Computational Skills
Class 2

EC 2000 Modules

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Class 2: Algorithms

- An algorithm is a step-by-step procedure for solving a problem.
- Computer programs merely implement your algorithm.
- Before writing a program, you need to have in mind how the program is going to solve your problem.

Challenge Problem

Find the surface area of one side of an arbitrarily shaped flat component. The component fits in a 1 meter by 1 meter square, and occupies from 1/5 to 4/5 of the total area.

Group Exercise

1. Break into groups of about 3 people.
2. Make a list of the problems you need to solve in order to find the area of the object.
3. Make a plan for how you would find the area.

One Solution

1. How do you represent the object?
   How do you calculate its area?

2. Divide the 1m x 1m square into 1cm x 1cm squares. Label each square as totally, partially or not in the object. Add the area of squares in the object, and half the area of squares partly in the object.

Algorithm

Representing the object: Create a 100 x 100 matrix with 0 for squares not in the object, .5 for squares partly in, and 1 for squares in the object.

Add up the entries in the matrix and multiply by .0001 m^2 . This will yield the area.

```
%  Matlab Solution.  Assume each element of matrix inobj is
%  1, 0 or ½ depending on whether the corresponding square
%  is in the object, or part way in.  Assume inobj is already
%  created.

        area = 0;

        for j = 1:100                       % add up elements

                for k = 1:100                       % of inobj.

                        area = area + inobj(j,k);

                end

        end

        area = area*.0001;                  % convert to meters^2
```

Solution Using Vector Functions

```
area = .0001*sum(sum(inobj));
```

The inner sum adds up each column, and returns a row vector of column sums. The outer sum adds up these sums.

Levels of Abstraction

Sometimes it is helpful to look at a problem at different levels of abstraction. For example, our algorithm just said add up the elements of the matrix. We saw there were two ways to do this in Matlab, either through looping, or using vector functions.

Exercise 2

Develop a step-by-step procedure to open a door. You may assume the door is unlocked, has a doorknob, and swings open towards you.

Solution

1. Grasp doorknob.
2. Turn doorknob.
3. Pull on door.
4. Stop pulling when door is open.

Exercise 3

Develop a step-by-step procedure for computing the mean and variance of 10000 numbers.

$$\bar{x} = \frac{1}{10000} \sum_{k=1}^{10000} x_k$$

$$\sigma_x^2 = \frac{1}{10000} \sum_{k=1}^{10000} (x_k - \bar{x})^2$$

Solutions

1. Add up x values.
2. Divide by 10000 to get mean.
3. Add up $(x_k - \bar{x})^2$.
4. Divide by 10000 to get variance.

Exercise 4

Develop a Matlab program to compute the mean and variance of 10000 numbers.

$$\bar{x} = \frac{1}{10000} \sum_{k=1}^{10000} x_k$$

$$\sigma_x^2 = \frac{1}{10000} \sum_{k=1}^{10000} (x_k - \bar{x})^2$$

```
% Compute mean and variance
        meanx = 0; var = 0;                     % add up x's
        for k = 1:10000
                meanx = meanx + x(k);
        end
        meanx = meanx/10000;                    % average
        for k = 1:10000
                var = var + (x(k)-meanx)^2;
        end
        var = var/10000;
```

Solution Using Vector Functions

```
% Compute mean and variance
   meanx = sum(x)/10000;
   var = sum((x-meanx).^2)/10000;
% or
   meanx = mean(x);
   var = mean((x-meanx).^2);
%  Advantage: number of points is not stated.
```