DistArray: NumPy + distributed computing

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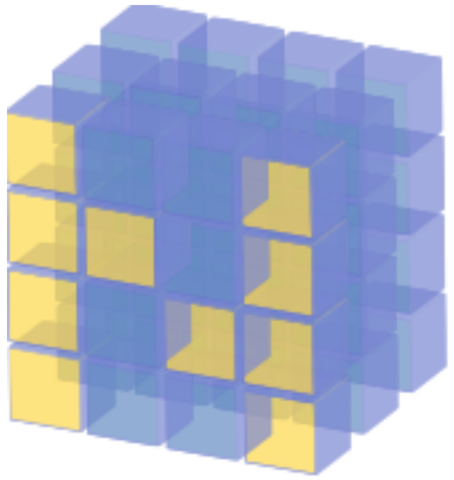
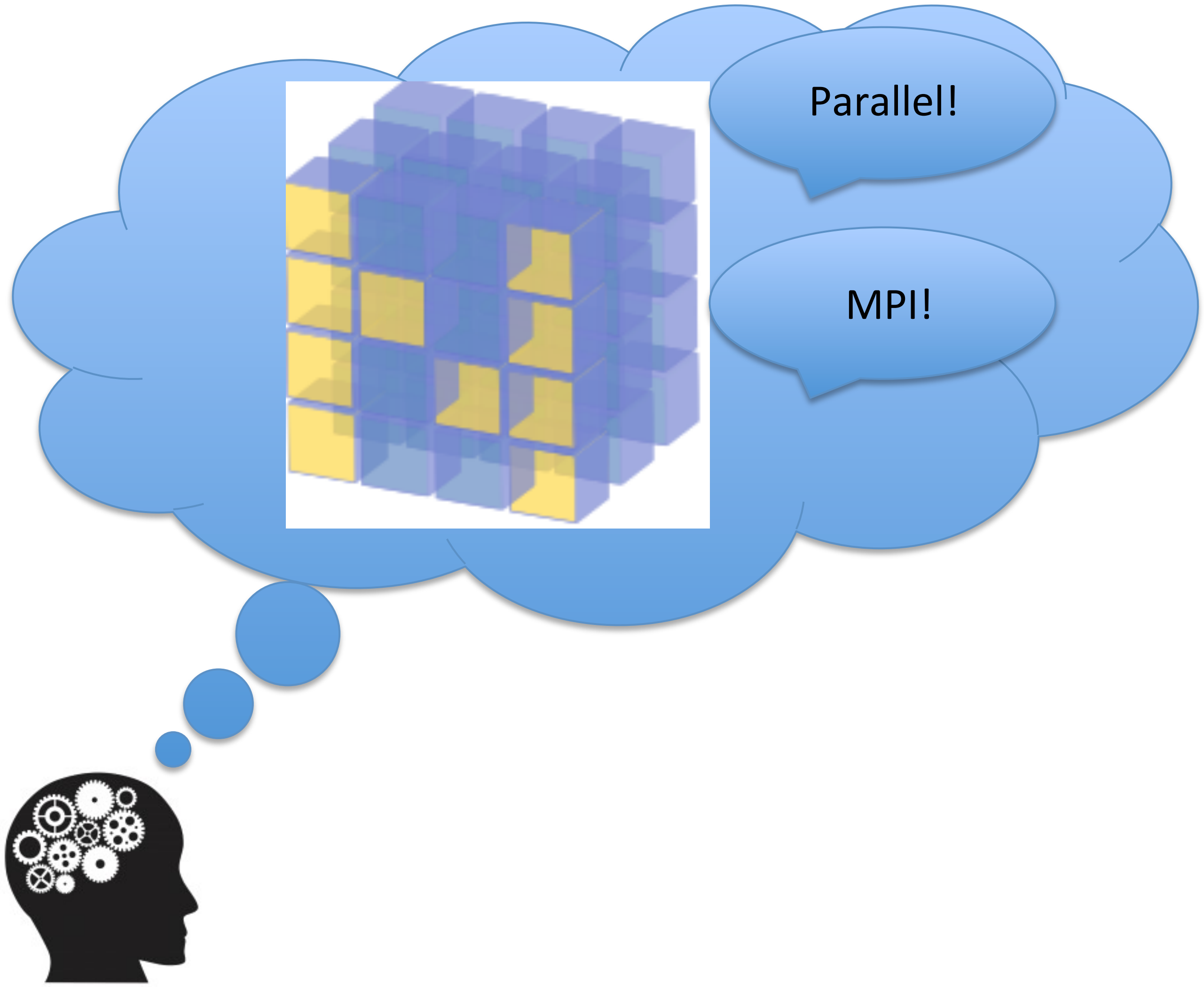
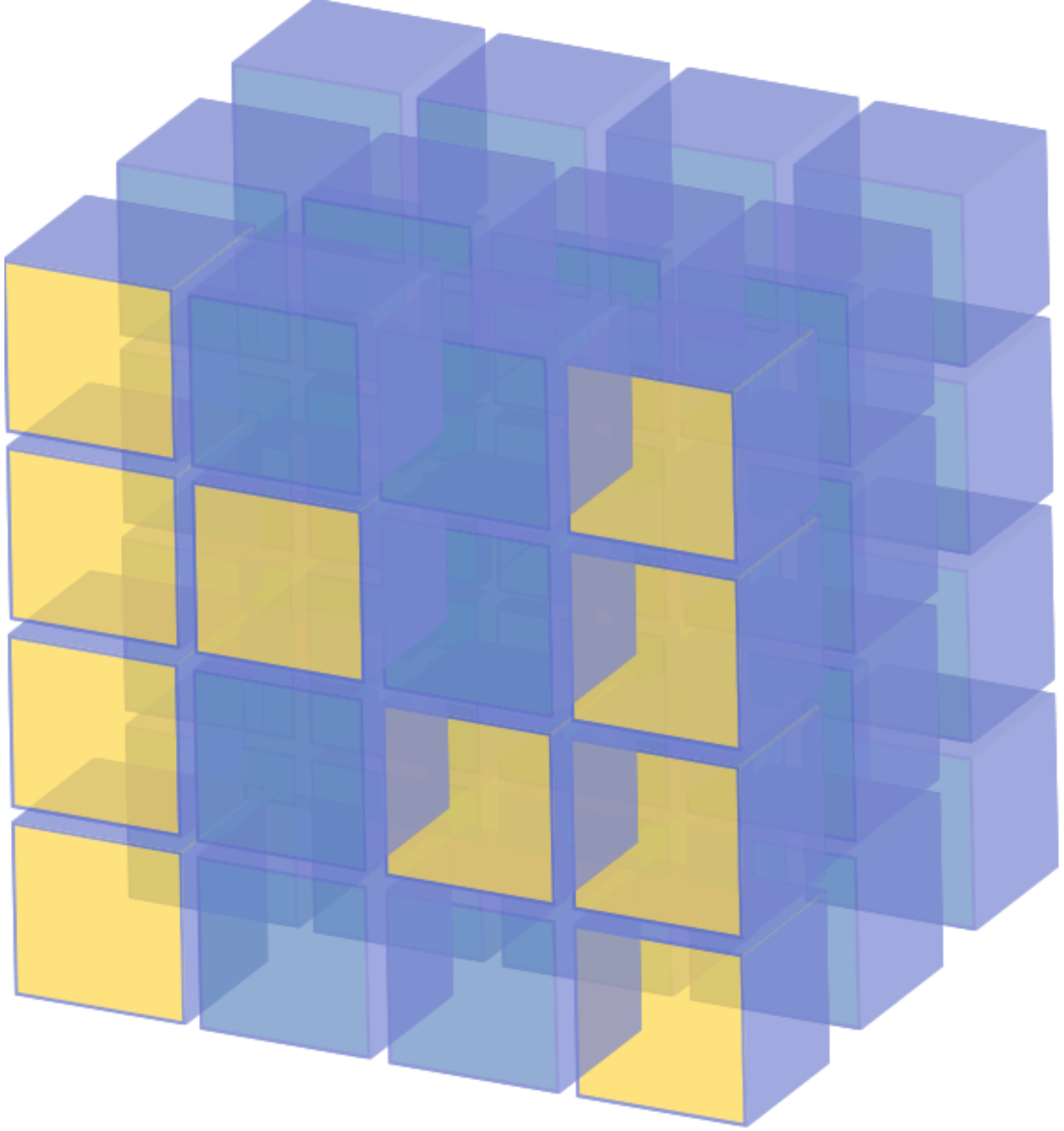
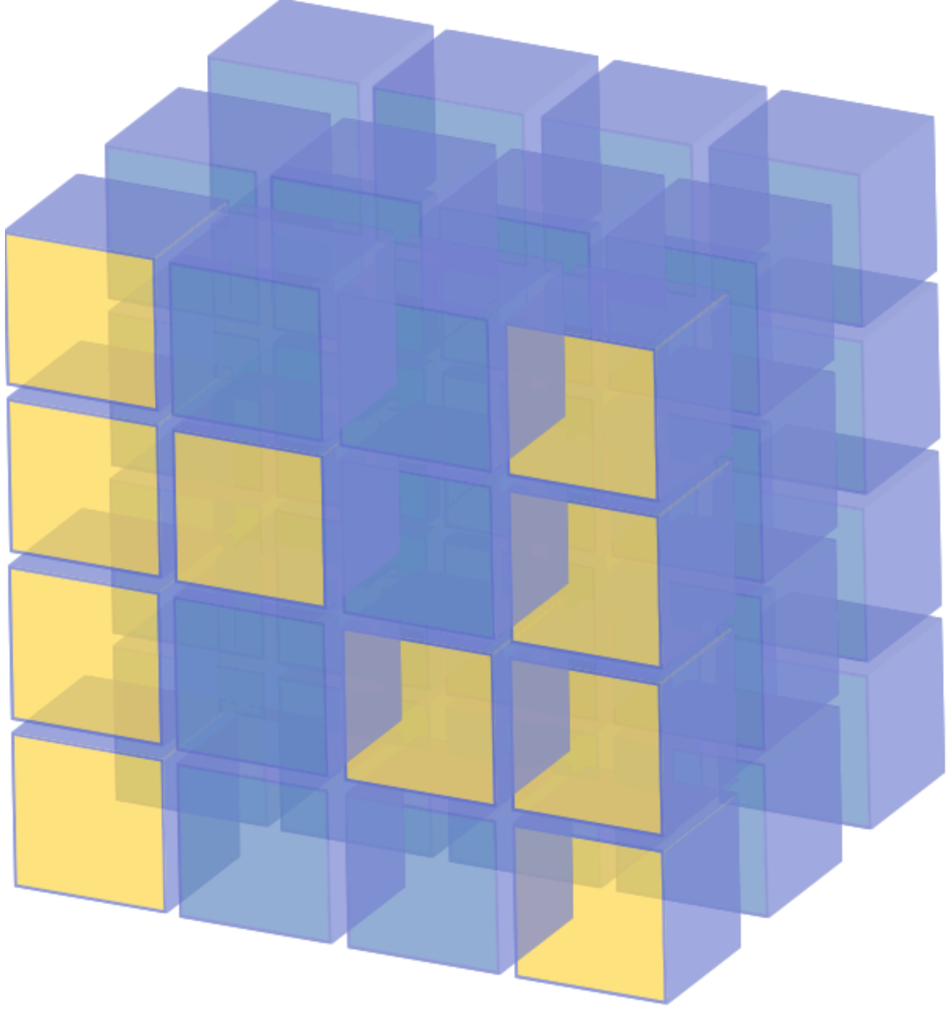
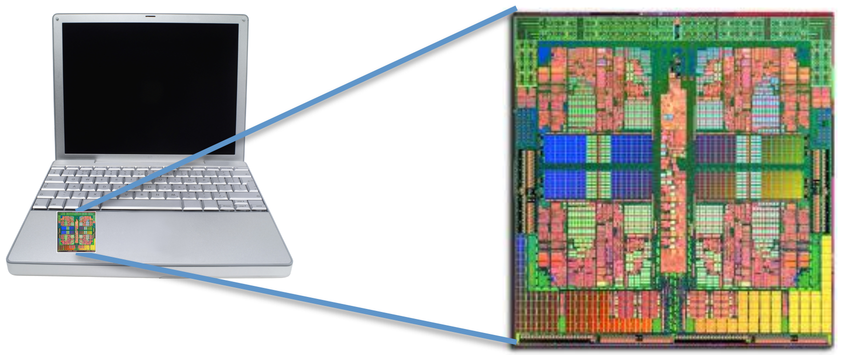
Enthought

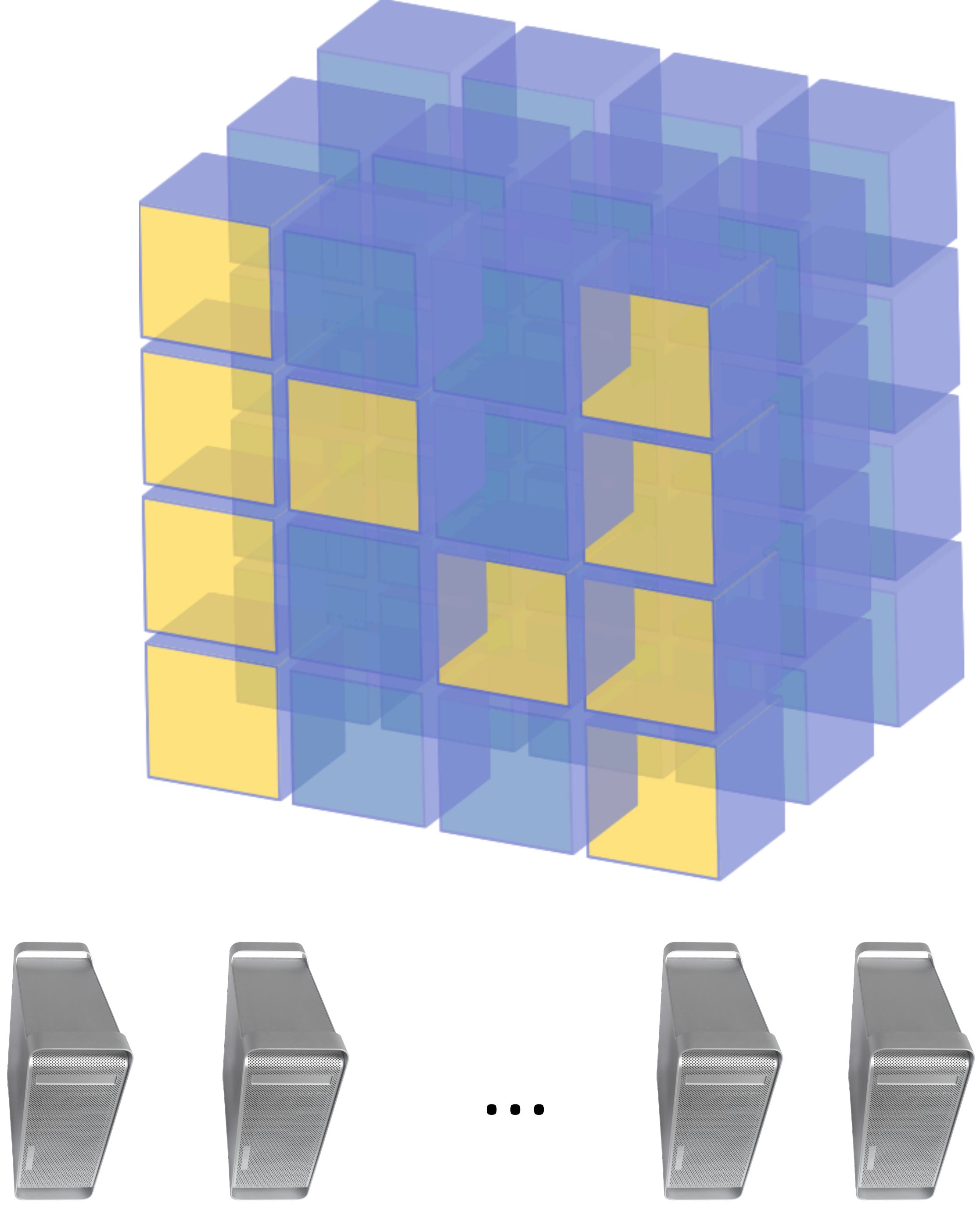


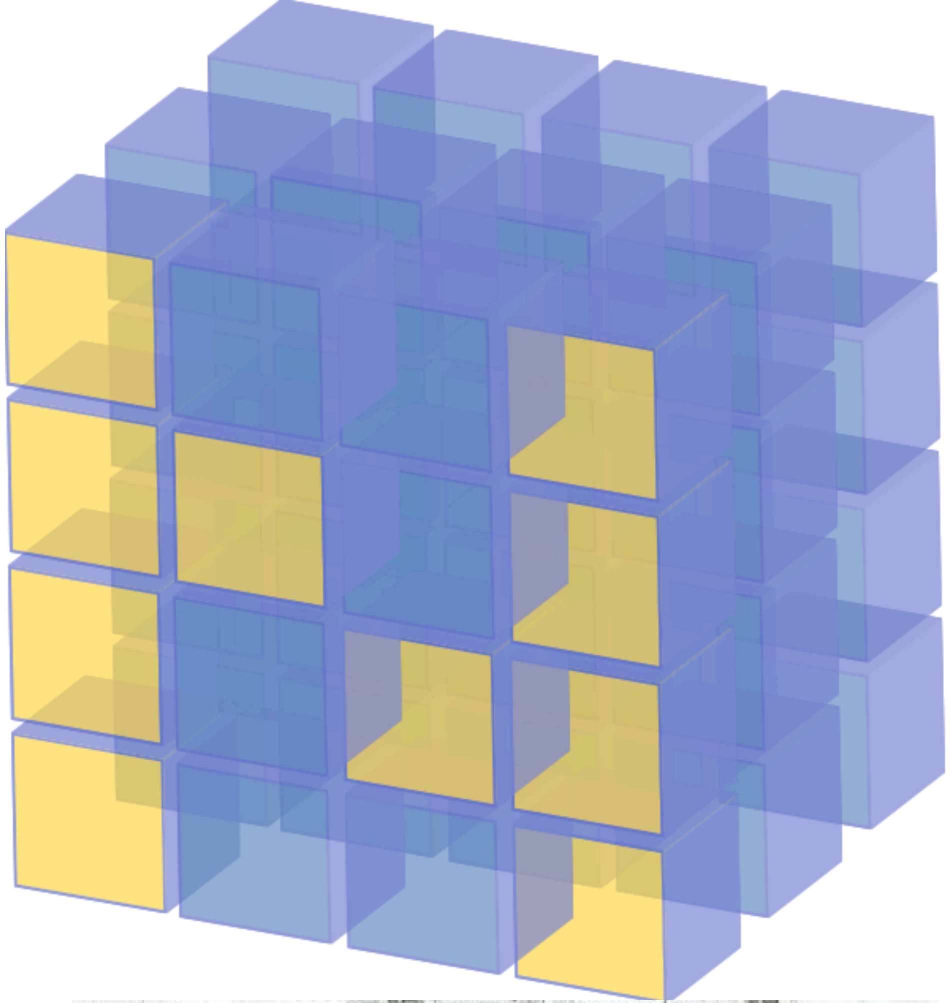

Parallel!
MPI!

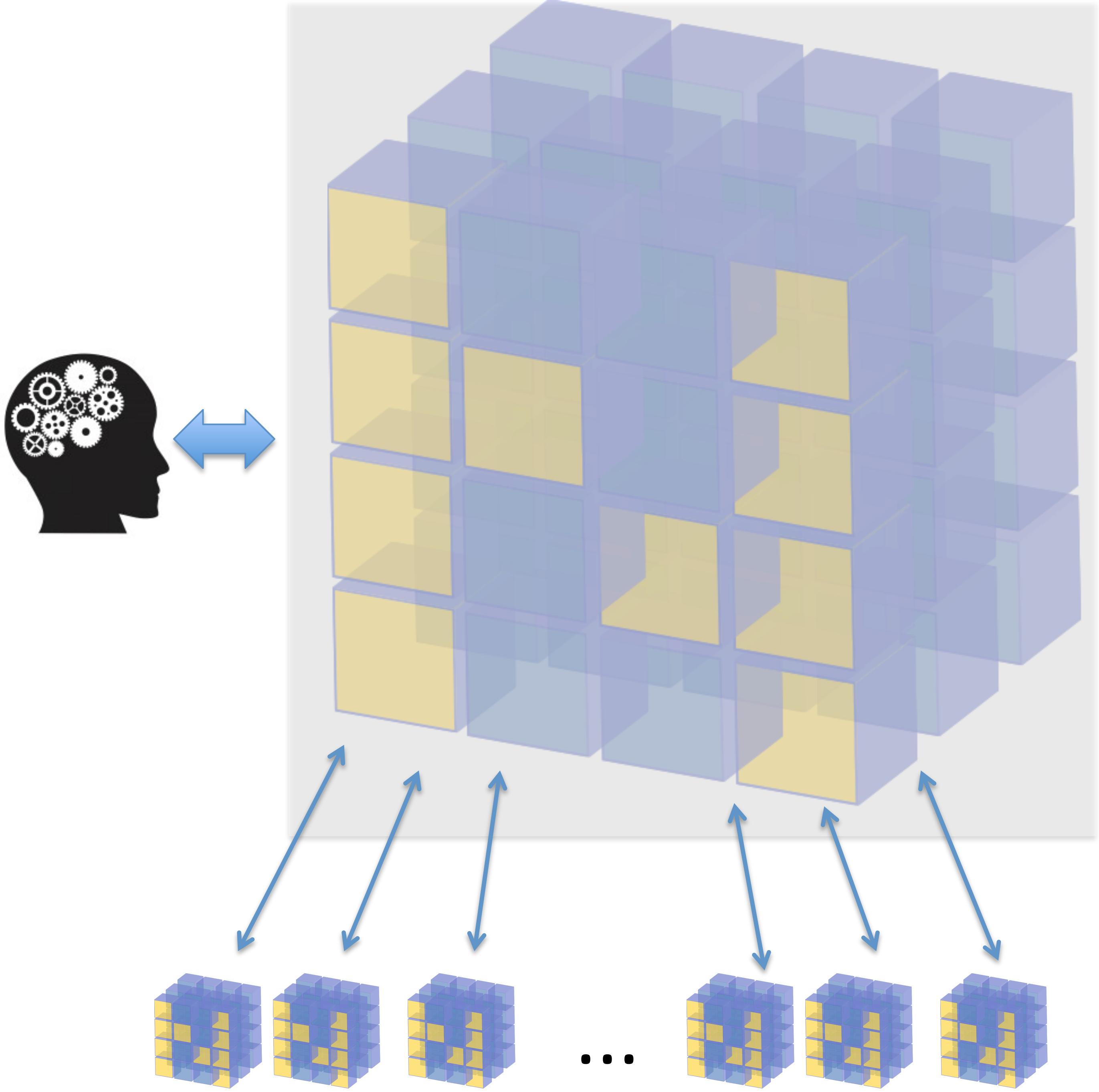


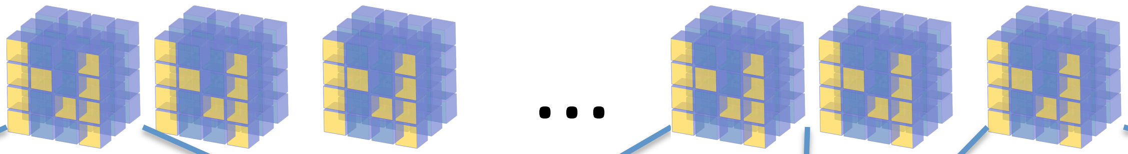












Parallel C++

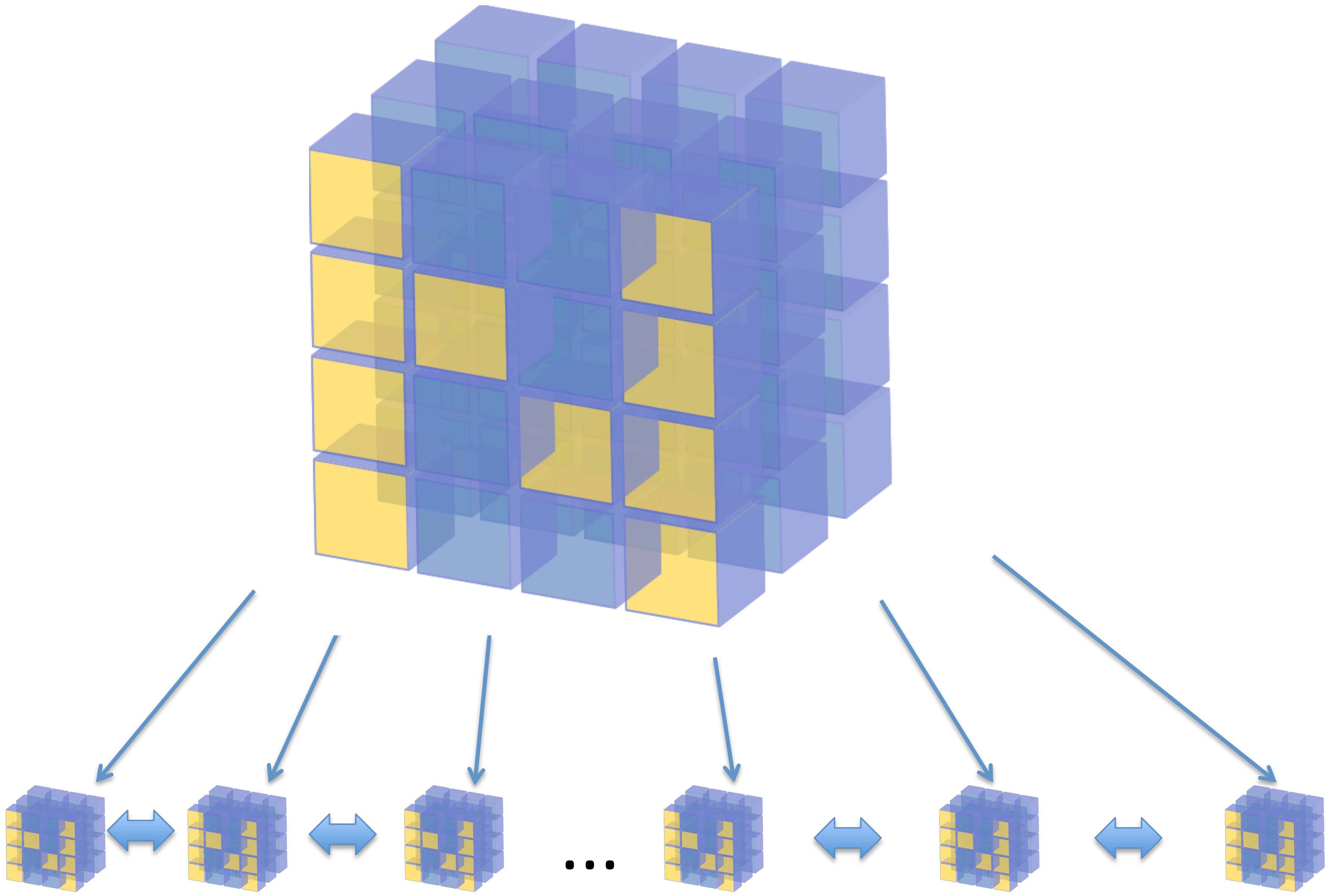
```
for(int i=0; i<n; i++)
    sum += a[i];
MPI_AllReduce(&sum, &total_sum,
              1, MPI_REAL,
              MPI_SUM, comm);
```

Parallel Python

```
def _basic_reducer(reduce_comm, op, func, args, kwargs, out):
  """ Handles simple reductions: min, max, sum.  Internal. """
  if out is None:
    out_ndarray = None
  else:
    out_ndarray = out.ndarray
    if out.ndarray.dtype == np.bool:
      out.ndarray.dtype = np.uint8
  local_reduce = np.asarray(func(*args, **kwargs))
  reduce_comm.Reduce(local_reduce, out_ndarray, op=op, root=0)
  return out
```

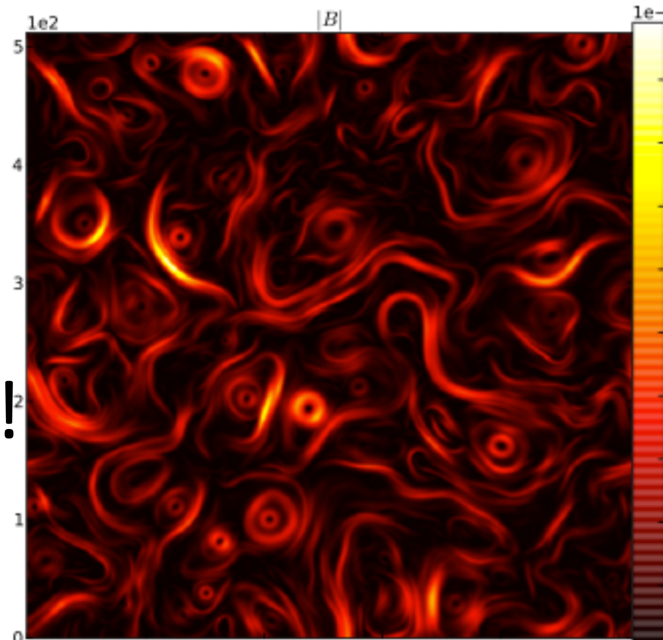
Parallel Fortran

```
do other_pid=1, np-1
  if(pid .eq. other_pid) then
    call mpi_send(carr, nelts, MPI_COMPLEX,&
      root, tag, MPI_COMM_WORLD, ierr)
  endif
  if(pid .eq. root) then
    call mpi_recv(buffer, nelts, MPI_COMPLEX,&
     other_pid, tag, MPI_COMM_WORLD, stat, ierr)
    if(formatted_flag) then
      write(OUT_FH_BASE, *) buffer
    else
      write(OUT_FH_BASE) buffer
    endif
  endif
enddo
```



Parallel Plasma Turbulence simulation

- Core: 30%
- Auxiliary stuff: 70%
  – Initialization, parallel IO, parallel test suite, etc.
- Convert nearly all auxiliary stuff to idiomatic NumPy with DistArray.
  – Much easier testing!
- Core stays the same.
- Same performance and scaling!



Current features:

- IPython.parallel integration
- Block, cyclic, block-cyclic, unstructured distributions
- Parallel IO – flat files, HDF5
- Slicing, ufuncs, reductions
- user-defined local functions

Coming features:

- Copy-free access to Trilinos packages
- MPI-only communication
- Lazy eval, latency hiding
- Padded arrays

Not just for modeling / simulation

- As flexible and generally useful as NumPy
- Use other upcoming NumPy implementations

Links, contact info

github.com/enthought/distarray

distarray.readthedocs.org

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