

# Research Activities at the Computer Science Research Centre of WUT

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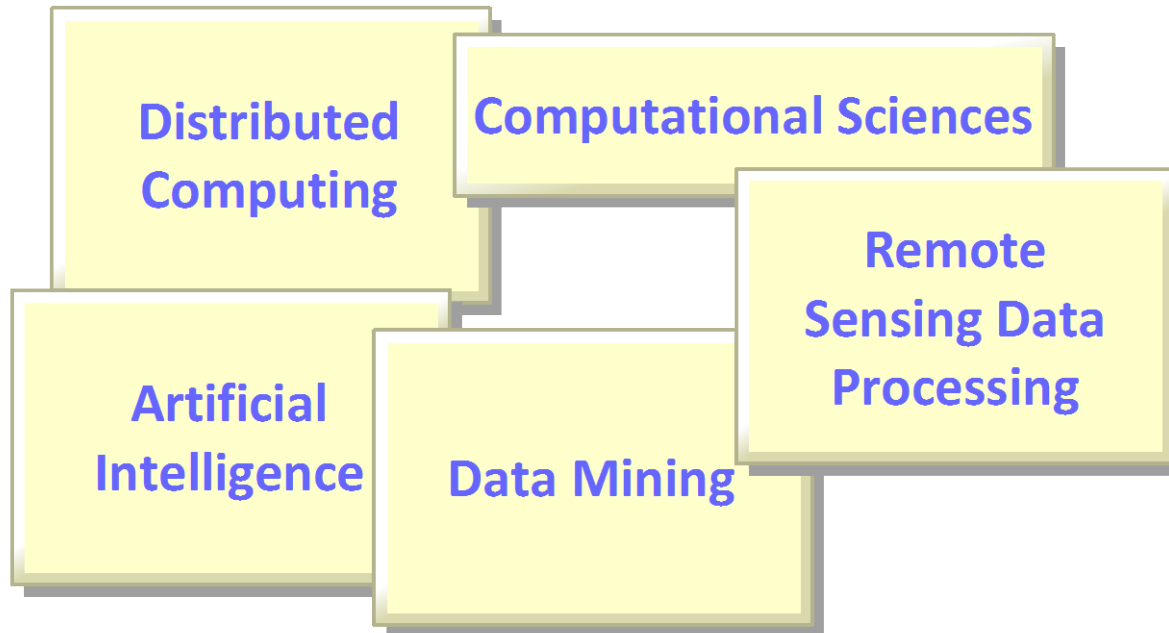
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# Research Topics Overview

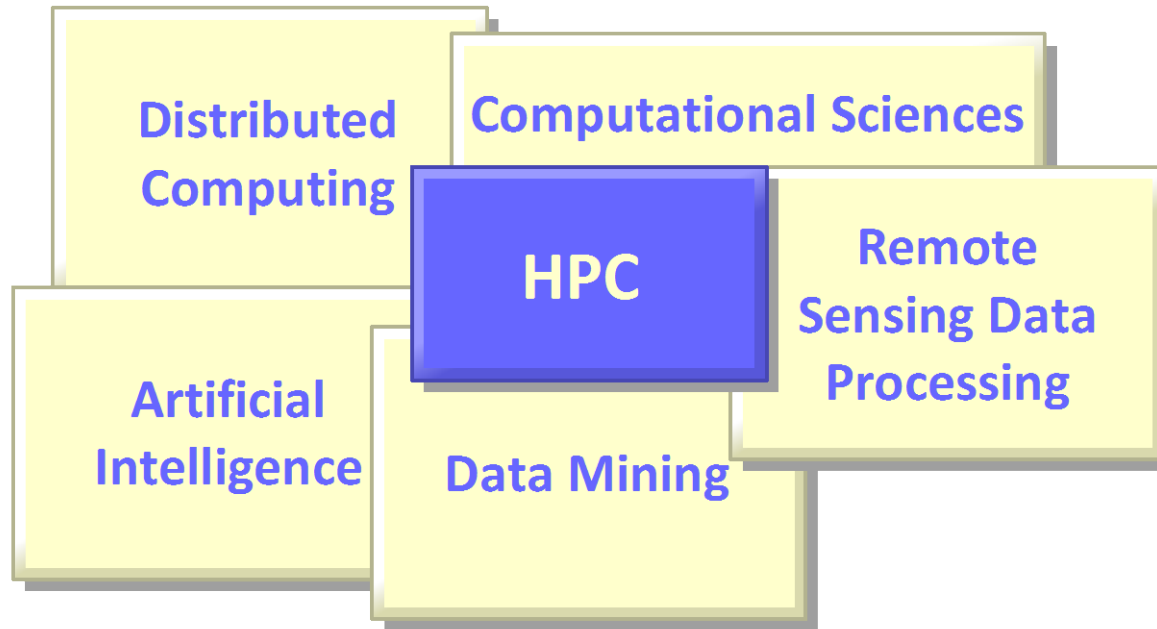


Different topics but similar challenges:

- Large sets of data or large search spaces
- Computationally intensive tasks



# Research Topics Overview



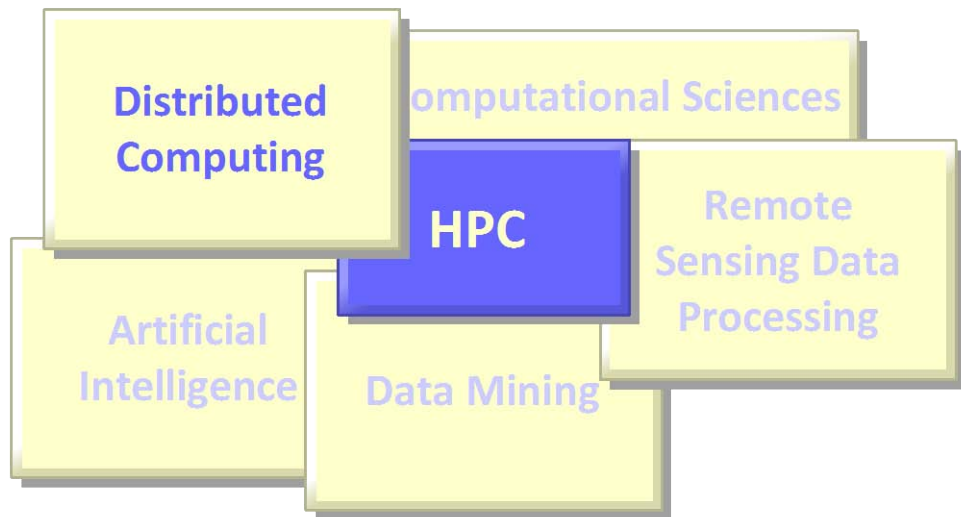
Different topics but similar challenges:

- Large sets of data or large search spaces
- Computationally intensive tasks

**... which require high performance solutions**



# Distributed Computing



## Related projects:

- AMICAS - Automated Management in Cloud and Sky Computing Environments (PN-II-ID-PCE)
- Open European Network for High Performance Computing on Complex Environments (COST Action)

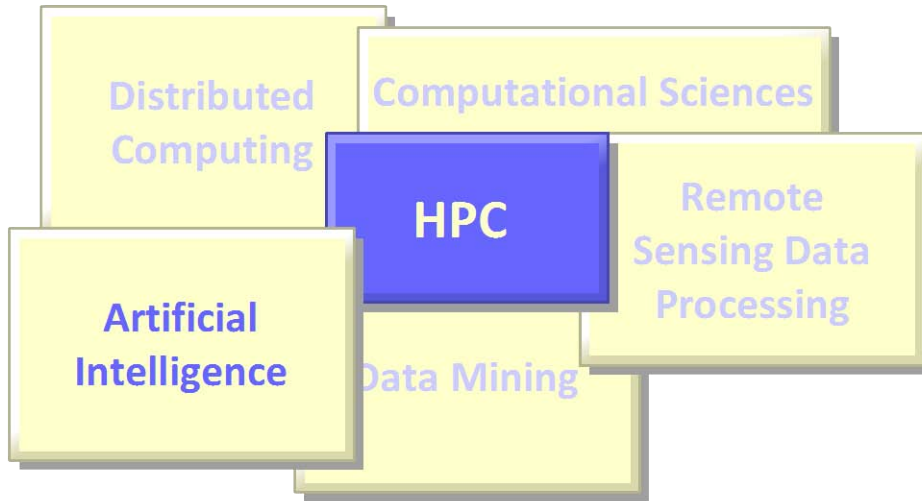
## Current research topics:

- Cloud computing technologies for HPC service exposure
- Scheduling algorithms and techniques

## Challenges in solving scheduling problems:

- Large search space
- Complex optimization problem (multiple objectives, constraints, dynamic)

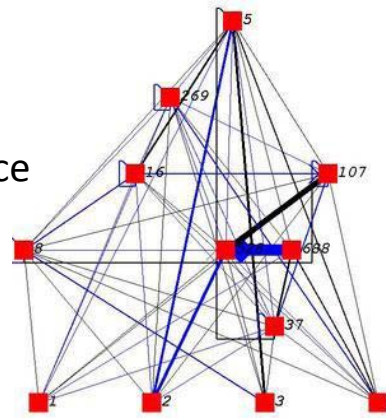
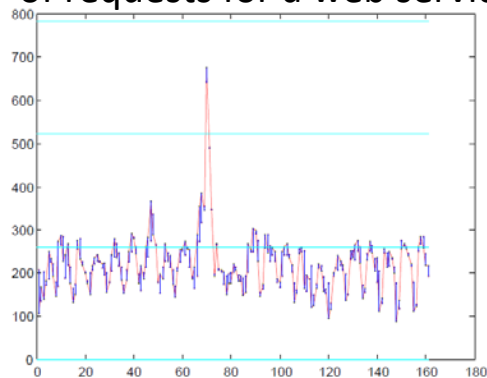
# Artificial Intelligence



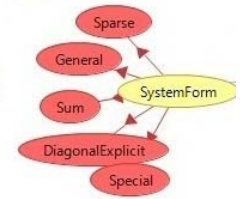
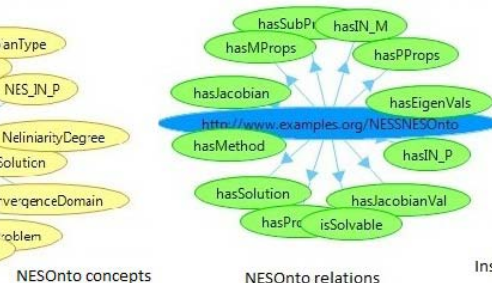
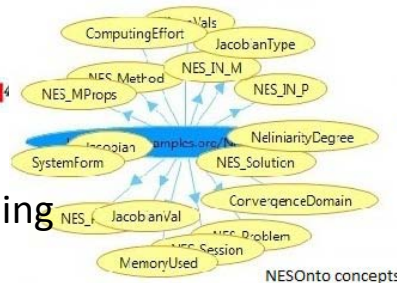
## Current research topics:

- HPC-based intelligent services
- Multi-agent approaches in:
  - Stock trading systems
  - Frameworks for strategy games
- Machine learning techniques in:
  - Prediction for auto-scaling of resources in distributed systems
  - Analysis of financial data
- Ontologies for semantic services

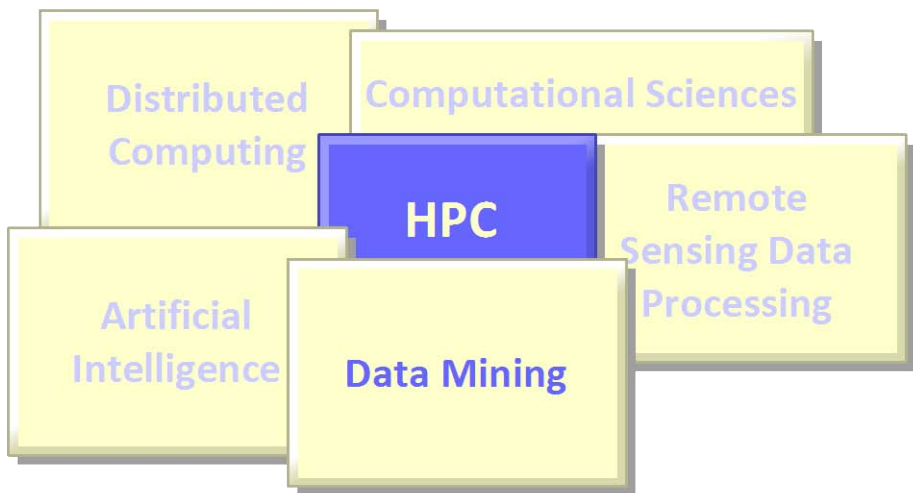
Predicting the number of requests for a web service



Neural network for game strategy learning



# Data Mining



## Research topics:

- Distributed architectures for data mining
- Unsupervised classification of distributed data
- Extracting classification/prediction rules from data

## Data mining and machine learning as a Service:

- Access through lightweight web services (REST)
- Access to algorithms' parameters
- User experience enhancements

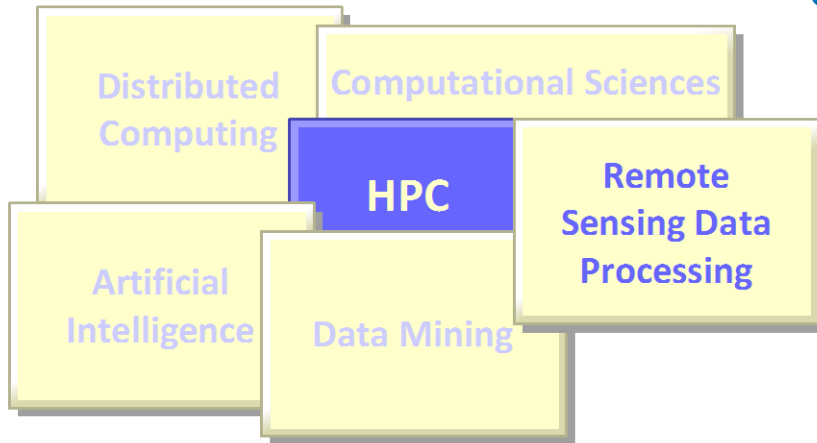
Semantic modeling

## Challenges in data mining:

- Large sets of data
- Response in real-time (prediction models)



# Remote Sensing Data Processing

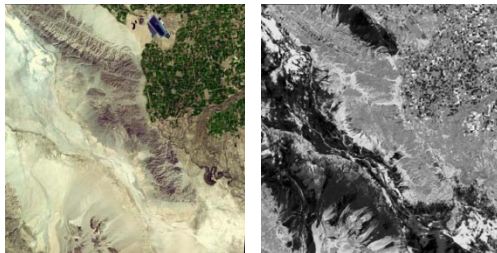


## Challenges:

- Large images (many pixels, many spectral bands)
- Computational intensive image analysis algorithms

## Current research topics:

- Processing multi/hyper spectral images:
  - Identify homogeneous regions
  - Identify reference substances



## Results:

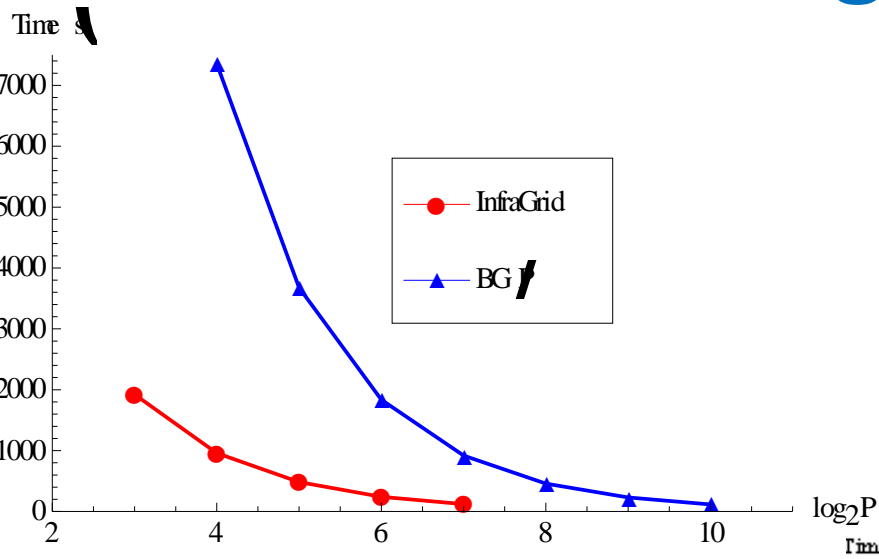
- Parallel implementations of
  - spatial variants of fuzzy clustering
  - algorithms for spectral mixture analysis (end-members extraction and abundances estimation)



# Remote Sensing Data Processing

Efficiency of parallel fuzzy clustering tested on:

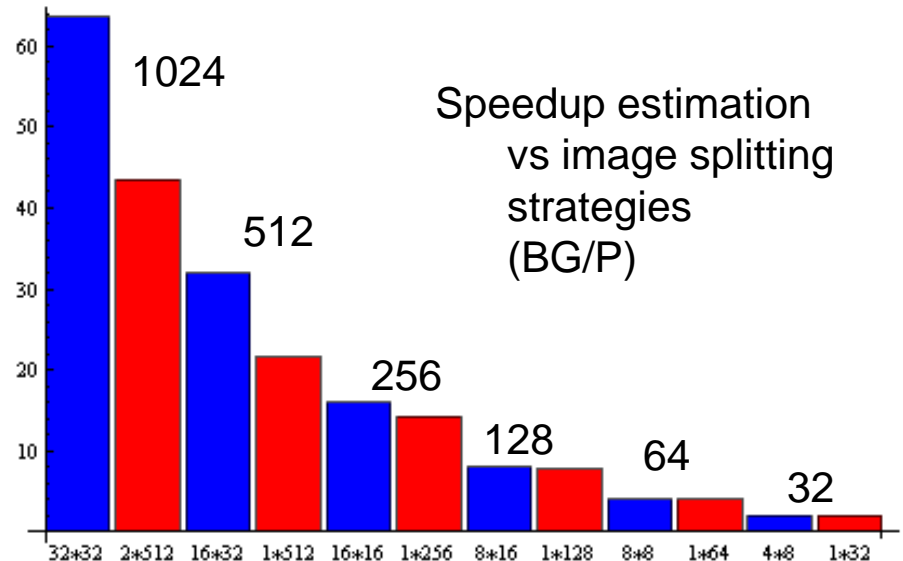
- InfraGrid cluster
- BG/P



Test images:

- LANDSAT (8786 x 7856 pixels, 4 spectral bands)
- AVIRIS (614 x 2206 pixels, 224 spectral bands)

Time(16)/Time(P)

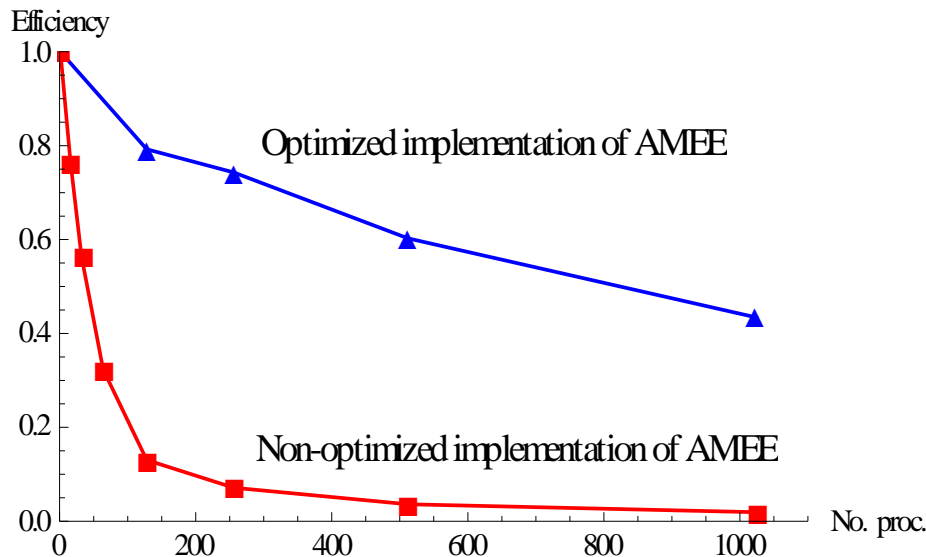




# Remote Sensing Data Processing

- Efficient implementation of endmembers extraction algorithms
  - AMEE (Automated Morphological Endmembers Extraction)
  - MVSA (Minimum Volume Simplex Analysis)

## AMEE on BG/P

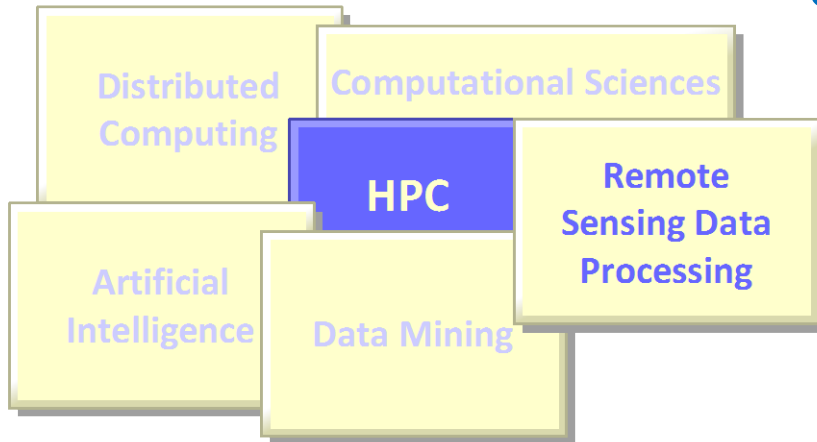


## MVSA on GPU

- Sequential implementation (Matlab): **3h**
- Parallel implementation (IBM blade with two Intel Xeon quad-core processors and one FermiTesla M2075 GPU, C+CUDA ): **2 minutes**



# Remote Sensing Data Processing



## Collaborations

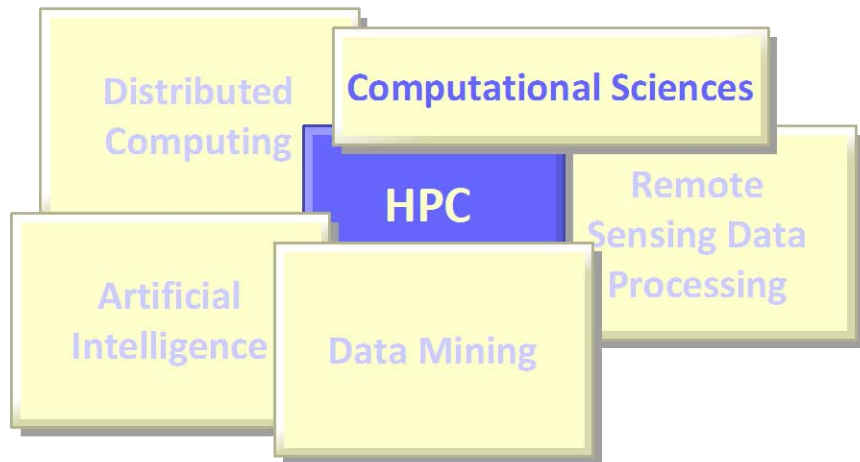
- IBM CAS Cairo, Egypt
- Ain Shams University, Cairo, Egypt
- University of Extremadura, Spain

## Related projects:

- IBM OCR – High-Performance Satellite Multi/Hyperspectral Image Processing (2010-2011)
- GiSHEO - On demand Grid services for high education and training in Earth observation (ESA-PECS, 2008-2010)
- HPC-SEE - High-Performance Computing Infrastructure for South East Europe's Research Communities (FP7-Infrastructures, 2010-2013)
- HOST – HPC Service Center (FP7-REGPOT, 2012-2014)



# Computational Sciences



## Related projects:

- Analysis of some mathematical physics problems occurring in the sound attenuation in an acoustically lined duct carrying gas flow (PN-II-ID-PCE, 2011-2013)
- SIMTIM -Modeling and simulation of the dynamics of thymocyte populations and cells of the thymus medulla under normal and pathological situations (PN-II-ID-PCE, 2012-2014)

## Computational Mathematics:

- Efficient methods for solving large systems of equations
- Preconditioning through bandwidth reduction

## Computational Physics:

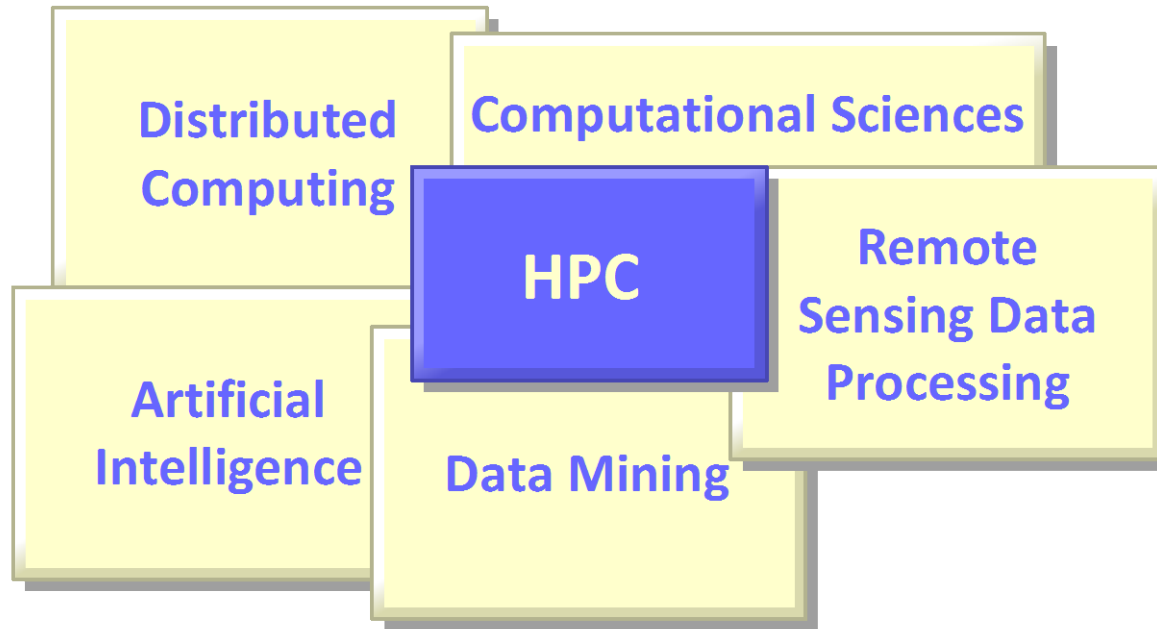
- Efficient computational methods in nanoscale optics
- Simulation of crystallization processes, transport phenomena, acoustic lining

## Computational Biology :

- Simulating the dynamics of thymus cells populations starting from experimental data



# Summary



**HPC** tools allow to solve challenging problems arising in various fields

**HPC** raises new challenges

**HPC** as a Service

