Becs-114.1100 Computational Science
Exercise round 9

https://mycourses.aalto.fi/course/view.php?id=4367

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Problems

- Problem 1: 3 points
- Problem 3: 2 points

Problems 2 and 4 are optional (0 points).

Problem 1

- In part a, give formulae for the estimator of A and its error.
- When the exact expected value and error of a single measurement A_i is unknown, we can use the sample mean and sample variance to estimate them. (Why are these usually unknown in application of Monte Carlo? In part b, one can actually compute their theoretical values.)
- Why is the central limit theorem (or the law of large numbers) crucial for obtaining an estimate of A?

Problem 1

- In part b, you should run a loop where N (the number of attempts in a single measurement) runs from 1000 to 30000. Inside this loop, you should make 1000 measurements to obtain a reliable estimate for π and the error. Each measurement (giving you a π_i) consists of N attempts, so you have three nested loops:

```
for N=1000:1000:30000 % Number of attempts
   for i=1:1000 % Loop over independent measurements
      for j=1:N % N attempts
         [Monte Carlo stuff]
      end
      [Get estimate for pi]
   end
   [Get statistics of the 1000 estimates for the given N.
end
```

Problem 1

- Of course, it is recommended to organize your code into functions. For example, you could write a function for computing one Monte Carlo estimate of π, which takes N as argument and which you call 1000 times.
- Use smaller number of measurements and/or N when developing and testing your code, if the computation takes too long.
- Comment on the relation between the errors and N in the report.

Problem 3

- The example in the lecture material on page 12 is very similar to the task here.
- Let the number of samples N range from 100 to 100000, for example. Use preferably log-scale and plot the error in log-log-plot (for example, use pylab's `logspace` command to generate a set of Ns,
  `Ns = map(lambda x: int(round(x)), logspace(2, 5, 50))`,
  and `loglog` for plotting).
- Compute one estimate of the value of the integral for each value of N. Do this using both methods.
- Compute the exact value of the integral by hand and use that for computing the errors.