# Finding Answers

## Importing Necessary Libraries

In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import scipy.interpolate as interpolate
import _pickle as pickle
```

## Function to Sort Dictonary

In [2]:
```
def sort_dict(dct,parameter,order='Ascending'):
    if parameter=='key':
        if(order=='reverse'):
            sorted_tuples = sorted(dct.items(),key=lambda item:item[0],reverse=True)
            return {k:v for k,v in sorted_tuples}
        else:
            sorted_tuples = sorted(dct.items(),key=lambda item:item[0])
            return {k:v for k,v in sorted_tuples}
    else:
        if(order=='reverse'):
            sorted_tuples = sorted(dct.items(),key=lambda item:item[1],reverse=True)
            return {k:v for k,v in sorted_tuples}
        else:
            sorted_tuples = sorted(dct.items(),key=lambda item:item[1])
            return {k:v for k,v in sorted_tuples}
```

## Importing Database

In [3]:
```
df = pd.read_csv('Complete_database.csv')
```

In [4]:
```
df.head()
```

Out[4]:

| | Unnamed: 0 | Authors | Title | Year | Cited by | Country | Funding_Details |
|---|---|---|---|---|---|---|---|
| **0** | 0 | Soares, J.V.B., Leandro, J.J.G., Cesar Jr., R.... | Retinal vessel segmentation using the 2-D Gabo... | 2006 | 1083.0 | Australia | 0 |
| **1** | 1 | Scarselli, F., Gori, M., Tsoi, A.C., Hagenbuch... | The graph neural network model | 2009 | 1031.0 | Australia | 0 |
| **2** | 2 | Karantonis, D.M., Narayanan, M.R., Mathie, M.,... | Implementation of a real-time human movement c... | 2006 | 908.0 | Australia | 0 |
| **3** | 3 | Mirjalili, S. | Dragonfly algorithm: a new meta-heuristic opti... | 2016 | 865.0 | Australia | 0 |
| **4** | 4 | Naseem, I., Togneri, R., Bennamoun, M. | Linear regression for face recognition | 2010 | 768.0 | Australia | 0 |

In [5]:
```
df.shape
```

Out[5]:
```
(67694, 7)
```

## Removing Unnamed column and renaming Cited by column for ease of use

In [6]:
```
df.drop('Unnamed: 0',axis='columns',inplace=True)
```

In [7]:
```
df.rename(columns={'Cited by':'Cited_by','Funding Details':'Funding_Details'},inplace
=True)
```

## Reading Authors names from previously created file and storing those in python list

In [8]:
```
set_authors = []
with open('Authors_list.txt','r') as filehandle:
    filecontents = filehandle.readlines()

    for line in filecontents:
        # remove linebreak which is the last character of the string
        author = line[:-1]

        # add item to the list
        set_authors.append(author)
filehandle.close()
```

## Reading Previously Created Author:Database Dictonary

In [9]:
```
dct_author_database = {}
with open('Author_database_dictonary.txt','rb') as file:
    dct_author_database = pickle.load(file)
file.close()
```

In [10]:
```
index = 6
print(set_authors[index])
dct_author_database[set_authors[index]]
```

```
Jelinek, H.F.
```

Out[10]:

| | Authors | Title | Year | Cited_by | Funding Details |
|---|---|---|---|---|---|
| **0** | Soares, J.V.B., Leandro, J.J.G., Cesar Jr., R.... | Retinal vessel segmentation using the 2-D Gabo... | 2006 | 1083.0 | 0 |
| **1** | Rocha, A., Carvalho, T., Jelinek, H.F., Golden... | Points of interest and visual dictionaries for... | 2012 | 96.0 | 0 |
| **2** | Jelinek, H.F., Cree, M.J., Leandro, J.J.G., So... | Automated segmentation of retinal blood vessel... | 2007 | 47.0 | 0 |
| **3** | Hassan, M.M., Huda, S., Yearwood, J., Jelinek,... | Multistage fusion approaches based on a genera... | 2018 | 18.0 | 0 |
| **4** | Abawajy, J., Kelarev, A., Chowdhury, M., Stran... | Predicting cardiac autonomic neuropathy catego... | 2013 | 15.0 | 0 |

# a) Highest cited author and his h-index (from the world)

In [11]:
```
author_with_highest_citations = ""
max_citations = 0
for author in set_authors:
    cites = dct_author_database[author]['Cited_by'].sum()
    if max_citations<cites:
        author_with_highest_citations = author
        max_citations = cites
```

In [12]:
```
df_of_highest_cited_author = dct_author_database[author_with_highest_citations]
rows,cols = df_of_highest_cited_author.shape
avg_citations_of_author_with_highest_citations = max_citations/rows
h_index = min(rows,avg_citations_of_author_with_highest_citations)
```

In [13]:
```
print(f'Max cited author    = {author_with_highest_citations}')
print(f'Total cited by      = {max_citations}')
print(f'His h-index         = {h_index}')
```

```
Max cited author    = Hassabis, D.
Total cited by      = 17466.0
His h-index         = 13
```

# b) Highest publication author

In [14]:
```
author_with_highest_publication = ""
max_publication_count = 0
for author in set_authors:
    rows, columns = dct_author_database[author].shape
    if rows>max_publication_count:
        max_publication_count=rows
        author_with_highest_publication = author
        # print(f'{author}                    \t{rows}')
```

In [15]:
```
print(f'Author\t\t= {author_with_highest_publication}\nPublications\t= {max_publication_count}')
```

```
Author          = Wang, Y.
Publications    = 439
```

# c) Highest cited authors avg. citations, and the country name.

In [16]:
```
dct_author_database[author_with_highest_citations]
```

Out[16]:

| | Authors | Title | Year | Cited_by | Funding Details |
|---|---|---|---|---|---|
| **0** | Vinyals, O., Babuschkin, I., Czarnecki, W.M., ... | Grandmaster level in StarCraft II using multi-... | 2019 | 224.0 | 0 |
| **1** | Mnih, V., Kavukcuoglu, K., Silver, D., Rusu, A... | Human-level control through deep reinforcement... | 2015 | 7346.0 | 0 |
| **2** | Silver, D., Huang, A., Maddison, C.J., Guez, A... | Mastering the game of Go with deep neural netw... | 2016 | 5282.0 | 0 |
| **3** | Silver, D., Schrittwieser, J., Simonyan, K., A... | Mastering the game of Go without human knowledge | 2017 | 2391.0 | 0 |
| **4** | Kirkpatrick, J., Pascanu, R., Rabinowitz, N., ... | Overcoming catastrophic forgetting in neural n... | 2017 | 647.0 | 0 |
| **5** | De Fauw, J., Ledsam, J.R., Romera-Paredes, B.,... | Clinically applicable deep learning for diagno... | 2018 | 602.0 | 0 |
| **6** | Silver, D., Hubert, T., Schrittwieser, J., Ant... | A general reinforcement learning algorithm tha... | 2018 | 457.0 | 0 |
| **7** | McKinney, S.M., Sieniek, M., Godbole, V., Godw... | International evaluation of an AI system for b... | 2020 | 266.0 | NIHR Imperial Biomedical Research Centre\n\nOf... |
| **8** | Wang, J.X., Kurth-Nelson, Z., Kumaran, D., Tir... | Prefrontal cortex as a meta-reinforcement lear... | 2018 | 112.0 | 0 |
| **9** | Jaderberg, M., Czarnecki, W.M., Dunning, I., M... | Human-level performance in 3D multiplayer game... | 2019 | 71.0 | 0 |
| **10** | Dabney, W., Kurth-Nelson, Z., Uchida, N., Star... | A distributional code for value in dopamine-ba... | 2020 | 43.0 | 0 |
| **11** | Yim, J., Chopra, R., Spitz, T., Winkens, J., O... | Predicting conversion to wet age-related macul... | 2020 | 23.0 | 0 |
| **12** | Schrittwieser, J., Antonoglou, I., Hubert, T.,... | Mastering Atari, Go, chess and shogi by planni... | 2020 | 2.0 | 0 |

In [17]:
```
rows, cols = dct_author_database[author_with_highest_citations].shape

avg_citations_of_author_with_highest_citations = max_citations/rows
print(f'Highest Cited Author \t= {author_with_highest_citations}')
print(f'His Average Citations \t= {avg_citations_of_author_with_highest_citations}')
print(f'His Total Publications \t= {rows}')
```

```
Highest Cited Author    = Hassabis, D.
His Average Citations   = 1343.5384615384614
His Total Publications  = 13
```

## A google search with above author's name tells us that he's from 'United Kingdom' and doing reasearch on 'Artificial Intelligence'

# d) Total number of publications of the highest cited author

In [18]:
```
print(f'Highest Cited Author \t= {author_with_highest_citations}')
print(f'Total Publications \t= {rows}')
dct_author_database[author_with_highest_citations]
```

```
Highest Cited Author    = Hassabis, D.
Total Publications      = 13
```

Out[18]:

| | Authors | Title | Year | Cited_by | Funding Details |
|---|---|---|---|---|---|
| **0** | Vinyals, O., Babuschkin, I., Czarnecki, W.M., ... | Grandmaster level in StarCraft II using multi-... | 2019 | 224.0 | 0 |
| **1** | Mnih, V., Kavukcuoglu, K., Silver, D., Rusu, A... | Human-level control through deep reinforcement... | 2015 | 7346.0 | 0 |
| **2** | Silver, D., Huang, A., Maddison, C.J., Guez, A... | Mastering the game of Go with deep neural netw... | 2016 | 5282.0 | 0 |
| **3** | Silver, D., Schrittwieser, J., Simonyan, K., A... | Mastering the game of Go without human knowledge | 2017 | 2391.0 | 0 |
| **4** | Kirkpatrick, J., Pascanu, R., Rabinowitz, N., ... | Overcoming catastrophic forgetting in neural n... | 2017 | 647.0 | 0 |
| **5** | De Fauw, J., Ledsam, J.R., Romera-Paredes, B.,... | Clinically applicable deep learning for diagno... | 2018 | 602.0 | 0 |
| **6** | Silver, D., Hubert, T., Schrittwieser, J., Ant... | A general reinforcement learning algorithm tha... | 2018 | 457.0 | 0 |
| **7** | McKinney, S.M., Sieniek, M., Godbole, V., Godw... | International evaluation of an AI system for b... | 2020 | 266.0 | NIHR Imperial Biomedical Research Centre\n\nOf... |
| **8** | Wang, J.X., Kurth-Nelson, Z., Kumaran, D., Tir... | Prefrontal cortex as a meta-reinforcement lear... | 2018 | 112.0 | 0 |
| **9** | Jaderberg, M., Czarnecki, W.M., Dunning, I., M... | Human-level performance in 3D multiplayer game... | 2019 | 71.0 | 0 |
| **10** | Dabney, W., Kurth-Nelson, Z., Uchida, N., Star... | A distributional code for value in dopamine-ba... | 2020 | 43.0 | 0 |
| **11** | Yim, J., Chopra, R., Spitz, T., Winkens, J., O... | Predicting conversion to wet age-related macul... | 2020 | 23.0 | 0 |
| **12** | Schrittwieser, J., Antonoglou, I., Hubert, T.,... | Mastering Atari, Go, chess and shogi by planni... | 2020 | 2.0 | 0 |

# e) Total publication in year

In [19]:
```
year_lst = sorted(list(df['Year'].unique()))
country_lst = list(df['Country'].unique())
```

In [20]:
```
df_without_duplicates = df.drop_duplicates(subset=['Authors','Title'],keep='first')
```

In [21]:
```
dct_df_per_year_publications = {}
for year in year_lst:
    dct_df_per_year_publications[year], cols = df_without_duplicates[df_without_dupli
cates.Year==year].shape
```

In [22]:
```
dct_df_per_year_publications = sort_dict(dct_df_per_year_publications,'Values','rever
se')
dct_df_per_year_publications
```

Out[22]:
```
{2020: 6222,
 2019: 4688,
 2018: 4122,
 2016: 3341,
 2014: 3159,
 2015: 3117,
 2017: 3049,
 2021: 2688,
 2013: 2277,
 2004: 2191,
 2012: 2010,
 2008: 1933,
 2009: 1565,
 2011: 1559,
 2010: 1542,
 2006: 1464,
 2007: 1401,
 2003: 1357,
 2005: 1346,
 2000: 793,
 1989: 734,
 1999: 730,
 2001: 726,
 1997: 718,
 1996: 713,
 1994: 703,
 2002: 702,
 1998: 697,
 1995: 601,
 1988: 531,
 1993: 485,
 1990: 457,
 1991: 394,
 1992: 357,
 1987: 351,
 1986: 165,
 1985: 117,
 1984: 70,
 1983: 25,
 1982: 23,
 1977: 17,
 1980: 13,
 1973: 12,
 1978: 12,
 1979: 12,
 1981: 11,
 1974: 8,
 1975: 8,
 1976: 8,
 1971: 7,
 1972: 6,
 1970: 3,
 1962: 1,
 1963: 1,
 1964: 1,
 1965: 1,
 1968: 1,
 1969: 1}
```

# f) Total citation per year

In [23]:
```
dct_citations_per_year = {}
for year in year_lst:
    dct_citations_per_year[year] = df_without_duplicates[df_without_duplicates.Year==
year]['Cited_by'].sum()

dct_citations_per_year = sort_dict(dct_citations_per_year,'Values','reverse')
```

In [24]:
```
dct_citations_per_year
```

Out[24]:
```
{2008: 86548.0,
 2016: 85426.0,
 2015: 81343.0,
 2005: 78325.0,
 2004: 75544.0,
 2007: 73896.0,
 2006: 73652.0,
 2014: 69065.0,
 2009: 68433.0,
 2018: 66871.0,
 2013: 63245.0,
 2017: 61390.0,
 2010: 61118.0,
 2012: 56435.0,
 2011: 55280.0,
 2019: 42281.0,
 2000: 36085.0,
 2003: 32783.0,
 1999: 28128.0,
 1998: 26193.0,
 2002: 25418.0,
 2001: 25176.0,
 1997: 21638.0,
 2020: 21386.0,
 1995: 18774.0,
 1994: 18694.0,
 1996: 16943.0,
 1989: 12072.0,
 1992: 10540.0,
 1990: 9800.0,
 1993: 8807.0,
 1991: 8453.0,
 1988: 8385.0,
 1987: 5439.0,
 1986: 3652.0,
 1980: 2616.0,
 1985: 1930.0,
 1977: 1644.0,
 2021: 1568.0,
 1979: 997.0,
 1984: 812.0,
 1971: 446.0,
 1973: 256.0,
 1978: 252.0,
 1976: 215.0,
 1983: 208.0,
 1982: 202.0,
 1975: 186.0,
 1970: 83.0,
 1981: 76.0,
 1972: 49.0,
 1974: 33.0,
 1963: 17.0,
 1962: 16.0,
 1969: 4.0,
 1964: 2.0,
 1965: 2.0,
 1968: 0.0}
```

# g) Author(country) having highest co-authorship with indian authors.

## Reading India Authors name from previously created file

In [25]:
```
set_of_indian_authors = []
with open('Indian_authors_list.txt','r') as filehandle:
    filecontents = filehandle.readlines()

    for line in filecontents:
        # remove linebreak which is the last character of the string
        author = line[:-1]

        # add item to the list
        set_of_indian_authors.append(author)
filehandle.close()
```

## Reading Foreign Authors name from previously created file

In [26]:
```
set_of_foreign_authors = []
with open('Foreign_authors_list.txt','r') as filehandle:
    filecontents = filehandle.readlines()

    for line in filecontents:
        # remove linebreak which is the last character of the string
        author = line[:-1]

        # add item to the list
        set_of_foreign_authors.append(author)
```

## Loading Previously created dictonary from file

In [27]:
```
dct_foreign_author_coauth_count = {}
with open('Foreign_auth_and_their_publication_count_with_india_authors_dct.txt','rb')
as file:
    dct_foreign_author_coauth_count = pickle.load(file)
file.close()
```

## Finding Foreign author with highest co-authorship with India authors

In [28]:
```
mx_pubs_with_indian_authors = 0
foreign_auth_corr_to_mx_pubs_with_indian_authors = ""
for author in set_of_foreign_authors:
    pubs = dct_foreign_author_coauth_count[author]
    if mx_pubs_with_indian_authors < pubs:
        mx_pubs_with_indian_authors = pubs
        foreign_auth_corr_to_mx_pubs_with_indian_authors = author
```

In [29]:
```
print(f'Foreign author with Highest Co-authorship with Indian Authors =  {foreign_aut
h_corr_to_mx_pubs_with_indian_authors}')
print(mx_pubs_with_indian_authors)
```

```
Foreign author with Highest Co-authorship with Indian Authors =  Nicolaides, A.
127
```

### A google search with above authors name tells us that he is from "Vascular Screening and Diagnostic Centre, University of Nicosia, Nicosia, Cyprus"

## h) Highest cited author from India and the university

In [31]:
```
highest_cited_indian_author
```

Out[31]:
```
'Raghava, G.P.'
```

In [30]:
```
max_cites_of_indian_author = 0
highest_cited_indian_author = ""

for author in set_of_indian_authors:
    cites = dct_author_database[author]['Cited_by'].sum()
    if max_cites_of_indian_author < cites:
        max_cites_of_indian_author = cites
        highest_cited_indian_author = author
```

In [32]:
```
print(f'Highest Cited Author from India = {highest_cited_indian_author}')
print(f'His Total Citations = {max_cites_of_indian_author}')
```

```
Highest Cited Author from India = Raghava, G.P.
His Total Citations = 3132.0
```

Out[32]:

| | Authors | Title | Year | Cited_by | Funding Details |
|---|---|---|---|---|---|
| **0** | Saha, S., Raghava, G.P.S. | AlgPred: Prediction of allergenic proteins and... | 2006 | 348.0 | 0 |
| **1** | Gupta, S., Kapoor, P., Chaudhary, K., Gautam, ... | In Silico Approach for Predicting Toxicity of ... | 2013 | 298.0 | 0 |
| **2** | Bhasin, M., Raghava, G.P.S. | ESLpred: SVM-based method for subcellular loca... | 2004 | 252.0 | 0 |
| **3** | Bhasin, M., Raghava, G.P.S. | Prediction of CTL epitopes using QM, SVM and A... | 2004 | 239.0 | 0 |
| **4** | Kumar, M., Gromiha, M.M., Raghava, G.P.S. | Prediction of RNA binding sites in a protein u... | 2008 | 202.0 | 0 |
| **5** | Bhasin, M., Garg, A., Raghava, G.P.S. | PSLpred: Prediction of subcellular localizatio... | 2005 | 161.0 | 0 |
| **6** | Singh, H., Ansari, H.R., Raghava, G.P.S. | Improved Method for Linear B-Cell Epitope Pred... | 2013 | 158.0 | 0 |
| **7** | Kumar, M., Gromiha, M.M., Raghava, G.P.S. | Identification of DNA-binding proteins using s... | 2007 | 158.0 | 0 |
| **8** | Bhasin, M., Raghava, G.P.S. | GPCRpred: An SVM-based method for prediction o... | 2004 | 151.0 | 0 |
| **9** | Dhanda, S.K., Vir, P., Raghava, G.P.S. | Designing of interferon-gamma inducing MHC cla... | 2013 | 140.0 | 0 |
| **10** | Bhasin, M., Raghava, G.P.S. | SVM based method for predicting HLA-DRB1*0401 ... | 2004 | 115.0 | 0 |
| **11** | Bhasin, M., Raghava, G.P.S. | Analysis and prediction of affinity of TAP bin... | 2004 | 113.0 | 0 |
| **12** | Rashid, M., Saha, S., Raghava, G.P.S. | Support Vector Machine-based method for predic... | 2007 | 101.0 | 0 |
| **13** | Kaundal, R., Kapoor, A.A., Raghava, G.P.S. | Machine learning techniques in disease forecas... | 2006 | 83.0 | 0 |
| **14** | Bhasin, M., Raghava, G.P.S. | Pcleavage: An SVM based method for prediction ... | 2005 | 75.0 | 0 |
| **15** | Kumar, M., Bhasin, M., Natt, N.K., Raghava, G.... | BhairPred: Prediction of β-hairpins in a prote... | 2005 | 63.0 | 0 |
| **16** | Mishra, N.K., Agarwal, S., Raghava, G.P.S. | Prediction of cytochrome P450 isoform responsi... | 2010 | 55.0 | 0 |
| **17** | Bhasin, M., Raghava, G.P.S. | GPCRsclass: A web tool for the classification ... | 2005 | 55.0 | 0 |
| **18** | Verma, R., Varshney, G.C., Raghava, G.P.S. | Prediction of mitochondrial proteins of malari... | 2010 | 43.0 | 0 |
| **19** | Garg, A., Raghava, G.P.S. | ESLpred2: Improved method for predicting subce... | 2008 | 43.0 | 0 |
| **20** | Garg, A., Raghava, G.P.S. | A machine learning based method for the predic... | 2008 | 40.0 | 0 |
| **21** | Lata, S., Bhasin, M., Raghava, G.P. | Application of machine learning techniques in ... | 2007 | 38.0 | 0 |
| **22** | Kaundal, R., Raghava, G.P.S. | RSLpred: An integrative system for predicting ... | 2009 | 34.0 | 0 |
| **23** | Rashid, M., Ramasamy, S., Raghava, G.P.S. | A simple approach for predicting protein-prote... | 2010 | 33.0 | 0 |
| **24** | Kumar, M., Raghava, G.P. | Prediction of nuclear proteins using SVM and H... | 2009 | 29.0 | 0 |
| **25** | Bhasin, M., Lata, S., Raghava, G.P. | TAPPred prediction of TAP-binding peptides in ... | 2007 | 27.0 | 0 |
| **26** | Verma, R., Tiwari, A., Kaur, S., Varshney, G.C... | Identification of proteins secreted by malaria... | 2008 | 25.0 | 0 |

| | Authors | Title | Year | Cited_by | Funding Details |
|---|---|---|---|---|---|
| **27** | Kalita, M.K., Nandal, U.K., Pattnaik, A., Siva... | CyclinPred: A SVM-based method for predicting ... | 2008 | 23.0 | 0 |
| **28** | Mishra, N.K., Kumar, M., Raghava, G.P.S. | Support vector machine based prediction of glu... | 2007 | 16.0 | 0 |

# i) Comparative year wise article publication analysis of India, China and USA

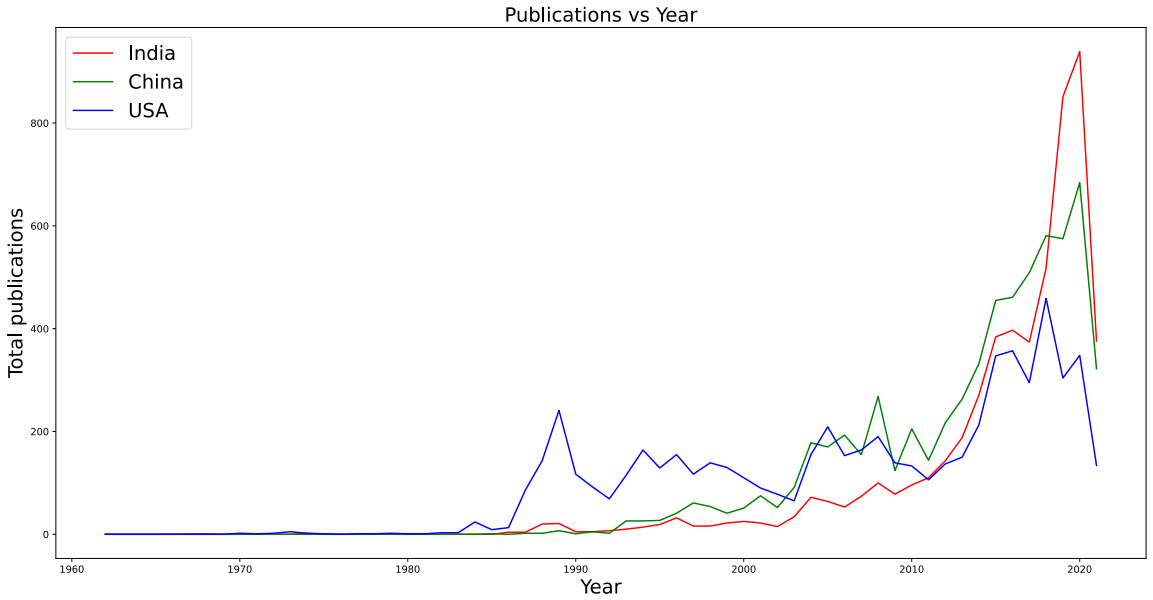
In [33]:
```
df_india = df[df.Country=='India'].copy().reset_index(drop=True)
df_china = df[df.Country=='China'].copy().reset_index(drop=True)
df_usa = df[df.Country=='United States'].copy().reset_index(drop=True)
```

In [34]:
```
dct_india_year_publications = {}
dct_china_year_publications = {}
dct_usa_year_publications = {}
for year in year_lst:
    dct_india_year_publications[year], cols1 = df_india[df_india.Year==year].shape
    dct_china_year_publications[year], cols2 = df_china[df_china.Year==year].shape
    dct_usa_year_publications[year], cols3 = df_usa[df_usa.Year==year].shape
```

## Comparative analysis using graph

In [35]:
```
x_data = [list(dct_india_year_publications.keys()),
          list(dct_china_year_publications.keys()),
          list(dct_usa_year_publications.keys())]

y_data = [list(dct_india_year_publications.values()),
          list(dct_china_year_publications.values()),
          list(dct_usa_year_publications.values())]
```

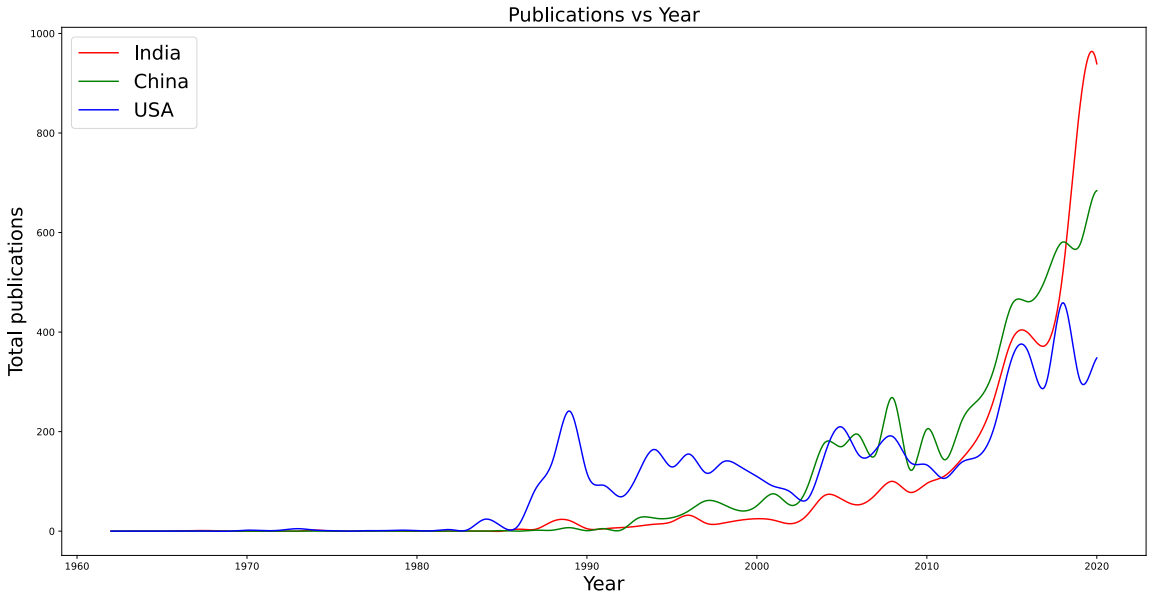
In [36]:
```
fig = plt.figure(figsize=[20,10])

plt.plot(x_data[0], y_data[0],    label='India',  color='r')
plt.plot(x_data[1], y_data[1],    label='China',  color='g')
plt.plot(x_data[2], y_data[2],    label='USA',    color='b')

plt.xlabel('Year',fontsize=20)
plt.ylabel('Total publications',fontsize=20)
plt.title('Publications vs Year',fontsize=20)
plt.legend(loc='upper left',fontsize=20)
plt.show()
```



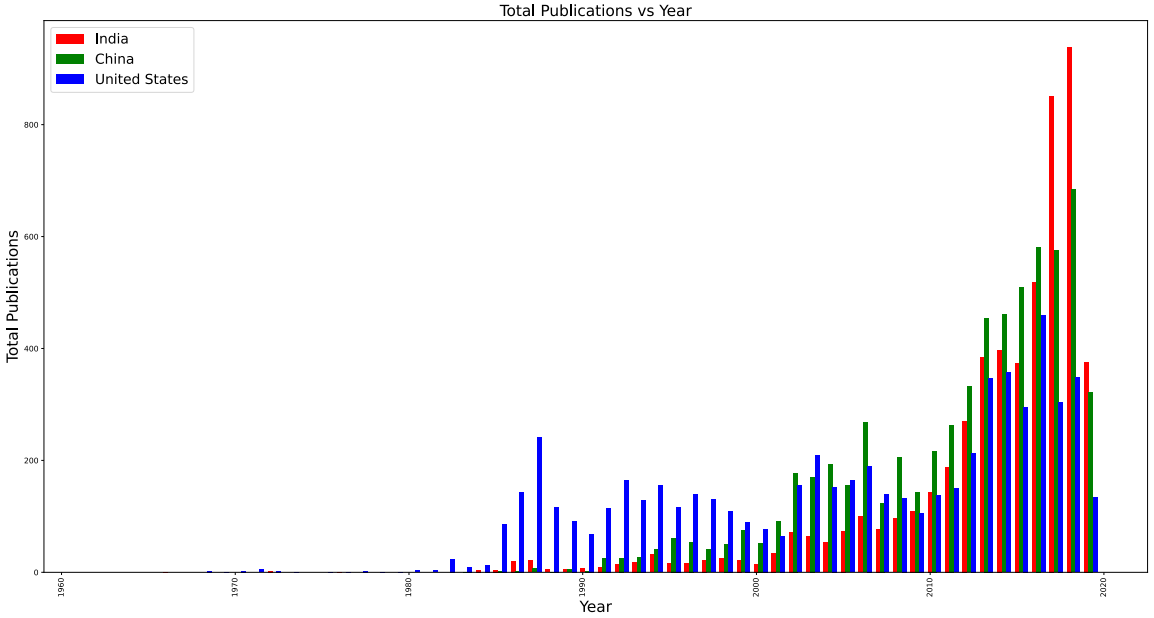

## Generating a smoother curve using scipy.interpolate library

In [37]:
```
y_new = []
x_new = []
for i in range(3):
    x_new_tmp = np.linspace(year_lst[0],year_lst[0]+len(x_data[0]),1000)
    x_new.append(x_new_tmp)

    spline = interpolate.make_interp_spline(x_data[i], y_data[i])
    y_new.append(spline(x_new_tmp))
```

In [38]:
```
fig = plt.figure(figsize=[20,10])

plt.plot(x_new[0], y_new[0],    label='India',  color='r')
plt.plot(x_new[1], y_new[1],    label='China',  color='g')
plt.plot(x_new[2], y_new[2],    label='USA',    color='b')

plt.xlabel('Year',fontsize=20)
plt.ylabel('Total publications',fontsize=20)
plt.title('Publications vs Year',fontsize=20)
plt.legend(loc='upper left',fontsize=20)
plt.show()
```



In [39]:
```
# plt.rcParams['figure.figsize'] = [20,10]
fig = plt.figure(figsize=[20,10])

X = np.arange(len(year_lst))
X = X + year_lst[0]

fig = fig.add_axes([0,0,1,1])

fig.bar(X + 0.00, list(dct_india_year_publications.values()),  label='India',
color='r',  width =0.25)
fig.bar(X + 0.25, list(dct_china_year_publications.values()),  label='China',
color='g',  width =0.25)
fig.bar(X + 0.50, list(dct_usa_year_publications.values()),    label='United States',
color='b',  width =0.25)

fig.legend(loc='upper left',fontsize=18)

plt.xticks(rotation = 'vertical')

plt.title('Total Publications vs Year',fontsize=20)
plt.xlabel('Year',fontsize=20)
plt.ylabel('Total Publications',fontsize=20)
plt.show()
```




# j) Total number of grants given to the field

In [40]:
```
grants, cols = df_without_duplicates[df_without_duplicates['Funding_Details']!='0'].s
hape
```

In [41]:
```
print(f'Grants given to field = {grants}')
```

```
Grants given to field = 4771
```

# k) Country wise total number of publication

In [42]:
```
dct_country_publications = {}
for country in country_lst:
    rows, columns = df[df.Country==country].shape
    dct_country_publications[country] = rows
```

In [43]:
```
dct_country_publications = sort_dict(dct_country_publications,'Value','reverse')
```

In [44]:
```
dct_country_publications
```

Out[44]:
```
{'United Kingdom': 8994,
 'China': 6401,
 'United States': 6104,
 'India': 5383,
 'Germany': 5186,
 'Spain': 4759,
 'Canada': 4486,
 'Japan': 4324,
 'Italy': 4214,
 'France': 4133,
 'Australia': 3361,
 'South Korea': 3026,
 'Iran': 2720,
 'Taiwan': 2430,
 'Netherlands': 2173}
```