WP5: High Performance Mathematical Computing (HPC)
OpenDreamKit Workpackage Presentations

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WP5: High Performance Mathematical Computing

<table>
<thead>
<tr>
<th>Site</th>
<th>UPSud</th>
<th>CNRS</th>
<th>UJF</th>
<th>UK</th>
<th>USHEF</th>
<th>USTAN</th>
<th>LogiLab</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effort</td>
<td>6</td>
<td>40</td>
<td>52</td>
<td>60</td>
<td>12</td>
<td>18</td>
<td>12</td>
<td>200</td>
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Objectives

Improve the performance of the computational components of OpenDreamKit.

- **Parallelization:**
  - Fine grain on many-core architectures
  - Coarse grain on clusters, grids and cloud

- Compilation of high level interpreted code
- HPC infrastructure for combinatorics
- Code composition
- Exchange expertise et best practices

Organization: 1 Task per component
WP5 Tasks

**T5.1: PARI (CNRS)**

Internal use of pthreads and MPI, but lacks a clean exposition of parallel features to outside software (e.g. SageMath)

- **D5.10** Devise a generic parallelisation engine for PARI and use it to prototype selected functions
- **D5.16** PARI suite release supporting parallelization

**T5.2: GAP (USTAN)**

- a library of parallel algorithms for algebraic computations
- interfaces between GAP and std Cloud and HPC infrastructures

- **D5.15** Final report
# WP5 Tasks

<table>
<thead>
<tr>
<th>T5.3: LinBox (UJF)</th>
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<tbody>
<tr>
<td><strong>D5.9</strong> DSL for code composition and hardware abstraction</td>
</tr>
<tr>
<td><strong>D5.12</strong> New algorithms and implementations with close integration in SageMath</td>
</tr>
<tr>
<td><strong>D5.14</strong> Support distributed computing and heterogeneous architectures</td>
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<th>T5.4: Singular (UK)</th>
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<tr>
<td><strong>D5.6</strong> Parallel relation sieving and Block-Wiedemann</td>
</tr>
<tr>
<td><strong>D5.7</strong> Parallel Matrix FFT and SIMD optimizations</td>
</tr>
<tr>
<td><strong>D5.13</strong> Parallel Sparse polynomial arithmetic</td>
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### WP5 Tasks

#### T5.5: MPIR (UK)

Need for an assembly expert to keep up with software evolution

- **D5.5** AVX support
- **D5.7** Parallel Matrix FFT and SIMD optimizations

#### T5.6: HPC for Combinatorics (UPSud)

Need to optimize and parallelize computationally intensive parts of SageCombinat, including tree exploration techniques

- **D5.1** Pythran/Cython based tree exploration
- **D5.11** Refactor Sage combinat to exploit Pythran/Cython/Cilk++ parallelization tools
## WP5 Tasks

### T5.7: Pythran (LogiLab)

Compiling Python code to (parallelized, vectorized) C++, and exposes OMP directives in Python

- **D5.1** Pythran/Cython based tree exploration
- **D5.2** Smooth integration of Pythran based kernels in SageMath
- **D5.4** Better support for object oriented types

### T5.8: SunGrid (USHEF)

Offer Jupyter notebook on an HPC cluster

- **D5.3** Sun Grid Engine support for Project JUPYTER Hub