.1.6.

The problem is `UNBOUNDED`, because you can keep lowering the value of `Y` by lowering `X1`. Remember that `X1` should be less than `A`, not equal to. So `X1` can get any value below `3`. Consequently, `Y` can get any value below `8`. The minimum is then minus infinity; GAMS reports this as unbounded.

The listing file gives the following solve summary:

```
**** SOLVER STATUS     1 NORMAL COMPLETION
**** MODEL STATUS      3 UNBOUNDED
```

Results from 1.1.7.

The results for the variables when the tax rate (`tax`) equals 30 is:

```
              LOWER        LEVEL         UPPER         MARGINAL
VAR DAMAGE    -INF      6000.0000        +INF             .
VAR ST_RATE   -INF         0.5000        +INF             .
VAR CATTLE    -INF       500.0000        +INF             .
VAR OBJ       -INF      4000.0000        +INF             .
```

For `tax=20`, `obj` equals `6000`; for `tax=10`, `obj` equals `6000` and for `tax=0`, `obj` equals 4000; the optimal value of `tax` is 15, when `obj` equals `6250`.

Make sure that you use the explanatory text.

Results from 1.1.8.

The values of `X1` and `Y` should be identical to the earlier exercises: `3` and `8`, respectively.

Did you think of removing the equation declaration and the equation definition for `QX2`?

The full model for emissions can look like this:

```
PARAMETERS
      coef  Emission coefficient CO2
      OTHER Emissions of other greenhouse gasses;
      Coef=0.03;
      OTHER=5;
VARIABLES

      CO2   Emissions of CO2
      PRD   Production quantity
      EMIS  Total emissions of greenhouse gasses;
EQUATIONS

      QPRD  Equation for economic production
      QCO2  Equation for CO2 emissions
      QEMIS Equation for total climate emissions;

QPRD..      PRD =G= 100;
QCO2..      CO2 =E= coef*PRD;
QEMIS..     EMIS =E= CO2+OTHER;

MODEL CLIMATE /ALL/;
SOLVE CLIMATE USING DNLP MINIMIZING EMIS;


With solution:
                        LOWER     LEVEL     UPPER    MARGINAL
---- VAR EMIS           -INF      8.000     +INF       .
---- VAR CO2            -INF      3.000     +INF       .
---- VAR PRD            -INF    100.000     +INF       .
```