# Parallel Horace – design ideas

## User interaction.

1. A user expected to continue to use Horace as he does now, i.e. typing or scripting Horace commands.
2. If appropriate powerful machine or parallel cluster is available to a user, user would enable parallel capabilities by issuing a simple command. (e.g. **hpc on**), which spawns execution of the time consuming operations in parallel.
3. The parallel Horace’s features are configured using Herbert configuration classes and available for advanced users to configure and fine-tune. A simplified default version of the framework should run without any users configuring.
4. User may or may not have access to parallel computing toolbox and distributed Matlab server. The presence to these resources improves user’s computational capabilities, but the basic access to parallel Horace resources expected to be independent on these resources.
5. The commands which may take long time and will benefit from parallelization are **gen\_sqw cut\_sqw**, **unit** and **binary operations**, **tobyfit.fit** ,**sqw\_eval** and **symmetrise**.

## Technical facts, constrains and opportunities.

1. All Horace algorithms benefiting from parallelization can be summarized by the following pseudocode:

*while* condition(Data):

*For* i=1:N\_iterations

Results(i) = Do\_processing(Data,i)

*End*

condition,summary =

reduce\_results\_process\_condition(Data,Results)

*end* (condition)

*return* summary

where expensive operations of interest on Data are in fact the operations over the pixels of one or the group of sqw objects. The sqw objects expected not fit the memory. The *Do\_processing* operation can be efficiently executed independently on each pixel or small group of pixels while *reduce\_results\_process\_condition* request interprocess communications. The condition and summary variables can be easy fit into memory of a single node and exchanged through MPI communications.

The sufficient way for parallelizing such job would be division of the Data in *For* loop among MPI workers and the usage of MPI communications to gather Results and condition on a head MPI node.

1. A MPI job can always and only be executed in the form:

>> mpiexec n\_workers the\_mpi\_program

1. Matlab supports MPI jobs through **spmd** block only:

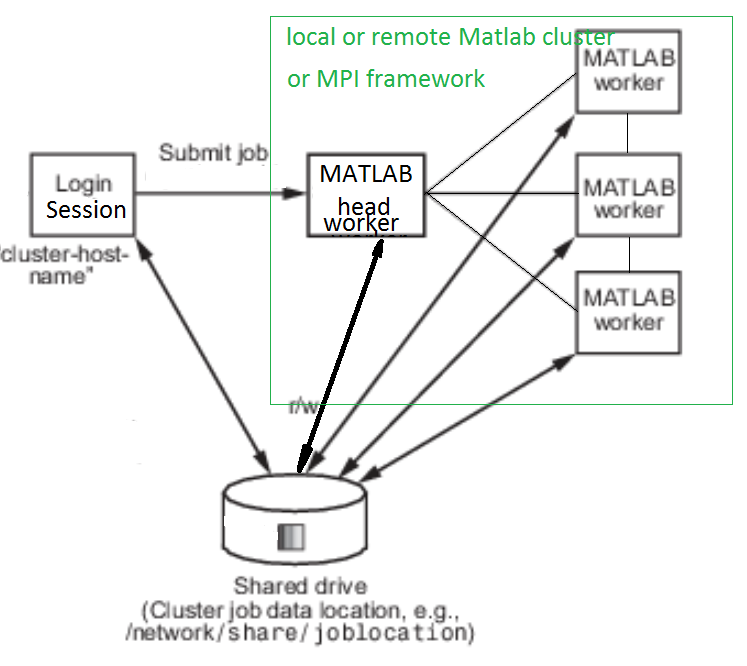
*spmd*

code\_to\_run(lab\_num)

*end* (spmd)

where the start of spmd block execution in fact equivalent to the start of mpiexec function and number of workers is defined previously within a *cluster* configuration.

1. The Matlab server configuration necessary and sufficient to run Horace MPI jobs 2.1 above has the form:



1. We expect to design and create software, working in 3 main hardware/software configurations:
   1. Powerful user machine with or without parallel computing toolbox powerful enough to run number of headless Matlab sessions.
   2. A user machine with parallel computing toolbox installed and connected to a parallel file system and accessing Matlab distributed computing server installed on a parallel cluster (like SCARF or block of DaaaS virtual machines)
   3. A user function comped on Matlab with Horace using Matlab compiler and deployed as part of an MPI job on a parallel cluster having compiled Horace installed on each node.

All these configurations can be united under the logical configuration 4)

1. Matlab parallel computing toolbox and distributed Matlab server provide range of classes and functions (blocks) to deliver system independent operations. The blocks we are decided to use are :
   1. parcluster (parpool?) -- provides interface to physical resources and job control operations
   2. MPI commands (e.g. labnum, labsend, labreceive etc), working in a spmd block only and providing low level communication and synchronization routines between different Matlab workers.
   3. SPMD blocks itself, hiding the procedure of task splitting and MPI jobs dispatching on the selected parcluster.

We are going to wrap these blocks into custom classes with common interface, to allow Horace user experience to be independent on presence of parallel computing toolbox and distributed server. The only difference should be in the performance of different configurations.

## Desighn choices.

Set of polymorphic classes will be developed to satisfy user requests 1) with the conditions 2) to support three user cases, namely:

a) User has parallel computing toolbox.

b) User have powerful machine without parallel computer toolbox

c) User has access to cluster where compiled Horace is installed

These classes are:

1. cluster : the interface to parpool class in case a), or the class which supports starting and managing the Matlab workers (headless Matlab sessions) on local machine case b) or MPI framework configurator and interface to mpiexec and MPI framework configuration in the case c)
2. MPI\_communicator: the wrapper for Matlab MPI commands in case a) , or class writing files to be interpreted as MPI messages in case b) or Matlab wrapper around mex file providing access C++ MPI framework in case c).
3. Job\_executor – the abstract class providing access to *Do\_processing* and *reduce\_results\_process\_condition* methods from chapter 2.1. Each supported algorithm from 1.5 would implement this class and provide its own algorithm specific implementations for these methods.
4. Job\_dispatcher – the class which execute Job\_executor’s *Do\_processing*  and *reduce\_results\_process\_condition* methods depending on parallel framework settings and resources, available to user
5. An sqw object and set of sqw objects will get *get\_pixels* method, which would provide access to specified number of pixels out of range of all pixels present in sqw object or sqw objects set regardless of these objects physical location (in memory or in a file)

Finally, a parallel\_config class would allow switching between all these three configurations and provide access to parameters of these frameworks.

## Note

Only options 3.a and 3.b would be implemented from the beginning of the project. Option 3.c will be implemented if sufficient resources are available.