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Title: Converting Abaqus Input Files into MCNP6 HDF5 Unstructured Mesh Files

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Converting Abaqus Input Files into MCNP6 HDF5 Unstructured Mesh Files

Pablo A. Vaquer

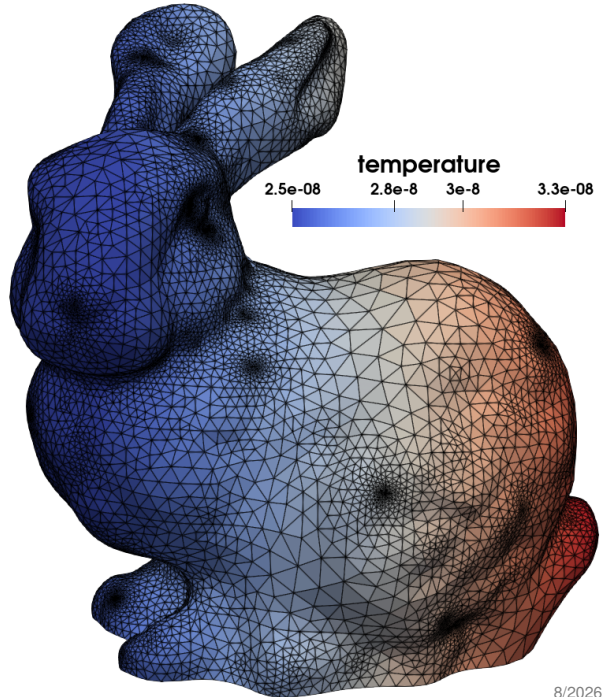
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Introduction

- Abaqus `.inp` Abaqus input files are a commonly used unstructured-mesh file format for MCNP6.3 simulations
- MCNP6.3 also supports newer HDF5/XDMF unstructured-mesh formats
- **Goal:** Use Python to automate conversion of Abaqus `.inp` files into MCNP HDF5/XDMF unstructured-mesh files

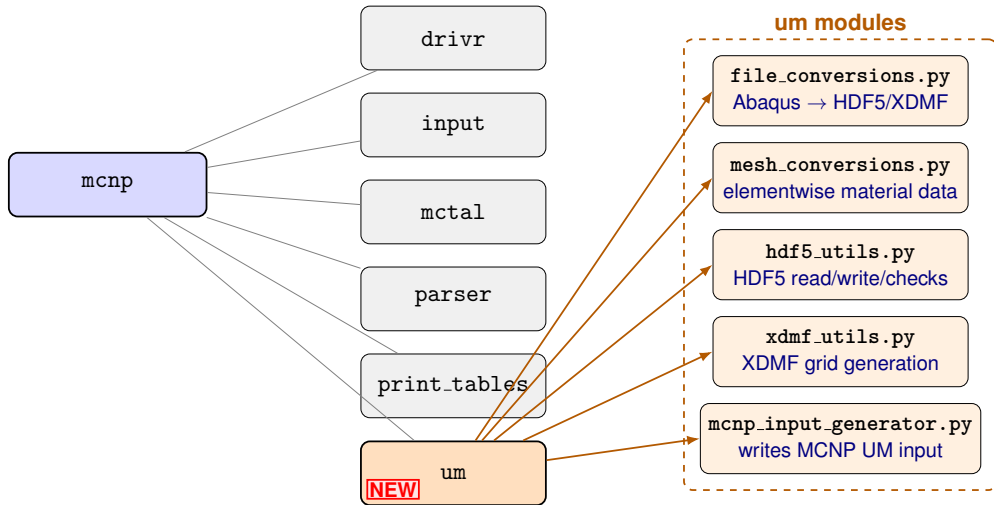


Abaqus vs. HDF5/XDMF Unstructured-Mesh Formats

Feature	Abaqus (.inp)	MCNP mesh HDF5(.h5)/XDMF(.xdmf)
Stores mesh data	Yes	Yes
File type	ASCII text file	Binary, hierarchical
Compressible	No	Yes
Read speed	Slower (text parsing)	Faster (direct binary access)
Material mapping	Per-elset	Stored directly per-pseudocell
Density mapping	Per-material	Per-pseudocell or per-element*
Temperature mapping	Not natively	Per-pseudocell or per-element*
Stores tally results	No	Yes (HDF5 EEOUT file)
MCNP compatible	It depends	Yes (with MCNP6.3 or newer)

* Element-wise densities and temperatures only supported in MCNP6.4 or newer

Current State of the MCNP Python Package (as of 8/2026)



Abaqus to HDF5/XDMF Conversion

```
from mcnp.um import file_conversions

file_conversions.abaqus_to_hdf5_and_xdmf(
    abaqus_file: "example.inp",
    hdf5_file: "example.inp.h5",
    default_mass_density: 0.0,
    default_temperature: 2.53e-8,
    add_missing_components: True,
    use_section_mapping: True,
)
```

- `default_mass_density` is the default density (g/cc) when is not specified in the Abaqus file
- `default_temperature` is the default temperature (MeV) for all materials
- `add_missing_components=True` auto-generates default elsets/sections when the Abaqus file omits them
- `add_section_mapping=True` uses `*Solid Section` or `*Shell Section` for material mapping

Add Element-wise Properties

```
from mcnp.um import hdf5_utils

with h5py.File("example.inp.h5", "a") as h5_file:
    for cell_name, densities in densities_by_cell:
        hdf5_utils.set_mat_property_for_pseudocell(
            pseudocell_group = h5_file[f"unstructured_mesh/{cell_name}"],
            mat_property_name = "mass_density",
            mat_property_array = densities
        )
```

- `pseudocell_group` must be an HDF5 group corresponding a pseudocell
- `mat_property_name` can either be "mass_density" or "temperature"
- `mat_property_array` must be an array, list, tuple or float containing cell-wise or element-wise material property values

Add Element-wise Properties (Cont'd)

The MCNP input file must be modified to include element-wise densities and/or temperature

```
embed1 meshgeo = hdf5
      mgeoin = bunny.inp.h5
      hdf5file = bunny.inp.eeout.h5
      matcell = 1 1
      background = 2
      denfrom = hdf5
      tempfrom = mcnpinput
```

- denfrom and tempfrom keywords must be set to hdf5 or mcnpinput

Questions?

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