LA-UR-22-30661

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Title:	Creating Unstructured Mesh Models for MCNP Simulations
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Intended for:	2022 MCNP User Symposium, 2022-10-17/2022-10-21 (Los Alamos, New Mexico, United States)
Issued:	2022-10-12

Los Alamos NATIONAL LABORATORY

Creating Unstructured Mesh Models for MCNP Simulations

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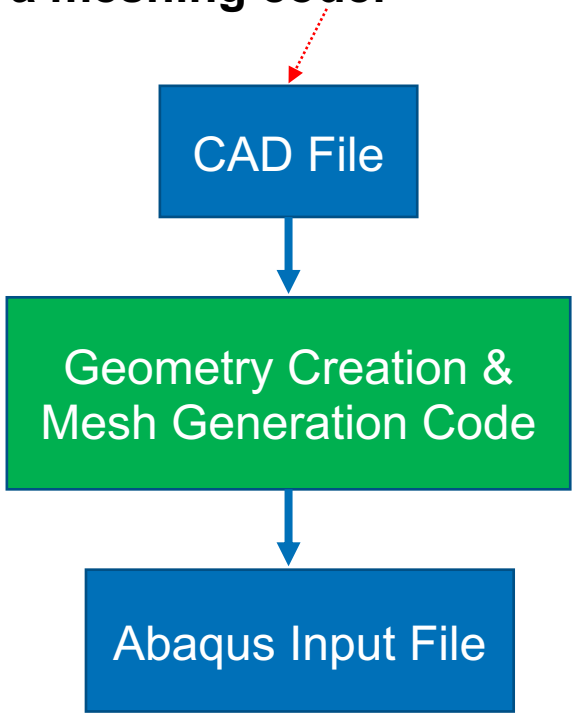
2022 MCNP User Symposium
October 17-21, 2022

LA-UR_

MCNP Unstructured Mesh (UM) Simulations

- An MCNP UM feature is useful for complex geometry models.
- **An MCNP UM calculation requires UM geometry files.**
  - MCNP6.0-6.3 can process UM geometry files formatted as Abaqus input files.
    - An Abaqus input file is an ASCII file that must meet the Abaqus syntax and ELSET naming rule required by MCNP.
  - MCNP6.3 can additionally process an MCNP HDF5 unstructured mesh input files.
    - Currently, no other code can be used to create MCNP HDF5 UM input files.
    - An Abaqus input file can be converted to an HDF5 UM input file by MCNP6.3.
- **The MCNP code cannot be used to create Abaqus input files.**
- Several other codes (not developed by the MCNP team) can be used to generate Abaqus input files for MCNP simulations.

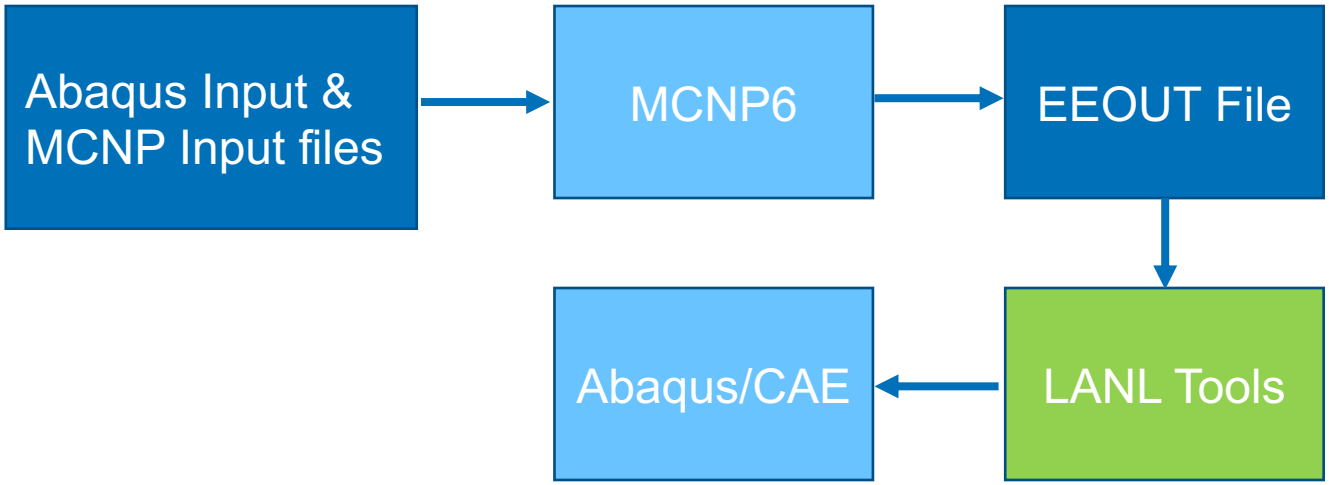
A CAD file is not needed if a solid geometry can be created by a meshing code.



Why are Abaqus input files used by the MCNP code?

- The MCNP UM feature was developed for MCNP/Abaqus Multiphysics calculations needed by LANL users.
- Using the same UM models for both MCNP and Abaqus codes provides better calculation workflow and more consistent results.

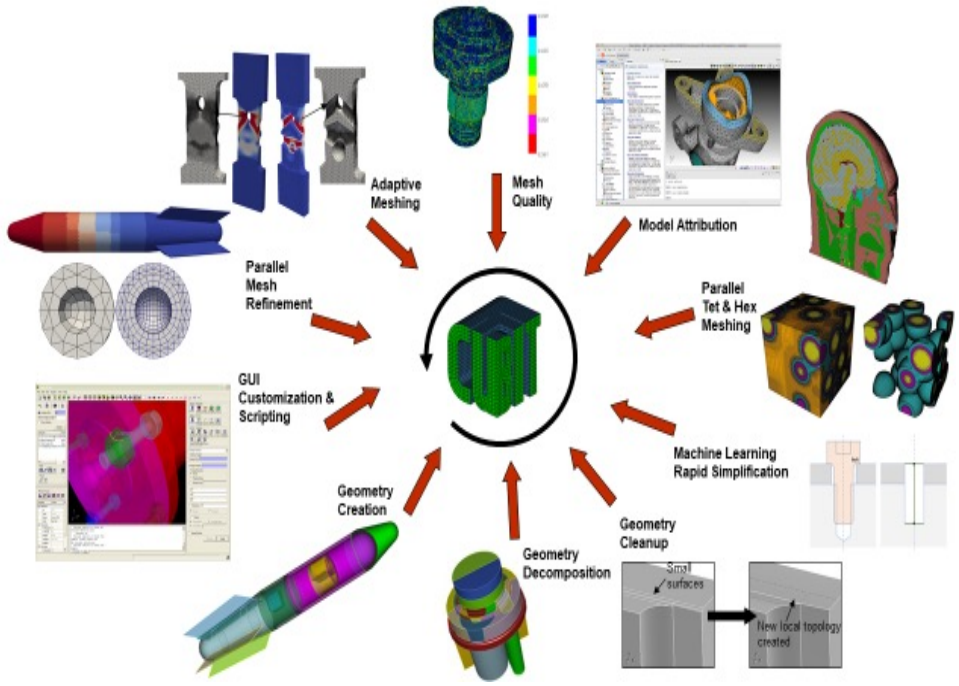
MCNP/Abaqus Multiphysics Workflow at LANL



Newman's presentation on Monday discusses MCNP/Abaqus calculations for reactor applications.

CUBIT: Geometry & Mesh Generation Toolkit

- CUBIT is developed by Sandia National Laboratories (SNL).
  - It is free for government uses and a commercial version is available for non-government uses [https://cubit.sandia.gov/licensing].



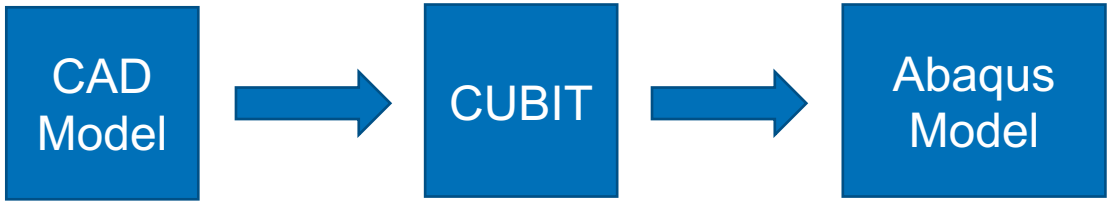
Images: from https://cubit.sandia.gov

CUBIT Process for Creating Abaqus Input File

1. Create solid 3D geometry or import CAD model.
2. Prepare geometry for meshing.
3. Generate mesh.
4. Check mesh qualities and volumes. If they are not good enough, go to 1, 2, or 3.
5. Create materials.
6. Create blocks and assign materials.
7. Export a mesh model as an Abaqus file.

iterative & complicated; trial-and-error

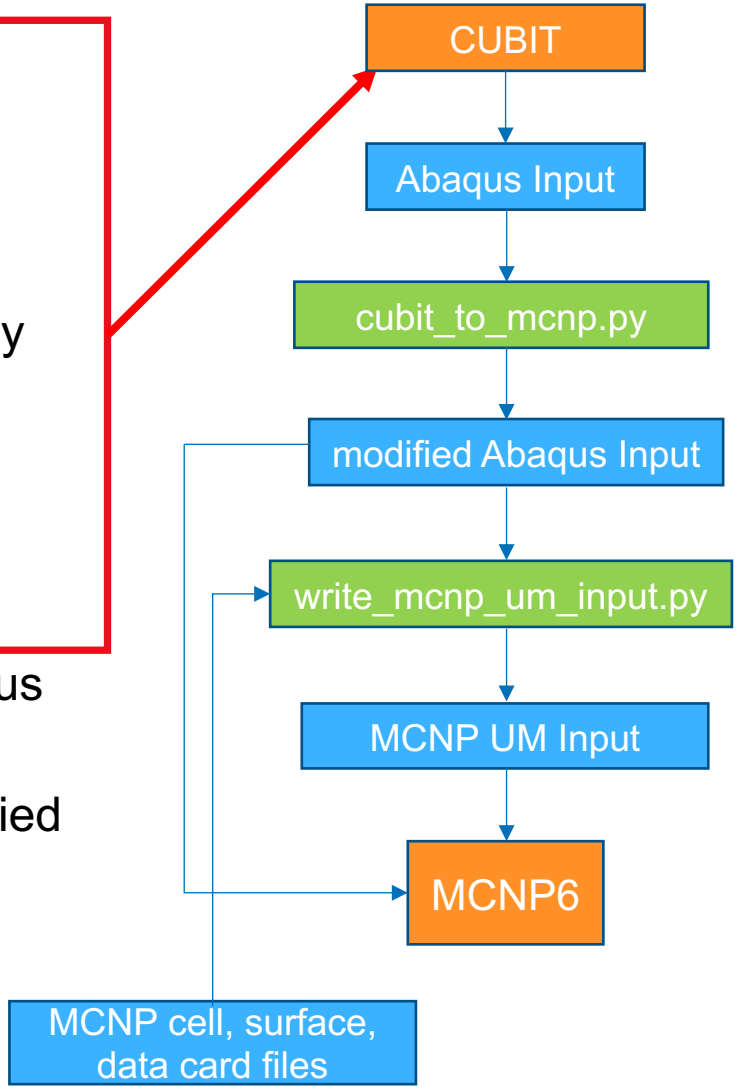
simple



MCNP cannot process Abaqus input files created by CUBIT. Python code was developed for file conversion.

Using CUBIT to create Abaqus Input Files for MCNP UM Calculations

1. Create solid 3D geometry or import CAD model.
2. Prepare model for meshing.
3. Generate mesh.
4. Check mesh qualities and volumes. If they are not good enough, go to 1, 2, or 3.
5. Create materials.
6. Create blocks and assign materials.
7. Export a mesh model as an Abaqus file.
8. Run cubit_to_mcnp.py to create an Abaqus file satisfying the MCNP requirement.
9. Run write_mcnp_um_input.py on a modified Abaqus input file to create an MCNP (skeleton) input file.
10. Run an MCNP UM Calculation.
11. Postprocess and analyze MCNP results.



Conclusion

- The MCNP code cannot be used to generate Abaqus input files.
- Other codes must be used to generate Abaqus input files.
- Some LANL users use CUBIT to generate Abaqus input files. But the MCNP code cannot process the Abaqus input files exported from CUBIT.
- We developed two Python codes for CUBIT to MCNP setup.
  - cubit_to_mcnp.py and write_mcnp_um_input.py
  - These two Python codes will be released to public.
- We developed Cubit to MCNP training materials.
  - CUBIT to MCNP trainings were given to LANL staff and students.
  - These three-hour training materials will be released to public.

Abstract

CUBIT can be used to generate Abaqus input files, but MCNP cannot process Abaqus input files exported from CUBIT. We have developed Python code and training materials on using CUBIT to create unstructured mesh models for MCNP simulations.