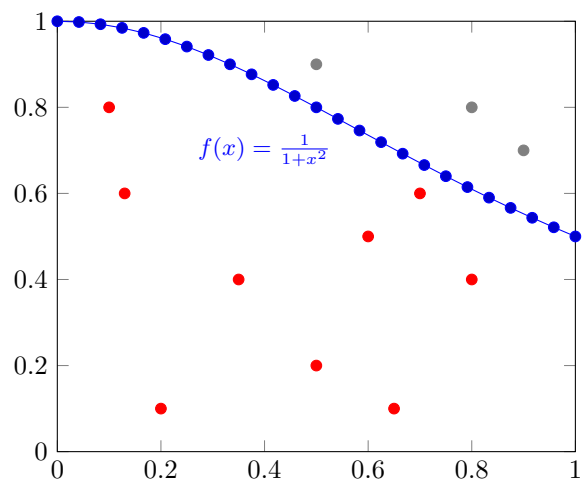
Numerical integration

1 Numerical integration

This exercise is about parallelizing a code that computes the integral of the function

$$f(x) = \frac{1}{1+x^2}$$

in the $[0,1]$ interval. This will be done by generating `npoints` random points in the $[0,1] \times [0,1]$ box; the number of points falling below $f(x)$ divided by the total number of points `npoints` will provide an estimate of the integral. The procedure is illustrated in the figure below.



In this case, the integral times 4 should be equal to π.

Random numbers are generated using the

```
double rnd_doub(int *seed)
```

routine which takes, as input, the address of the integer variable providing the seed which is a value used to generate a distinct sequence pseudo-random values. This routine is assumed to be "thread-safe", i.e. it can be called simultaneously by different threads, only if called with a different argument, that is, only if a different **seed variable address** (not value) is passed by the calling threads. If this routine is called simultaneously by multiple threads passing the same argument, it prints out an error message.

2 Package content

In the `Integration` directory you will find the following files:

- `main.c`: This file contains the main program. This reads from command line the number of random points to be generated. For a very high number of random points, the estimated value must be very close to π. **Only this file must be modified for this exercise.**
- `aux.c, aux.h`: these two files contain auxiliary routines and declarations and **must not be modified**.

The code can be compiled with the `make` command: just type `make` inside the `Integration` directory; this will generate a `main` program that can be run like this:

```
$ ./main npoints
```

where `npoints` is the number of random points to generate.

3 Assignment

- The objective of this exercise is to parallelize the code of the `main` program in order to reduce its execution time. Therefore, the same number of random points must be generated regardless of the number of working threads.