

FINAL CODE

TEAM ID	PNT2022TMID24427
PROJECT NAME	Industry Specific Intelligent Fire Management System

Source code

```
#!/usr/bin/env python
```

```
# coding: utf-8
```

```
# # <center> Determining Sprinkler Activation Time </center>
```

```
# In[1]:
```

```
import pandas as pd
```

```
import ipywidgets as widgets
```

```
import plotly.express as px
```

```
while True:
```

```
    try:
```

```
        amb_temp = float(input('Enter ambient room temperature (°C): '))
```

```
        rad_distance = float(input('Enter the horizontal distance between the fire and sprinkler head (m): '))
```

```
        height_above_fire = float(input('Enter the vertical distance between the fire and sprinkler head (m): '))
```

```
        RTI = float(input('Enter RTI value of the sprinkler head: '))
```

```
        c = float(input('Enter conduction value of the sprinkler head: '))
```

```
        activation = float(input('Enter sprinkler activation temperature (°C): '))
```

```
        break
```

```
    except ValueError as e:
```

```
        print('Error: Enter a valid number')
```

```
t_sq_list = ["slow", "medium", "fast", "ultra-fast"]
```

```
t_sq = None
```

```

while t_sq not in t_sq_list:

    t_sq = input('Enter fire t2 growth rate. Select from the list [slow, medium, fast, ultra-fast]: ').lower().strip()

if t_sq == 'slow':
    growth = 0.00293
elif t_sq == 'medium':
    growth = 0.01172
elif t_sq == 'fast':
    growth = 0.0469
else:
    growth = 0.1876

index = pd.RangeIndex(0, 1308, 1) # a slow t2 fire will take 1307 seconds to reach 5 MW
columns = ['Time', 'HRR', 'Gas Temp 1', 'Gas Temp 2', 'Gas Vel 1', 'Gas Vel 2', 'Gas Temp', 'Temp Sprinkler']

df = pd.DataFrame(index=index, columns=columns)

df = df.fillna(0) # with 0s rather than NaNs

df['Time'] = df.index
df['HRR'] = df['Time']*df['Time']*growth

if rad_distance/height_above_fire > 0.18:
    df['Gas Temp 1'] = (5.38*(df['HRR']/rad_distance)**(2/3))/(height_above_fire)
    df['Gas Temp'] = df['Gas Temp 1'] + amb_temp
    a = 'one'
else:
    df['Gas Temp 2'] = (16.9*(df['HRR']**(1/3))/height_above_fire**(5/3))
    df['Gas Temp'] = df['Gas Temp 2'] + amb_temp
    a = 'two'

if rad_distance/height_above_fire > 0.15:
    df['Gas Vel 1'] = (0.2*df['HRR']**(1/3)*height_above_fire**(1/2))/(rad_distance**(5/6))
    b = 'one'

```

```

else:

    df['Gas Vel 2'] = 0.95*((df['HRR']/height_above_fire)**(1/3))

    b= 'two'

x = 2

# initialise row 0

df.loc[0, 'Temp Sprinkler'] = amb_temp

if (a == 'one') & (b == 'one'):

    # initialise row 1

    df.loc[1, 'Temp Sprinkler'] = amb_temp + ((df.loc[1, 'Gas Vel 1']**0.5)/RTI)*((df.loc[1, 'Gas Temp']-amb_temp)-
    ((1+(c/df.loc[1, 'Gas Vel 1']**0.5)))*(df.loc[0, 'Temp Sprinkler']-amb_temp))

    # initialise remaining rows

    while x < 1308:

        df.loc[x, 'Temp Sprinkler'] = df.loc[x-1, 'Temp Sprinkler'] + ((df.loc[x-1, 'Gas Vel 1']**0.5)/RTI)*((df.loc[x-1, 'Gas
        Temp']-amb_temp)-((1+(c/df.loc[x-1, 'Gas Vel 1']**0.5)))*(df.loc[x-1, 'Temp Sprinkler']-amb_temp))

        x = x+1

    elif (a == 'one') & (b == 'two'):

        df.loc[1, 'Temp Sprinkler'] = amb_temp + ((df.loc[1, 'Gas Vel 2']**0.5)/RTI)*((df.loc[1, 'Gas Temp']-amb_temp)-
        ((1+(c/df.loc[1, 'Gas Vel 2']**0.5)))*(df.loc[0, 'Temp Sprinkler']-amb_temp))

        while x < 1308:

            df.loc[x, 'Temp Sprinkler'] = df.loc[x-1, 'Temp Sprinkler'] + ((df.loc[x-1, 'Gas Vel 2']**0.5)/RTI)*((df.loc[x-1, 'Gas
            Temp']-amb_temp)-((1+(c/df.loc[x-1, 'Gas Vel 2']**0.5)))*(df.loc[x-1, 'Temp Sprinkler']-amb_temp))

            x = x+1

        elif (a == 'two') & (b == 'one'):

            df.loc[1, 'Temp Sprinkler'] = amb_temp + ((df.loc[1, 'Gas Vel 1']**0.5)/RTI)*((df.loc[1, 'Gas Temp']-amb_temp)-
            ((1+(c/df.loc[1, 'Gas Vel 1']**0.5)))*(df.loc[0, 'Temp Sprinkler']-amb_temp))

            while x < 1308:

                df.loc[x, 'Temp Sprinkler'] = df.loc[x-1, 'Temp Sprinkler'] + ((df.loc[x-1, 'Gas Vel 1']**0.5)/RTI)*((df.loc[x-1, 'Gas
                Temp']-amb_temp)-((1+(c/df.loc[x-1, 'Gas Vel 1']**0.5)))*(df.loc[x-1, 'Temp Sprinkler']-amb_temp))

                x = x+1

    else:

        df.loc[1, 'Temp Sprinkler'] = amb_temp + ((df.loc[1, 'Gas Vel 2']**0.5)/RTI)*((df.loc[1, 'Gas Temp']-amb_temp)-
        ((1+(c/df.loc[1, 'Gas Vel 2']**0.5)))*(df.loc[0, 'Temp Sprinkler']-amb_temp))

        while x < 1308:

```

```

df.loc[x, 'Temp Sprinkler'] = df.loc[x-1, 'Temp Sprinkler'] + ((df.loc[x-1, 'Gas Vel 2']**0.5)/RTI)*((df.loc[x-1, 'Gas Temp']-amb_temp)-((1+(c/df.loc[x-1, 'Gas Vel 2']**0.5)))*(df.loc[x-1, 'Temp Sprinkler']-amb_temp))

x = x+1

```

```

try:

```

```

    act_time = df.loc[df['Temp Sprinkler']>activation, 'Time'].iloc[0]

```

```

except:

```

```

    print('The sprinkler does not activate')

```

```

try:

```

```

    act_hrr = round(df.loc[df['Temp Sprinkler'] > activation, 'HRR'].iloc[0],1)

```

```

except:

```

```

    print('The sprinkler does not activate')

```

```

act_time_text = 'Sprinkler activates at ' + str(act_time) + ' s.' + '\n' + ' Fire size: ' + str(act_hrr) + ' kW'

```

```

act_temp_text = 'Activation temperature: ' + str(activation) + ' °C'

```

```

fig = px.line(df, x="Time", y="Temp Sprinkler", title="Sprinkler Activation Time (' + t_sq + ' t² fire)', template = 'none')

```

```

fig.update_layout(

```

```

    autosize=False,

```

```

    width=600,

```

```

    height=500,

```

```

    yaxis=dict(

```

```

        title_text="Temperature (°C)",

```

```

        titlefont=dict(size=12),

```

```

    ),

```

```

    xaxis=dict(

```

```

        title_text="Time (s)",

```

```

        titlefont=dict(size=12),

```

```

    )

```

```

)

```

```
fig.update_layout(  
    title={  
        'y':0.9,  
        'x':0.5,  
        'xanchor': 'center',  
        'yanchor': 'top'}})
```

```
fig.update_layout(  
    xaxis = dict(  
        tickmode = 'linear',  
        tick0 = 0,  
        dtick = 250  
    )  
)
```

```
fig.add_hline(y=activation, line_width=1, line_dash="dash", line_color="green", annotation_text = act_temp_text)
```

```
fig.add_vline(x=act_time, line_width=1, line_dash="dash", line_color="green", annotation_text = act_time_text)
```

```
fig.update_annotations(font_size=10, font_color = 'darkblue')
```

```
fig.show()
```