Exercise 8

1. Open the file `h08t01.c`.

   a) Comment all commands related to pointers and arrays.

   b) What would the program print? Check your answer by compiling and executing the program.

   c) Execute the program in debug mode and watch the values of the elements of `t`.

2. Write a function which tests whether the elements in a number array are in order of magnitude.

   Hint: The function should take the array as argument. The checking can be made for example by comparing consecutive elements with some loop structure.

3. Write a function which sorts the elements of a number array into increasing order of magnitude.

   Hint: You can use the function of the previous exercise. The order can be accomplished for example as follows: Compare consecutive elements of the array, and if the former is greater than the latter, swap the elements. In this way, go through the whole array, and then check if the elements are in order. If not, do the same again.

4. Write functions which carry out the following vector calculations. Let $\vec{x} = (x_1, x_2, \ldots, x_n)$ and $\vec{y} = (y_1, y_2, \ldots, y_n)$ be vectors, and a a real number.

   a) The sum of two vectors:

   $$\vec{x} + \vec{y} = (x_1 + y_1, x_2 + y_2, \ldots, x_n + y_n).$$

   b) Scalar times vector:

   $$a\vec{x} = (ax_1, ax_2, \ldots, ax_n).$$

   c) The dot product of two vectors:

   $$\vec{x} \cdot \vec{y} = x_1 y_1 + x_2 y_2 + \ldots + x_n y_y.$$

   d) The cross product of two vectors (defined only if $n = 3$):

   $$\vec{x} \times \vec{y} = (x_2 y_3 - x_3 y_2, x_3 y_1 - x_1 y_3, x_1 y_2 - x_2 y_1)$$

   Hint: If the result of the calculation is a vector, the function should take as argument the array where the result is calculated. For example,

```
void vec_sum(double x[],double y[],double z[]);
```

or

```
void vec_sum(double* x,double* y,double* z);
```

5. Write functions which carry out the following matrix calculations. Let A and B be matrices, and α a real number. Denote the element on the ith row in the jth column of the matrix A by $(A)_{ij}$.

   a) The sum of two matrices:

   $$(A + B)_{ij} = (A)_{ij} + (B)_{ij}.$$

   Note that the matrices have to be of the same size!

   b) Scalar times matrix:

   $$(\alpha A)_{ij} = \alpha(A)_{ij}.$$

   c) The product of two matrices:

   $$AB = \sum_{k=1}^{N} (A)_{ik}(B)_{kj}.$$

   Note that the number of columns (i.e. the length of the rows) in matrix A has to be the same as the number of rows (i.e. the length of the columns) in matrix B.

   d) The transpose of a matrix:

   $$(A^T)_{ij} = (A)_{ji}.$$

   With your program, show that the multiplication of matrices is not commutative, that is, $AB \neq BA$ in general.

   Hint: As in the previous exercise, the functions should take as argument the array where the result is calculated.