In [1]:
```
import gc, argparse, sys, os, errno
%pylab inline
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
#from beakerx import *
import seaborn as sns
#import h5py
import os
from tqdm import tqdm_notebook as tqdm
import scipy
import sklearn
from scipy.stats import pearsonr
import warnings
warnings.filterwarnings('ignore')
from scipy.io import loadmat
from matplotlib.mlab import griddata
from ipywidgets import interact, FloatSlider,IntSlider, RadioButtons,Dropdown,Tab,Tex
from mpl_toolkits.mplot3d import Axes3D
import matplotlib.pyplot as plt
from matplotlib import cm
from matplotlib.ticker import LinearLocator, FormatStrFormatter
import numpy as np
from mpl_toolkits.mplot3d.axes3d import *
import matplotlib.pyplot as plt
from matplotlib import cm
from sklearn.preprocessing import MinMaxScaler,RobustScaler,StandardScaler
from IPython.core.display import HTML,Image
from functools import reduce
from bokeh.io import output_notebook, show
output_notebook()
from sklearn.decomposition import PCA
from sklearn.manifold import TSNE
from sklearn.metrics import roc_curve,roc_auc_score,auc,precision_recall_curve,averag
from sklearn.preprocessing import RobustScaler,MinMaxScaler,StandardScaler
from sklearn.neighbors import NearestNeighbors
from bokeh.palettes import Category20c
```

```
Populating the interactive namespace from numpy and matplotlib
```

(https://bokeh.pydata.org/)

Bokeh JS 0.13.0 successfully loaded.

In [2]:
```
cd /Users/james/NS_model
```

```
/Users/james/NS_model
```

In [3]:
```
# setup figure template
figure_template_path = 'bin/'
if figure_template_path not in sys.path:
    sys.path.append(figure_template_path)
from importlib import reload
import figure_template
# force reload of the module
reload(figure_template)
from figure_template import std_plot,display_dataframe, embed_pdf_figure, embed_pdf_p
fontlegend = {'family':'Arial',
                  'weight' : 'normal',
              #'linewidth':0.5,
                  'size' : 6.5*1}
```

In [ ]:

In [4]:
```
pd.read_excel('data/national_debt.xlsx',index_col=0)
```

Out[4]:

证券代码	证券简称	到期日期	每年付息次数	收盘价(全价) [交易日期] 最新收盘日 [单位] 元	债券初始面值 [单位] 元	债券最新面值 [交易日期] 最新收盘日	票面利率(发行时) [单位] %
010007.IB	01国债7	2021-07-31	2.0	100.7178	100.0	100.0	4.2600
010011.IB	01国债11	2021-10-23	2.0	107.0945	100.0	100.0	3.8500
020005.IB	02国债05	2032-05-24	2.0	96.9965	100.0	100.0	2.9000
030003.IB	03国债03	2023-04-17	2.0	101.5599	100.0	100.0	3.4000
030014.IB	03国债14	2033-12-15	1.0	100.4853	100.0	100.0	1.6400
050004.IB	05国债04	2025-05-15	2.0	107.1015	100.0	100.0	4.1100
050012.IB	05国债12	2020-11-15	2.0	103.2662	100.0	100.0	3.6500
060009.IB	06国债09	2026-06-26	2.0	104.9614	100.0	100.0	3.7000
060019.IB	06国债19	2021-11-15	2.0	101.4188	100.0	100.0	3.2700
0700002.IB	07特别国债02	2022-09-18	2.0	106.6821	100.0	100.0	4.6800
0700004.IB	07特别国债04	2022-09-29	2.0	106.2386	100.0	100.0	4.5500
0700006.IB	07特别国债06	2022-11-19	2.0	108.6628	100.0	100.0	4.6900
0700007.IB	07特别国债07	2022-12-11	2.0	101.3692	100.0	100.0	4.4500
070006.IB	07国债06	2037-05-17	2.0	106.5093	100.0	100.0	4.2700
070013.IB	07国债13	2027-08-16	2.0	109.6659	100.0	100.0	4.5200
080002.IB	08国债02	2023-02-28	2.0	105.0068	100.0	100.0	4.1600
080006.IB	08国债06	2038-05-08	2.0	110.8073	100.0	100.0	4.5000
080013.IB	08国债13	2028-08-11	2.0	115.0732	100.0	100.0	4.9400
080020.IB	08国债20	2038-10-23	2.0	106.5972	100.0	100.0	3.9100
080023.IB	08国债23	2023-11-27	2.0	104.6744	100.0	100.0	3.6200
090002.IB	09国债02	2029-02-19	2.0	106.0454	100.0	100.0	3.8600
090005.IB	09附息国债05	2039-04-09	2.0	111.1973	100.0	100.0	4.0200

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090007.IB	09附息国债07	2019-05-07	2.0	101.4056	100.0	100.0	3.0200
090011.IB	09附息国债11	2024-06-11	2.0	103.9566	100.0	100.0	3.6900
090012.IB	09附息国债12	2019-06-18	2.0	100.6879	100.0	100.0	3.0900
090016.IB	09附息国债16	2019-07-23	2.0	101.2299	100.0	100.0	3.4800
090020.IB	09附息国债20	2029-08-27	2.0	107.8416	100.0	100.0	4.0000
090023.IB	09附息国债23	2019-09-17	2.0	100.6912	100.0	100.0	3.4400
090025.IB	09附息国债25	2039-10-15	2.0	100.8127	100.0	100.0	4.1800
090027.IB	09附息国债27	2019-11-05	2.0	102.3138	100.0	100.0	3.6800
...	...	...	...	...	...	...	...
180027X2.IB	18附息国债27(续2)	2028-11-22	2.0	NaN	100.0	100.0	3.2500
180027X3.IB	18附息国债27(续3)	2028-11-22	2.0	NaN	100.0	100.0	3.2500
180027X4.IB	18附息国债27(续4)	2028-11-22	2.0	NaN	100.0	100.0	3.2500
180028.IB	18附息国债28	2025-12-06	1.0	101.0803	100.0	100.0	3.2200
180028X.IB	18附息国债28(续发)	2025-12-06	1.0	NaN	100.0	100.0	3.2200
180028X2.IB	18附息国债28(续2)	2025-12-06	1.0	NaN	100.0	100.0	3.2200
180028X3.IB	18附息国债28(续3)	2025-12-06	1.0	NaN	100.0	100.0	3.2200
189947.IB	18贴现国债47	2019-04-15	NaN	99.8966	100.0	100.0	2.2398
189952.IB	18贴现国债52	2019-05-13	NaN	99.8202	100.0	100.0	2.5147
189957.IB	18贴现国债57	2019-06-10	NaN	99.6086	100.0	100.0	2.4784
190001.IB	19附息国债01	2020-01-17	NaN	100.4192	100.0	100.0	2.3100
190001X.IB	19附息国债01(续发)	2020-01-17	NaN	NaN	100.0	100.0	2.3100

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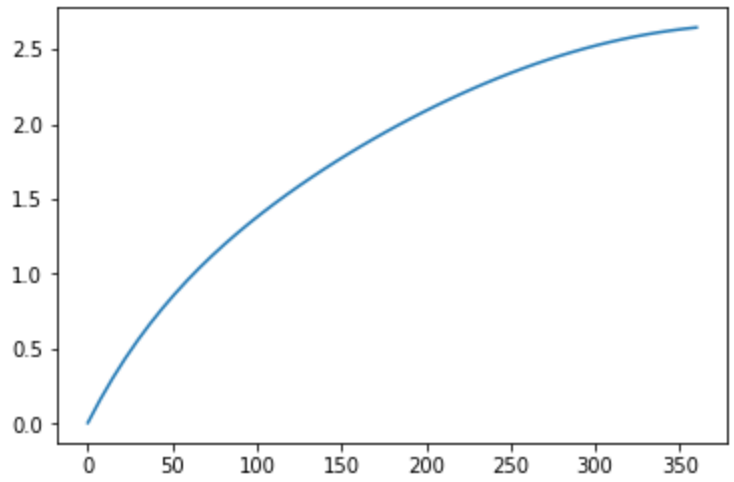
190001X2.IB	19附息国债01(续2)	2020-01-17	NaN	NaN	100.0	100.0	2.3100
190002.IB	19附息国债02	2021-02-21	1.0	100.0459	100.0	100.0	2.4400
190003.IB	19附息国债03	2022-03-07	1.0	100.0083	100.0	100.0	2.6900
199901.IB	19贴现国债01	2019-04-08	NaN	99.9562	100.0	100.0	2.3115
199902.IB	19贴现国债02	2019-07-08	NaN	99.4450	100.0	100.0	2.3798
199903.IB	19贴现国债03	2019-04-15	NaN	99.9053	100.0	100.0	2.2426
199904.IB	19贴现国债04	2019-04-22	NaN	99.8871	100.0	100.0	2.2109
199905.IB	19贴现国债05	2019-04-29	NaN	99.8445	100.0	100.0	2.2304
199906.IB	19贴现国债06	2019-05-20	NaN	99.7416	100.0	100.0	2.0050
199907.IB	19贴现国债07	2019-05-27	NaN	99.6912	100.0	100.0	1.9973
199908.IB	19贴现国债08	2019-06-03	NaN	99.6382	100.0	100.0	1.9736
199909.IB	19贴现国债09	2019-06-10	NaN	99.6150	100.0	100.0	1.8859
199910.IB	19贴现国债10	2019-09-09	NaN	99.0363	100.0	100.0	2.1068
199911.IB	19贴现国债11	2019-06-17	NaN	99.5762	100.0	100.0	2.0629
199912.IB	19贴现国债12	2019-06-24	NaN	99.5393	100.0	100.0	2.0475
9802.IB	98国债2	2028-08-18	1.0	104.4778	100.0	100.0	7.2000
NaN	NaN	NaT	NaN	NaN	NaN	NaN	NaN
数据来源：Wind	NaN	NaT	NaN	NaN	NaN	NaN	NaN

418 rows × 7 columns

In [5]:
```
from nelson_siegel_svensson import NelsonSiegelSvenssonCurve

y = NelsonSiegelSvenssonCurve(-20.88281 ,20.88888,   9.98873,  62.66161,  84.02785, 3
t = np.linspace(0, 360)
plot(t, y(t))
```

Out[5]:
```
[<matplotlib.lines.Line2D at 0x1221f4cc0>]
```

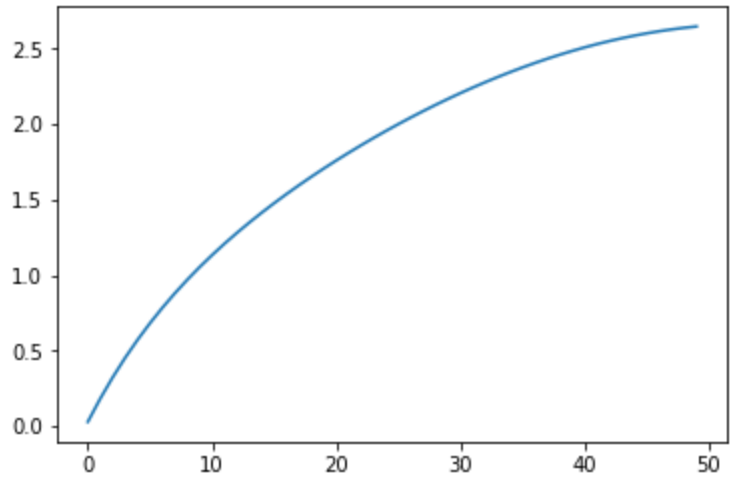


$$y(\tau) = \beta_1 + \beta_2 \left[\frac{1-\exp(-\tau/\lambda_1)}{\tau/\lambda_1}\right] + \beta_3 \left[\frac{1-\exp(-\tau/\lambda_1)}{\tau/\lambda_1} - \exp(-\tau/\lambda_1)\right] + \beta_4 \left[\frac{1-\exp(-\tau/\lambda_2)}{\tau/\lambda_2} - \exp(-\tau/\right.$$

In [6]:
```
def plot_r_nss_curve(beta_1,beta_2,beta_3, beta_4,lambda1,lambda2,tau):
    part1 = beta_1
    part2 = beta_2*((1-np.exp(-tau/lambda1))/(tau/lambda1))
    part3 = beta_3*((1-np.exp(-tau/lambda1))/(tau/lambda1)-np.exp(-tau/lambda1))
    part4 = beta_4*((1-np.exp(-tau/lambda2))/(tau/lambda2)-np.exp(-tau/lambda2))
    return part1+part2+part3+part4
```

In [7]:
```
plt.plot(plot_r_nss_curve(-20.88281 ,20.88888,   9.98873,  62.66161,  84.02785, 359.9
```

Out[7]:
```
[<matplotlib.lines.Line2D at 0x122307940>]
```



In [ ]: