



UNIVERSITÉ DE REIMS CHAMPAGNE-ARDENNE

INFORMATIQUE

École Doctorale Sciences Technologie Santé

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# The Way to Exascale: From Theorics to Applied Problems

Vers l'Exascale: Des Problèmes Théoriques aux Problèmes Appliqués

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# Acknowledgments

Thanks everyone !



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# Introduction



# Chapter 1

## HPC and Exascale

### 1.1 Introduction

We only consider homogenous cluster in that work.

### 1.2 Parallelism

#### 1.2.1 Flynn taxonomy

The Flynn taxonomy presents a hierarchical organization of computation machine.

In this classification [Fly72b], Michael J. Flynn presents the SIMD, SISO, MISD and MIMD. Add table and present some examples of machines

#### 1.2.2 Goals

##### Speedup

Speedup can be separated into two parts, Latency and Throughput.

#### 1.2.3 Bottlenecks

#### 1.2.4 Amdahl and Gustafson

The Amdahl's [Amd67] law is used to find the theoretical speedup in latency of a program. We can separate a program into two parts, the one that can be executed in parallel and the one that is sequential. And even if we reduce the parallel part to infinite the sequential part will reach 100% of the total time.

## 1.3 Hardware

### 1.3.1 Classical CPU

### 1.3.2 GPU

### 1.3.3 FPGA and ASICs

## 1.4 Clusters and Exascale

### 1.4.1 Benchmarking

TOP500

### 1.4.2 Composition and usage

### 1.4.3 Interconnection

## 1.5 Languages

### 1.5.1 Accelerators

### 1.5.2 Runtimes

## 1.6 Optimization

Memory locality

Vectorization

### 1.6.1 CPU specifications

### 1.6.2 GPUs specifications

### 1.6.3 Communications

## 1.7 Conclusion

# Chapter 2

## Complex systems

### 2.1 Introduction

### 2.2 Combinatorial problems

#### 2.2.1 Combinatorial search

#### 2.2.2 Combinatorial optimization

### 2.3 A case study, the Langford problem

Use the articles here for figures and a base report.

### 2.4 Complex systems as a benchmark

### 2.5 GRAPH500

Use the articles here too

### 2.6 Conclusion





## Chapter 3

# Application



# Conclusion

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# Annexes



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