



OpenSees

Open System for Earthquake Engineering Simulation
Pacific Earthquake Engineering Research Center



Getting Started with OpenSees

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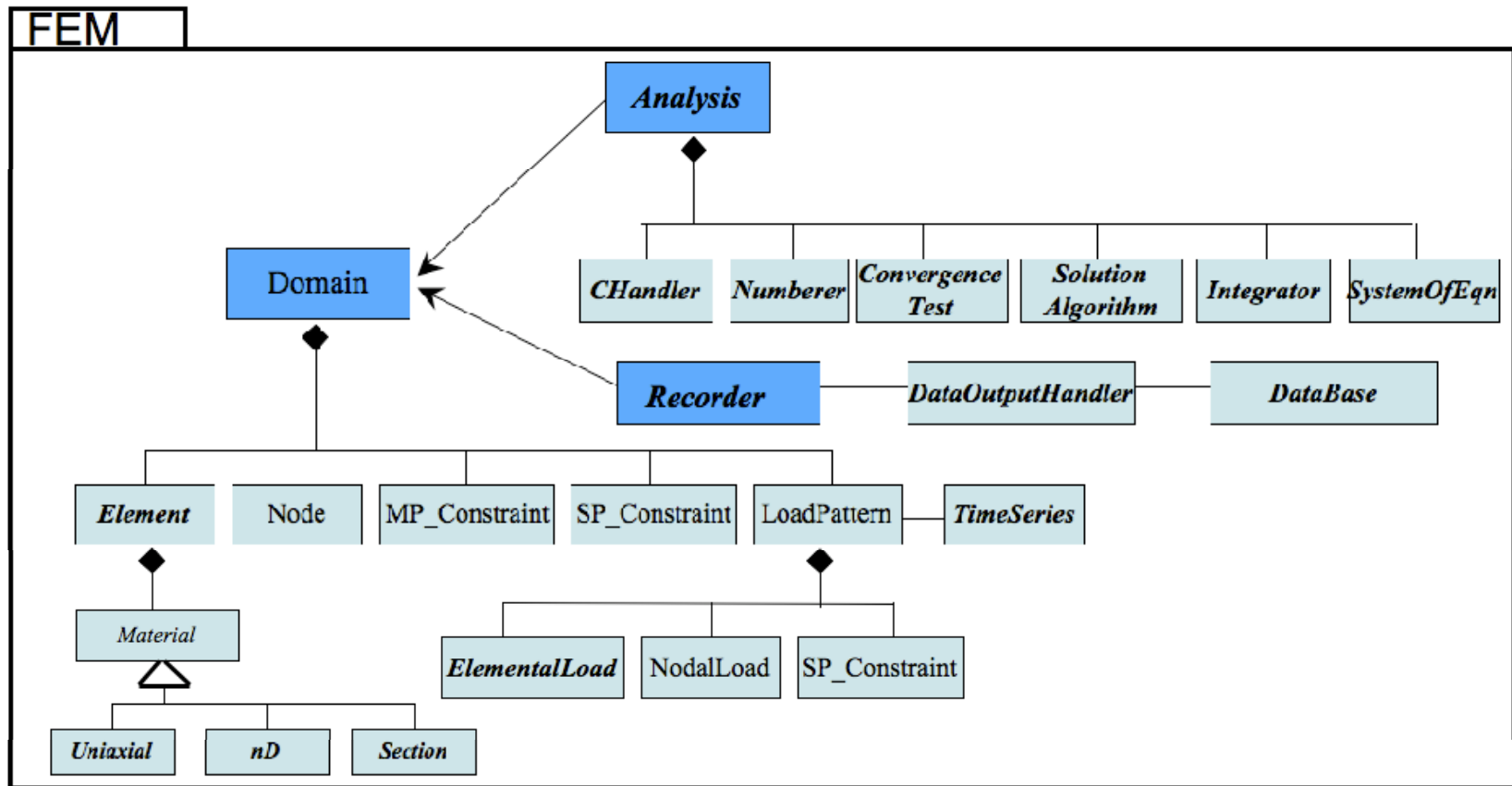
Agenda

- Introduction to OpenSees
- Introduction to Tcl programming language
- Demonstration of how to download OpenSees interpreter and install Tcl/Tk
- Discussion of OpenSees Resources (command manual, getting started manual, examples manual, message board)
- Example of how to create and run a small structure
- Q&A with web participants

What is OpenSees?

- A software *framework* (written primarily in C++) for simulation applications in earthquake engineering using finite element methods.
- It is open-source software framework
- A communication mechanism for exchanging and building upon research accomplishments
- OpenSees is fast, stable, efficient in solving large nonlinear models with multiple runs
- To make FEM in OpenSees you need to know basics of Tcl programming language

OpenSees Framework



How Do People Use the OpenSees Framework?

- Provide their own main() function in C++ and link to framework.
- Use OpenSees interpreters (**OpenSees.exe**, OpenSeesSP.exe, OpenSeesMP.exe). These are extensions of the Tcl interpreters (**tclsh**, **wish**) which have been extended to commands for finite element analysis:
 1. Modeling – create nodes, elements, loads and constraints
 2. Analysis – specify the analysis procedure.
 3. Output specification – specify what it is you want to monitor during the analysis.

*Being interpreters means that the files you create and submit to the OpenSees interpreters **are not input files**. You are creating and submitting **PROGRAMS**.*

What is Tcl?

- **Tcl is a dynamic programming language.**
 - It is a string based command language.
 - Variables and variable substitution
 - Expression evaluation
 - Basic control structures (if , while, for, foreach)
 - Procedures
 - File manipulation
 - Sourcing other files.

Command Syntax and Tutorial

- Command syntax:
command arg1 arg2 ...

- Help:

<http://www.tcl.tk/man/tcl8.5/tutorial/tcltutorial.html>

Tcl examples (1)

- *variables & variable substitution*

```
>set a 1
1
>set b a
a
>set b $a
1
```

- *expression evaluation*

```
>expr 2 + 3
5
>set b [expr 2 + $b]
3
```

- **sourcing other files**

```
>source Example1.tcl
```

- *lists*

```
>set a {1 2 three}
1 2 three
>set la [llength $a]
3
>set start [lindex $a 0]
1
>lappend a four
1 2 three four
```

- *file manipulation*

```
>set fileId [open tmp w]
>puts $fileId "hello"
>close $fileID
>type tmp
hello
```


Tcl examples (2)

- control structures

```
> for {set i 1} {$i < 10} {incr i 1} {  
    puts "i equals $i"  
}  
...  
> set sum 0  
foreach value {1 2 3 4} {  
    set sum [expr $sum + $value]  
}  
>puts $sum  
10
```

- procedures

```
>proc guess {value} {  
    if {$value < $sum} {  
        puts "too low"  
    } else {  
        if {$value > $sum} {  
            puts "too high"  
        } else {  
            puts "you got it!"  
        }  
    }  
}  
  
> guess 9  
too low
```

Tcl examples (3)

- If you add, subtract, multiply and divide two integer numbers the result is an integer.

```
> set a [expr 1/2]
0
```

- If you add, subtract, multiply and divide an integer number and a floating-point number, then the result is a floating-point number.

```
> set b [expr 1./2]
0.5
```

- Tcl does not work with ordinary decimal fractions, but with binary fractions

```
> set c [expr 1.2/0.1]
11.999999999999998
```

Downloading OpenSees.exe and Installing Tcl/Tk

- Download OpenSees.exe and tcl/tk from here:
<http://opensees.berkeley.edu/OpenSees/user/download.php>
- Tutorial on installing tcl/tk:
http://opensees.berkeley.edu/wiki/index.php/Getting_Started_with_OpenSees_--_Download_OpenSees

Running OpenSees through NEEShub

- In addition to being a platform that runs on a personal computer, OpenSees can be used through the OpenSeesLaboratory tool of NEEShub. By using this free tool, users can run analyses remotely on the NEEShub machines that are extremely fast. This can be very useful to advanced OpenSees users because it will drastically decrease computational time for large models or analyses that need to perform many runs. For new users, the OpenSeesLaboratory tool allows you to trial OpenSees without any initial set-up or installation.
- Here you can find tutorial on how to run OpenSees through NEEShub: http://opensees.berkeley.edu/wiki/index.php/Discovering_OpenSees_-_OpenSees_on_NEEShub

OpenSees Resources

- Getting Started Manual:

http://opensees.berkeley.edu/wiki/index.php/Getting_Started

- Command Manual:

http://opensees.berkeley.edu/wiki/index.php/Command_Manual

- Examples Manuals:

<http://opensees.berkeley.edu/wiki/index.php/Examples>

- Message Board:

<http://opensees.berkeley.edu/community/viewforum.php?f=2>

- Discovering OpenSees web-based learning series:

http://opensees.berkeley.edu/wiki/index.php/Discovering_OpenSees

Example of how to create and run a small structure

http://opensees.berkeley.edu/wiki/index.php/Eigen_analysis_of_a_two-storey_one-bay_frame

Questions?