RELAP5-3D

Lecture 12

Batch Files and Python Interfacing

BYU

Spiritual Thought

"When you are confronted with a dilemma, think celestial! When tested by temptation, think celestial! When life or loved ones let you down, think celestial! When someone dies prematurely, think celestial. When someone lingers with a devastating illness, think celestial. When the pressures of life crowd in upon you, think celestial! As you recover from an accident or injury, as I am doing now, think celestial!"

- President Nelson

BYU

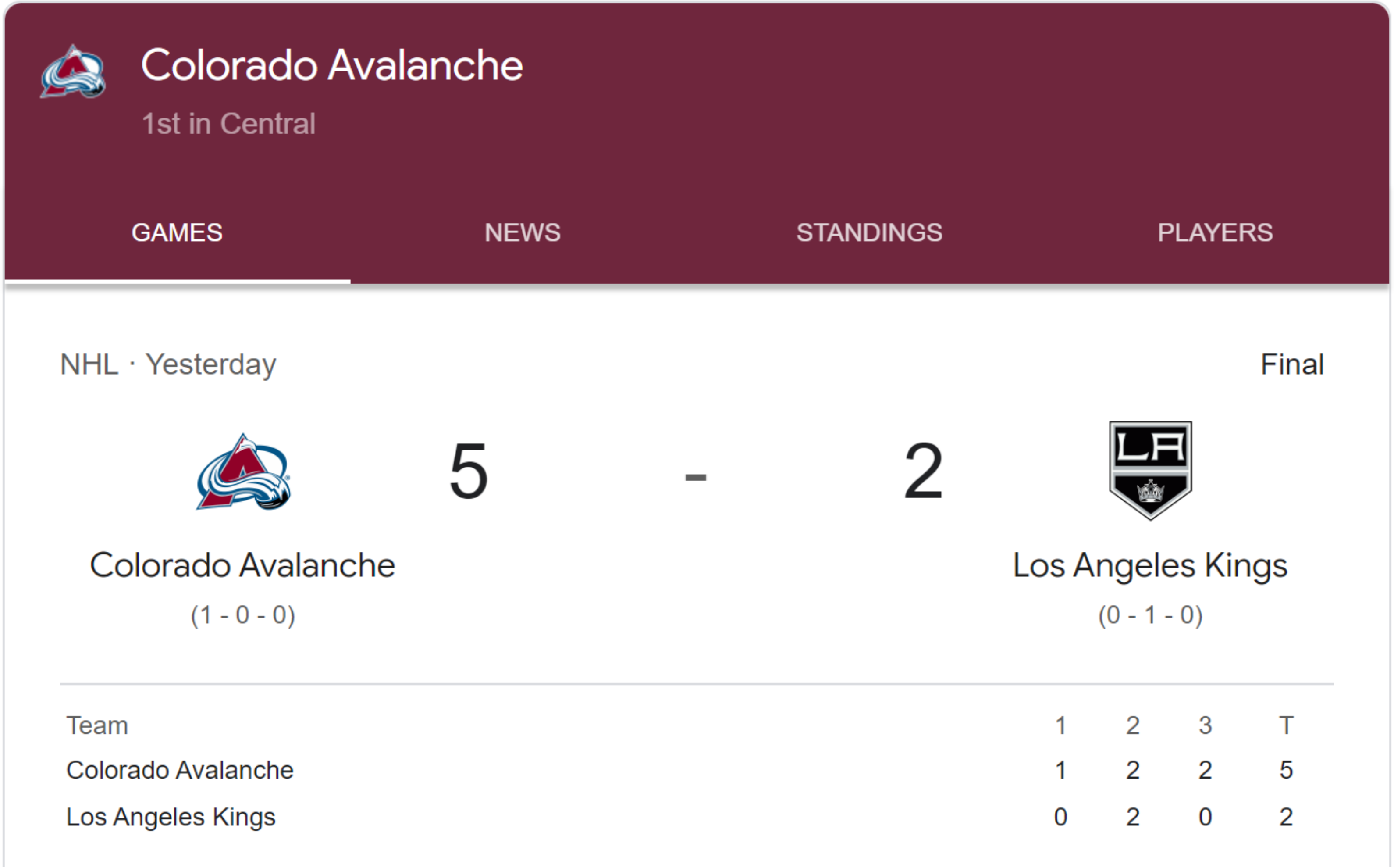
Objectives

- Batch Files
- Python Interfacing
- Practice Problem

BYU

Objectives

- Batch
- Pytho
- Practi



Batch Files – What They Are

- A Microsoft Windows script file
- File extension - .bat
- Can be written with Notepad ++ (or any other text editor)
- Command line script can be used

BYU

Batch Files and RELAP5-3D

- The RGUIStationJar is an interface to allow you to input file names and then runs a batch file
- RELAP/r3d434ie/relap/relapcommand.bat
- Batch files can be used to run multiple RELAP runs much more quickly

```
"..\relap\relap5.exe" -i ..\run\ReactorLoopBase.i -o ..\run\ReactorLoopBase.o -r ..\run\ReactorLoopBase.r -w tpfh2o -W tpfh2on -p ..\run\ReactorLoopBase.plt -tpfdir ..\fluids\
```

BYU

Create a batch file to run RELAP

- RELAP command (if preformed in the relap folder)
- "relap5.exe" -i file.i -o file.o -r file.r -w tpfh2o –W tpfh2on –p file.plt -tpfdir ../fluids/

- Delete a file in windows command line
- del /f file.o

BYU

How does Python come into all of this

- We can rapidly create multiple RELAP input decks, run them, and pull in results data all in one python script
- Why is this valuable?

Python Integration Practice

- Write a python script to do the following:
  - Delete output file
  - Execute RELAP command

RELAP command (if preformed in the relap folder)

"relap5.exe" -i file.i -o file.o -r file.r -w tpfh2o –W tpfh2on –p file.plt -tpfdir ../fluids/

Delete a file in windows command line

del /f file.o

BYU

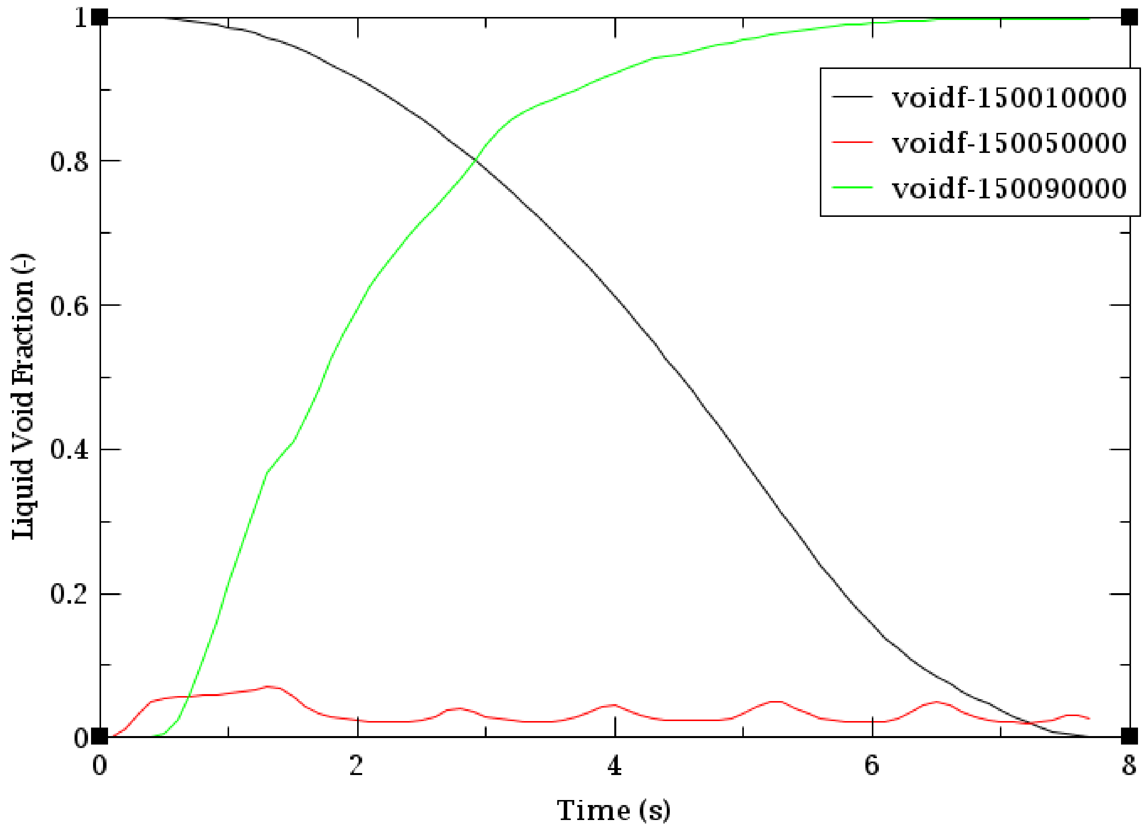
Python Integration Practice

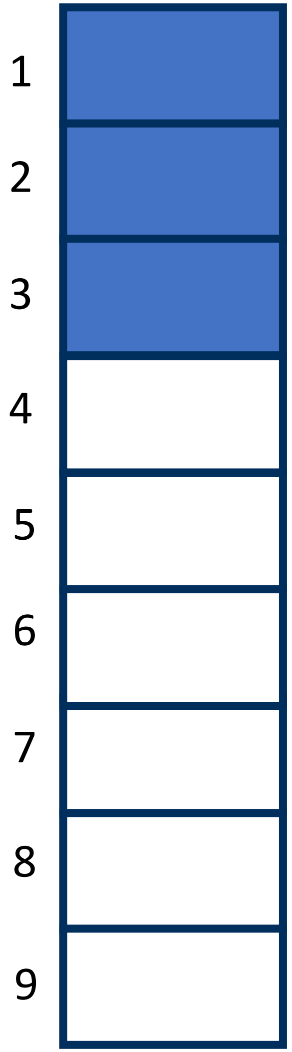
```python
import subprocess
import os

# Get the filename from the user
filename = input("Enter a filename (without extension): ")

# Define the input and output filenames
input_file = f"{filename}.i"
output_file = f"{filename}.o"
relap5_command = f'relap5.exe -i {input_file} -o {output_file} -r {filename}.r -w tpfh2o -W tpfh2on -p {file

# Check if the output file exists and delete it
if os.path.exists(output_file):
    os.remove(output_file)
    print(f"Deleted {output_file}")

try:
    subprocess.run(relap5_command, shell=True, check=True)
except subprocess.CalledProcessError as e:
    print(f"Command execution failed with error code {e.returncode}")
except Exception as e:
    print(f"An error occurred: {str(e)}")
else:
    print("Command executed successfully")
```

BYU

Practice: Nodalization Study

- Remember HW 2?





Practice: Nodalization Study

- What is the optimum number of volumes?
- Time step has already been set to be less than Courant limit
- To compare results we will plot the time it takes for all of the water to leave the top 1/3 of the pipe

- (19 RELAP experts)*(10 min) = 3.17 hours of manpower
- (1 python script)*(18 sec) = 0.005 hours of machinepower

BYU

Let's take a look at the code

```
%%capture
# Import needed packages
import numpy as np
import os
%matplotlib inline
import matplotlib.pyplot as plt

# Create arrays to store data
Volumes = np.zeros(17)
Times = np.zeros(17)

# Starting number of Volumes
j = 3

for i in range(17):

    # Initial Parameters
    NoV = j # Number of Volumes
    pipe_length = 4.16448 # meters
    name = 'lecture12'

    # Calculated Parameters
    minor_edit_vol = int(NoV*2/3+1) # Minor edit volume of interest (used to see when top 1/3 of the pipe is 99.9% empty)
    param = "{:02d}".format(minor_edit_vol) # placed in 2 digit form for input into deck

```

BYU

Creating an input deck

```
# Create Input File
file_name = f'''{name}.i'''

input_deck = f'''* Title Of Deck
= {name}
*******************************************************************************
*                                                                             *
*                       Miscellaneous Control Cards                           *
*                                                                             *
*******************************************************************************
*
*      Type     Option
100    new      transnt
*      Inp-Chk/Run
101    run
*      Input-Units     Output-Units
102    si              si
*      CPUrem1   CPUrem2   CPUalloted
105    5.0       6.0       1000.0
*      Noncondensables
110    air
*      Ref-Vol       Elev     Fluid    Name
120    140010000     0.0      h2o     'Primary'
*
*******************************************************************************
*                                                                             *
*                           Time Step Control Cards                           *
*                                                                             *
*******************************************************************************
*
*      TimeEnd  MinStep  MaxStep  Ssdtt  MinorEditFreq  MajEditFreq  ResrtFreq
201    30.      1.0e-6   0.01      00007  1              30000        30000
```

BYU

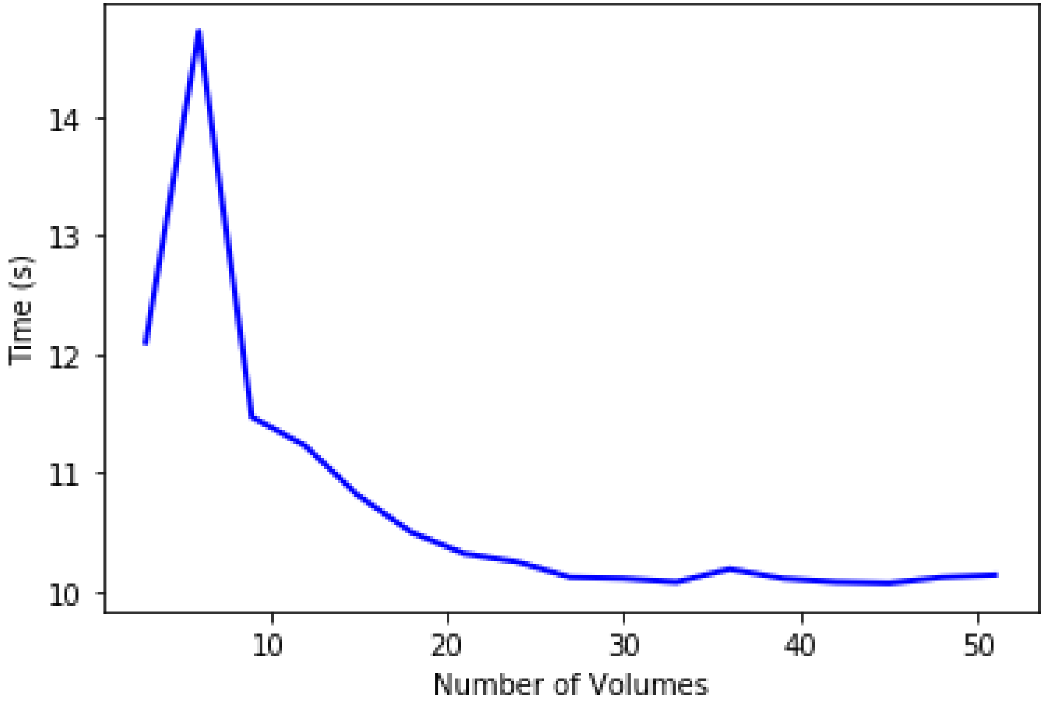
Changing values in the input deck

```
*******************************************************************************
*                                                                             *
*                            Minor Edit Requests                              *
*                                                                             *
*******************************************************************************
*
*      Variable-Code      Parameter
301    voidg              140{param}0000
*******************************************************************************
*                                                                             *
*                          Hydrodynamic Components                            *
*                                                                             *
*******************************************************************************
*********************************
*           Pipe - 140          *
*********************************
*          Name     Type
1400000    pipe     pipe
*          NumOfVolumes
1400001    {int(NoV)}
*          Area                         VolNum
1400101    1.0                         {int(NoV)}
*          Length                       VolNum
1400301    {pipe_length/NoV}                      {int(NoV)}
*          InclAng                      VolNum
1400601    90.                           {int(NoV)}
*          ElevationChange              VolNum
1400701    {pipe_length/NoV}              {int(NoV)}
*          Roughness  HydraulicDiam  VolNum
1400801    0.0005        0.0          {int(NoV)}
*          tlpvbfe                      VolNum
1401001    00000000                     {int(NoV)}
*          Jefvcahs                     JunNum
1401101    00000000                     {int(NoV-1)}
*          Ebt   Initial-Conditions          VolNum
1401201    004   101325.  298.  0.  0  0  {int(NoV*2/3)}
1401202    003   101325.  298.  0.  0  0  {int(NoV)}
*          Vel/Mfr
1401300    1
*          Liquid  Vapor  Interface  JunNum
1401301    0.0     0.0    0.0        {int(NoV-1)}
*
.
'''
```

Write deck, run deck, read results

```
# Write deck to input file
with open(file_name, 'w') as test_file:
    test_file.write(input_deck)

# Run RELAP5-3D
!del /f lecture12.o
!"./relap5.exe" -i lecture12.i -o lecture12.o -r lecture12.r -w tpfh2o -W tpfh2on -p lecture12.plt -tpfdir ../fluids/

# Read Output File
with open("lecture12.o", "r") as a_file:
  for line in a_file:
    stripped_line = line.strip()
    a_list = stripped_line.split()

    try:
        map_object = map(float, a_list)

        list_of_floats = list(map_object)

        if(len(list_of_floats) ==2):
            if(list_of_floats[1] >= 1.0000):
                ans = list_of_floats[0]
                break

    except:
        pass

# Store data from run
Volumes[i] = NoV
Times[i] = ans

j = j + 3
```

Results



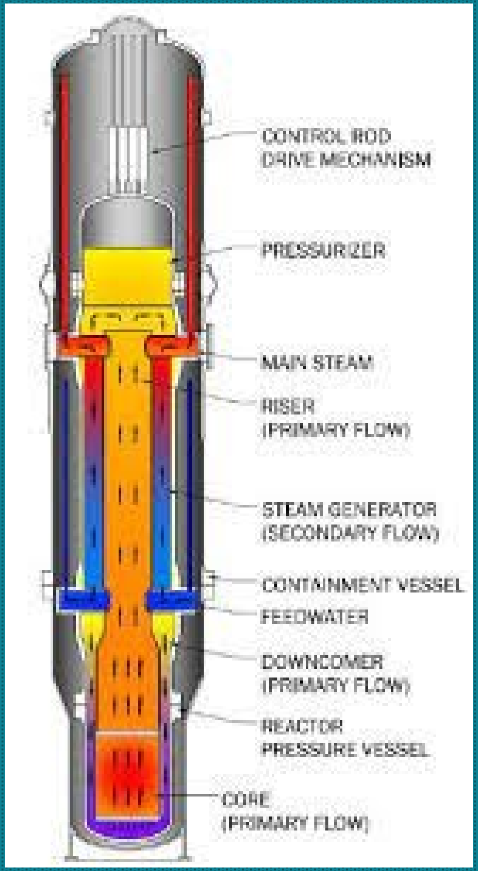
Brainstorming

- If this is possible, what else is possible?

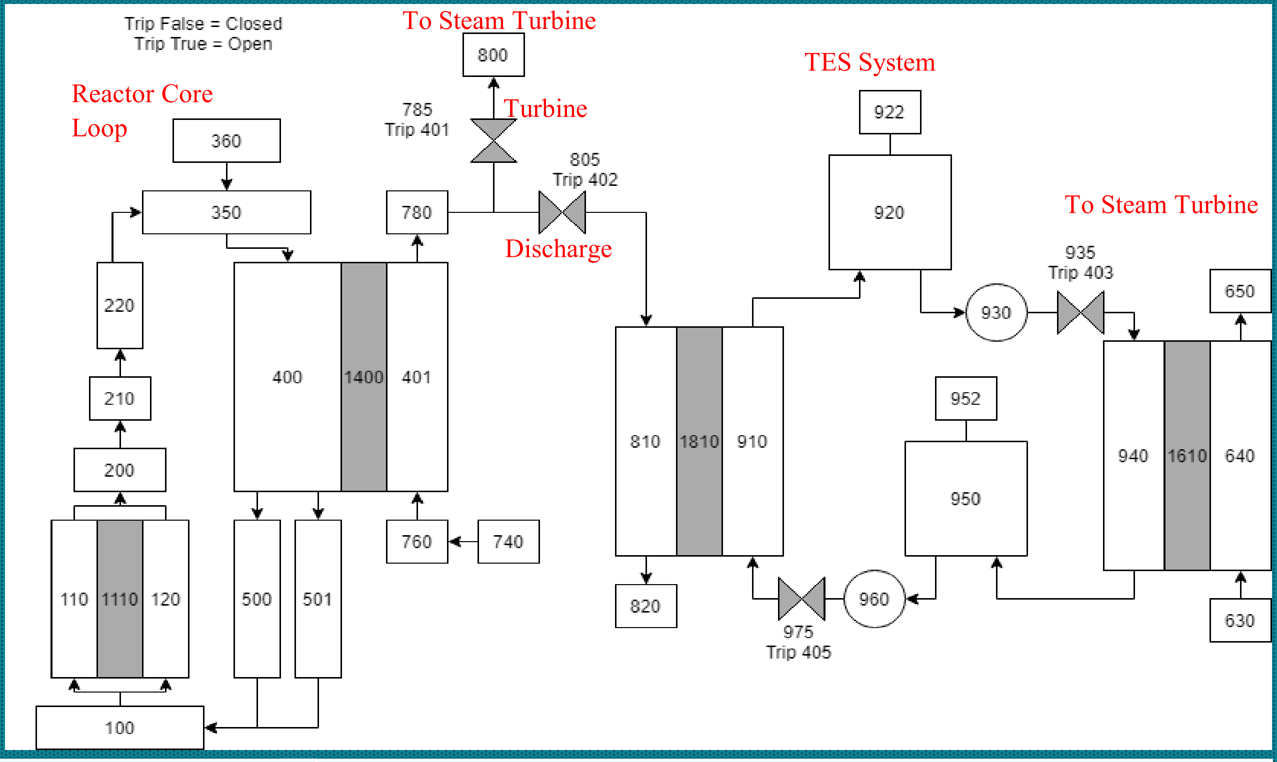
```python
def update(prev_C, prev_D, prev_J, C,D,J,time_step):

    time = time_step*900

    a_file = open(f"{n_o_r}.i", "r")

    list_of_lines = a_file.readlines()

    #valve 785 cv change min and max and scaling factor based on C
    #valve 805 cv change min and max and scaling factor based on D


    list_of_lines[29] = f'9300201    {float(time)-900}        {1388.0*prev_J}       0.0     0.0\n'
    list_of_lines[42] = f'9600201    {float(time)-900}        {1388.0*prev_D}       0.0     0.0\n'
    list_of_lines[83] = f'6350201    {float(time)-900}       {100.0*prev_J}       0.0     0.0\n'
    list_of_lines[30] = f'9300202    {float(time)-840}        {1388.0*J}       0.0     0.0\n'
    list_of_lines[43] = f'9600202    {float(time)-840}        {1388.0*D}       0.0     0.0\n'
    list_of_lines[84] = f'6350202    {float(time)-840}       {100.0*J}       0.0     0.0\n'

    if prev_C > Cs[i]:
        print('prev_C > Cs')
        list_of_lines[88] = f'20500100    var1   integral   -0.005   {0.785*prev_C}   0   3  {.784*C} .
        list_of_lines[96] = f'20500110    var1   integral   0.005   {0.785*prev_D}   0   3  0.0 {.785}\
    elif prev_C < Cs[i]:
        print('prev_C < Cs')
        list_of_lines[88] = f'20500100    var1   integral   -0.005   {0.785*prev_C}   0   3  0.0 {.785*
        list_of_lines[96] = f'20500110    var1   integral   0.005   {0.785*prev_D}   0   3  0.0 {.785}
    else:
        print('prev_C = Cs')
        list_of_lines[88] = f'20500100    var1   integral   -0.005   {0.785*prev_C}   0   3  {0.785*C-.
        list_of_lines[96] = f'20500110    var1   integral   0.005   {0.785*prev_D}   0  3  {.785*D-.001

    list_of_lines[10] = f"201    {float(time)}      1.0e-7   0.01      07003  6000  60000000   60000000
    a_file.close()

    a_file = open(f"{n_o_r}.i", "w")
    a_file.writelines(list_of_lines)
    a_file.close()
```

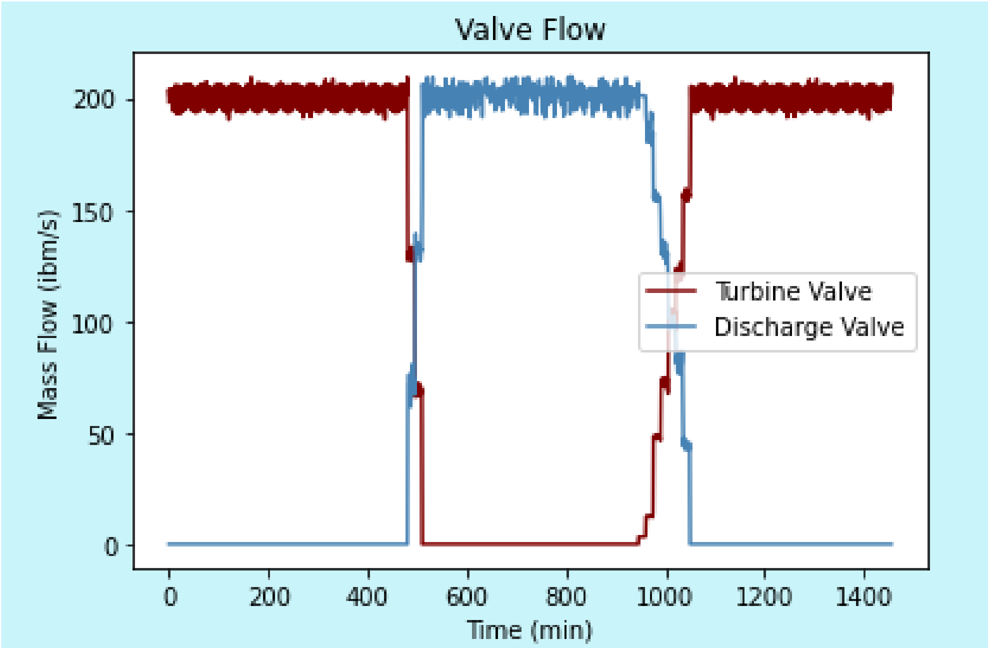
Thermal Energy Storage

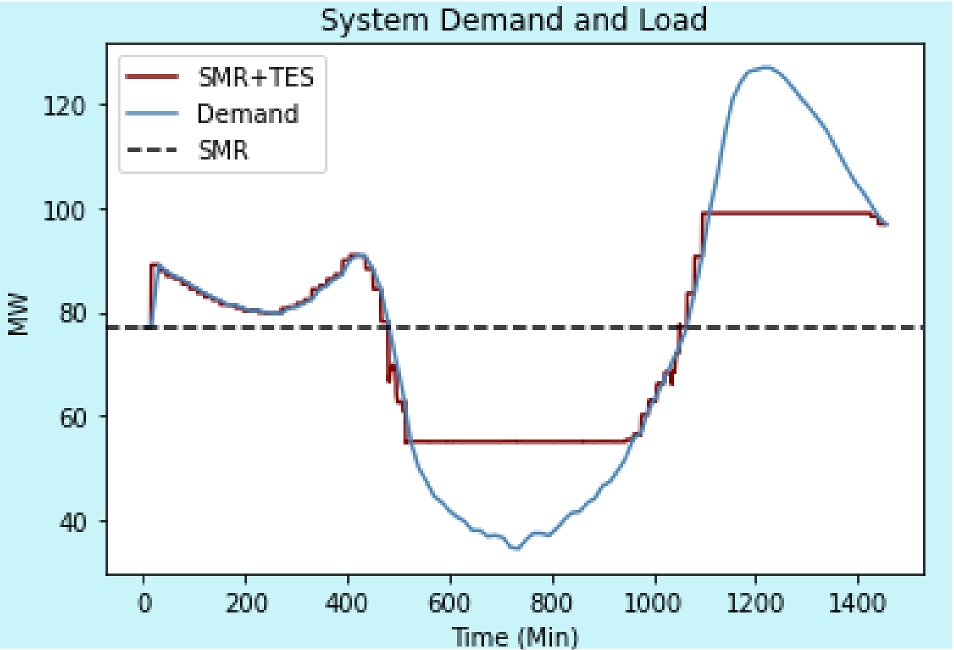
NuScale SMR



Being a baseload power, keeping up with high energy demand is a problem for nuclear reactors. Thermal energy storage systems are a proposed solution to better meet demand at all times of the day and night. The control of these systems is an important feature that requires extensive study for these reactors to be licensed with a storage system. In this work, a model predictive controller matches the load of the entire system with the demand of the power grid over a 24-hour period.

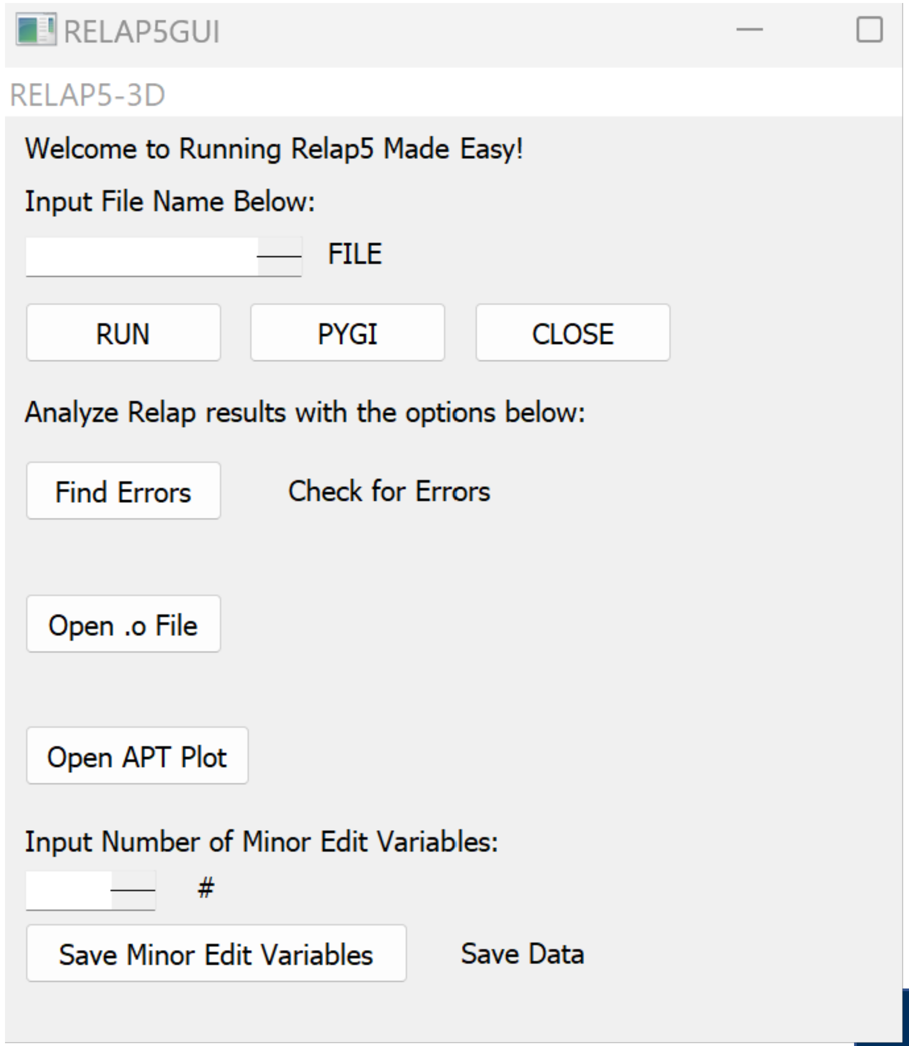






Brainstorming

- If this is possible, what else is possible?



BYU

Assignment

- Watch DVD sections 64-71 before next class
- HW 6 due Tuesday (10/17)