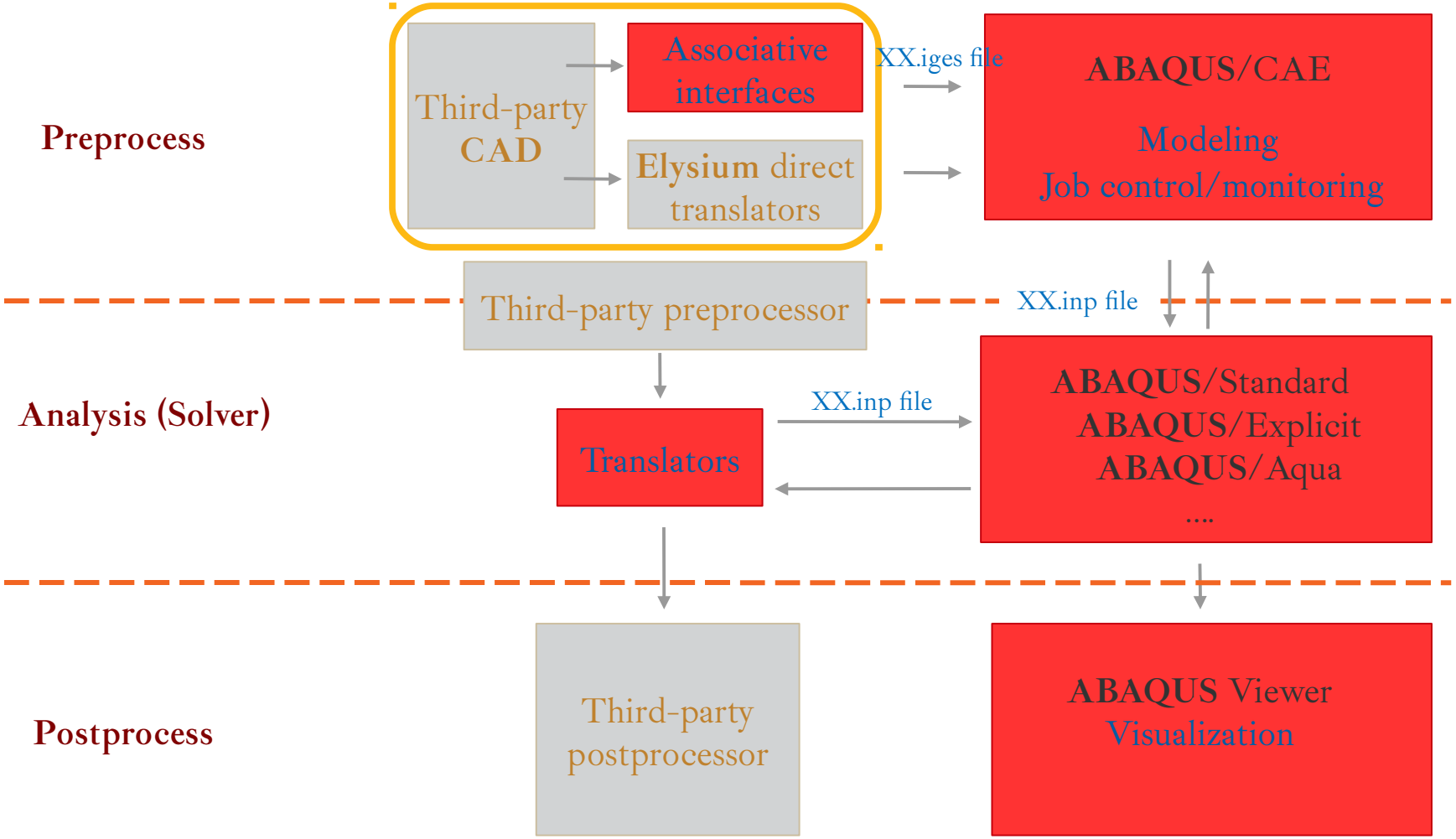
ME 498CA1 Fall 2015

Introduction & Workflow

Outline of Module

1. FEA Workflow (Redux), Postprocessing
2. Meshing
3. Loading & Analysis
4. Coupling Physics
5. Materials & Modeling
6. Fracture & Contact FEA
7. Dynamic FEA (Standard *v.* Explicit)
8. Batch Jobs & Scripting

ABAQUS Ecosystem

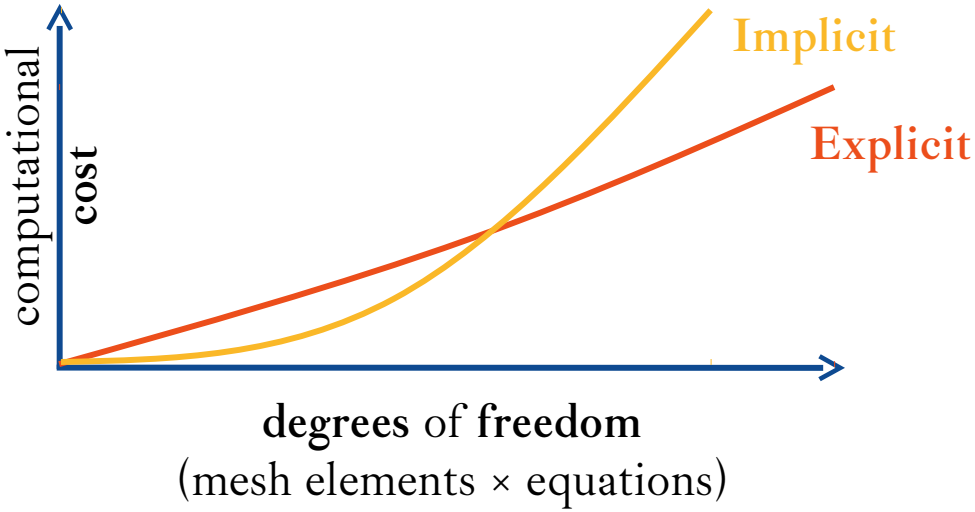


Comparison of Implicit and Explicit

Quantity	ABAQUS/Standard	ABAQUS/Explicit
Element library	Extensive	Subset
Analysis procedures	General & linear perturbation	General
Material models	Wide range of material models	Wide range + failure material models
Contact formulation	contact problems	complex contact problems
Solution technique	unconditionally stable stiffness-based solution technique	conditionally stable explicit integration solution technique
Disk space & memory	large with many iterations	small
Ideal Problem	smooth nonlinear problems etc.	brief transient dynamic events

Comparison of **Implicit** and **Explicit**

Cost of Degrees of Freedom Refinement



Implicit: computational cost proportional to square of degrees of freedom (actually *f*(connectivity))

Explicit: computational cost proportional to number of elements, inversely proportional to smallest element dimension

ABAQUS Workflow

Preprocessing

ABAQUS/CAE
Modules:
Part, *Property*, *Assemble*, *Step*, *Interaction*, *Load*, *Mesh*

`inp` file

Simulation

ABAQUS/Standard
ABAQUS/Explicit
Module:
Job

`odb`, `fil`, `dat`, `res` files

Postprocessing

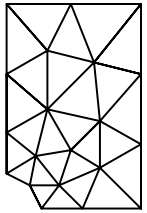
ABAQUS/CAE
Module:
Visualization

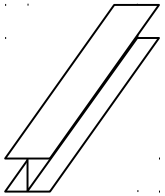
`png`, `txt`, `csv` files, etc.

ABAQUS Workflow

1. Draw 2D **sketch** and create 3D **part**s.
2. Assign **Material** and **Section** property.
3. **Assemble** the model; give **interaction**s in form.
4. **Mesh** the frame.
5. Apply **Load** and boundary conditions.
6. Create **job** and configure output requests.
7. Submit it for **analysis** (Standard/Explicit).
8. **Visualize** the results of analysis.

ABAQUS Preprocessing



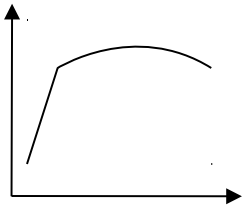


Discretized Geometry (**Mesh**)

Material Model (**Property**)

Element Section Properties (**Section**)

Loads and Boundary Conditions (**Load**)



ABAQUS Solvers

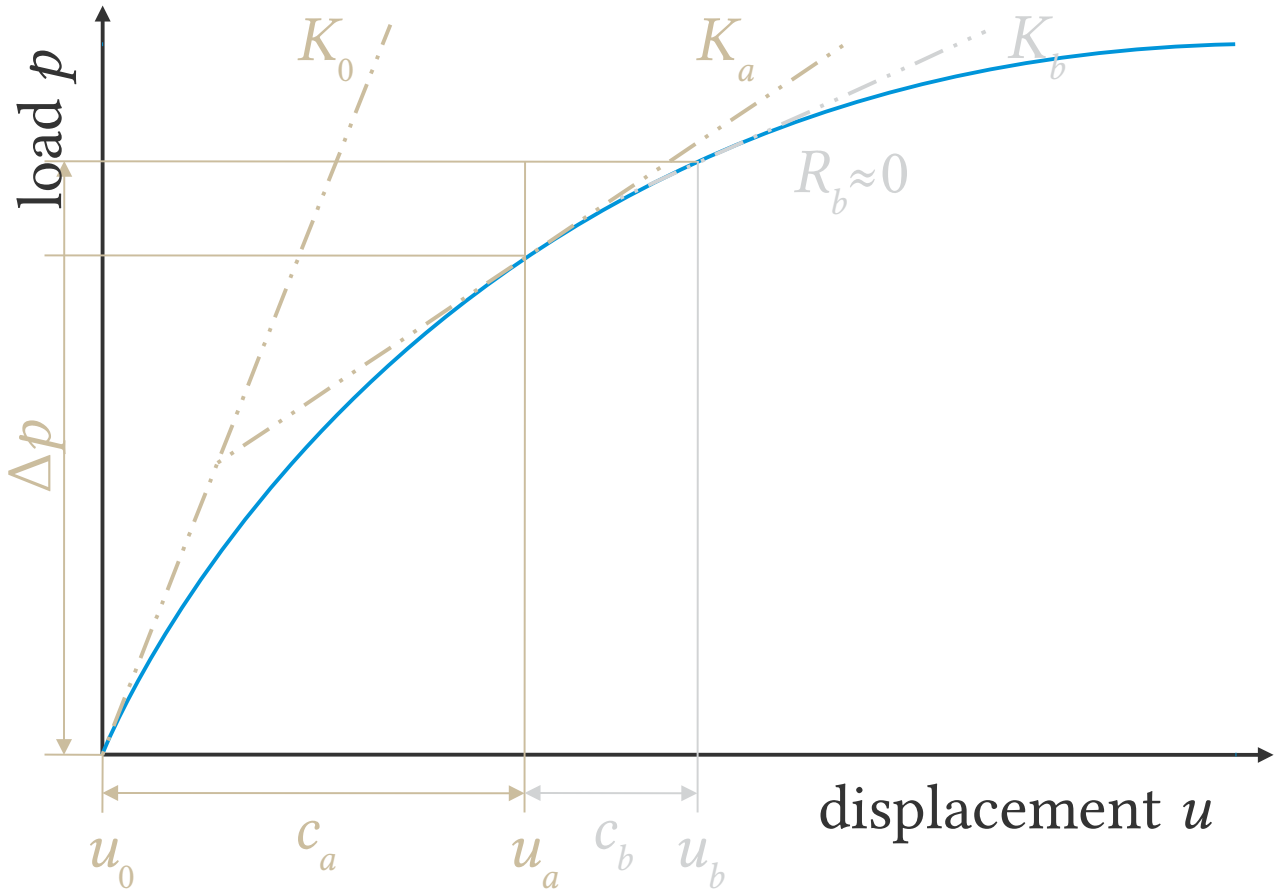
- **ABAQUS/Standard**

  Solves system of equations **implicitly** at each solution "increment".

- **ABAQUS/Explicit**

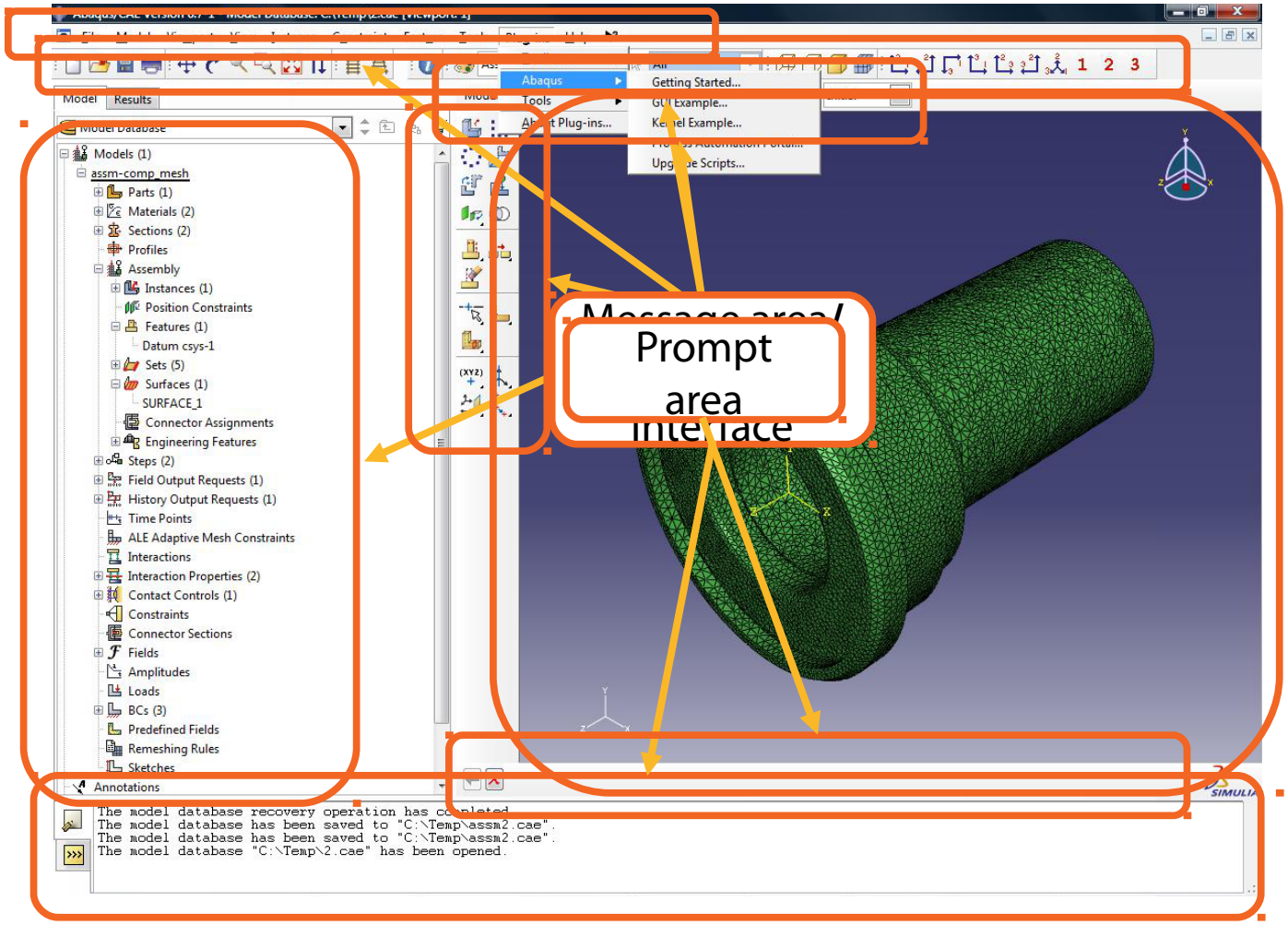
  Marches solution forward through time **explicitly** in small time increments *without* solving coupled system of equations at each increment.

ABAQUS Solvers—Standard



ABAQUS/CAE

- Modeling
  - Geometry
  - Material Property
  - Mesh
  - Load & BC
  - Job manage
- Result Viewing



ABAQUS Units

- ABAQUS has no built-in units
- Specify all input data in consistent units

m	l	t	F	σ	E
kg	m	s	N	Pa	J
kg	cm	s	10^{-2} N		
kg	cm	ms	10^{4} N		
kg	cm	μs	10^{10} N		
kg	mm	ms	kN	GPa	kN·mm
g	cm	s	dyne	dyne·cm^{-2}	erg
g	cm	μs	10^{7} N	Mbar	10^{7} N·cm
g	mm	s	10^{-6} N	Pa	
g	mm	ms	N	MPa	N·mm
ton	mm	s	N	MPa	N·mm
lb$_f$·s^2·in^{-1}	in	s	lb$_f$	psi	lb$_f$·in
slug	ft	s	lb$_f$	psf	lb$_f$·ft
kg$_f$·s^2·mm^{-1}	mm	s	kg$_f$	kg$_f$·mm^{-2}	kg$_f$·mm
kg	mm	s	mN	kPa	
g	cm	ms	10^{1} N	10^{5} Pa	

Suggested FEM Courses

ME 471—Introduction to Finite Element Analysis
ME 570—Nonlinear Solid Mechanical Design

CEE 470—Structural Analysis
CEE 570—Finite Element Methods
CEE 576—Nonlinear Finite Elements

CS 555—Numerical Methods for PDES

TAM 574—Advanced Finite Element Methods