

High Performance Computing for Science and Engineering

Exercise 3: Monte Carlo, OpenMP, False Sharing

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Monte Carlo integration

- Estimate integral as mean over random variables

$$\int_{\Omega} f(x) dx \approx \frac{|\Omega|}{N} \sum_{i=1}^N f(X_i) \quad \Omega \in \mathbb{R}^d$$

- Used in high dimensional space due convergence rate, the error scales as:

$$\text{MC: } \sim N^{-0.5}$$

$$\text{rectangle rule: } \sim N^{-2/d}$$

Random numbers in C++11

```
#include <random>

// generator: provides pseudorandom sequence in its internal state
std::default_random_engine g(123);

// distribution: converts to desired range
std::uniform_real_distribution<double> u(-1., 1.);

double a = u(g);
```

- generators are not thread safe!
- distribution is a lightweight object with constant internal state

Hints for Euler

- interactive job: from login node run

```
OMP_NUM_THREADS=24 bsub -n 24 -R "span[ptile=24] fullnode" -W 0:10 -Is /bin/bash
```

gives direct access to full compute node once the allocation is granted

- copy files: from your computer run

```
rsync -Pa <user>@euler.ethz.ch:<path> .
```

copies from remote to current folder, with path absolute or relative to home