基于全球大学生招生数据集的数据可视化实践

一、简介

全球大学入学数据集（GLUED）提供了世界各地大学入学数据，系统地整理了大约17000名学生入学数据1950年至2020年间的194个国家和地区的大学。在本数据集中，对大学的定义是提供至少一个学士、硕士或博士课程的机构。本数据集来源于Buckner, Elizabeth. 2022. “Global Longitudinal University Enrollment Dataset (GLUED).” https://doi.org/10.5683/SP3/P0D1KE, Borealis, V1.
文件enrollments.csv 共包含161561行，27列。每一行代表一个大学，每一列的含义如下：
1.国家 2.国家代码 3.地区 4.收入阶层 5.iau代码（用于衡量大学水平） 6.iau代码1（用于曾经合并但后来分离的大学）7.英文名称 8.拉丁语名称 9.成立年份 10.关闭年份 11.是否为私立学校 12.坐标
13.纬度 14.经度 15.是否授予博士学位 16.是否授予硕士学位 17.是否授予本科学位 18.学院数量 19.总学位数量
20.专业数量（total_fields 和 unique_fields两个变量的区别在于它们计算大学提供的学位课程数量的方式不同。total_fields 是指大学在IAU WHED 上列出的所有学位课程的数量，如果一所大学提供了社会学专业的文学士和文学硕士两个学位，那么这两个学位都会被计入 total_fields。而 unique_fields 是指大学在IAU WHED 上列出的独特学位课程的数量，如果一所大学提供了社会学专业的文学士和文学硕士两个学位，那么这两个学位只会被计入 unique_fields 一次。包含这个变量是为了捕捉大学提供的课程广度）
21.是否为专一型大学 22.是否为合并类大学 23.是否有iau代码 24.年份 25.学生新增人数 26.学生减少人数 27.学生注册人数估计

本次作业主要利用Mathematica软件的**可视化**功能对以上数据分析，主要包括：

1. 各地区招生大学数量和人口对比
2. 各地区随年份 （1950 - 2020） 招生人数变化：(1) 时间可视化 (2) 地理可视化 (3) 2020 年录取人数前十的大学
3. 各地区私立学校数变化趋势
4. 各地区收入水平
5. 私立大学与公立大学在其余方面的差异：(1) 学院数与学位数(2) 本科、硕士、博士招生

二、数据处理

导入数据并进行数据清洗

In[2]:=
```
data0 = Import["C:\\Users\\zhangyz\\Desktop\\mma大作业\\enrollments.csv", "CSV"];
        导入      常量
DeleteDuplicates[data0];
删除重复元素
```

将其中空缺元素用0填充

In[4]:=
```
data = Map[ToString, data0, {161557}] /. "" → "0";
       映射 转换为字符串
data = Map[ToExpression, data, {161557}]
       映射 转换为表达式
```

Out[5]=
```
{{country, countrycode, region, incomegroup, iau_id, iau_id1, eng_name,
  orig_name, foundedyr, yrclosed, private01, coordinates, latitude, longitude, phd_granting,
  m_granting, b_granting, divisions, total_fields, unique_fields, specialized, merger,
  noiau, year, students5_interpolated, students5_extrapolated, students5_estimated},
 {afghanistan, AFG, South Asia, Low income, IAU-000810, IAU-000810-1, Alberoni University, Alberoni University,
  1998, 0, 0, 35.1270053, 69.3193192, 35.127, 69.3193, 0, 0, 0, 0, 0, 0, 0, 0, 2000, 0, 1546, 1546},
 ··· 161557 ···, {zimbabwe, ZWE, Sub-Saharan Africa, Lower middle income, IAU-024536,
  IAU-024536-1, Zimbabwe Ezekiel Gut University, (ZEGU), 2012, 0, 1,
  -17.3152904, 31.365549, -17.3153, 31.3655, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2015, 0, 1262, 1262},
 {zimbabwe, ZWE, Sub-Saharan Africa, Lower middle income, IAU-024536, IAU-024536-1,
  Zimbabwe Ezekiel Gut University, (ZEGU), 2012, 0, 1, -17.3152904, 31.365549,
  -17.3153, 31.3655, 0, 1, 1, 4, 25, 25, 0, 0, 0, 2020, 1347, 1347, 1347}}
```

内存中的大小： 172.8 MB | ✚ 显示更多 | 显示全部 | 图标化 | 将完整的表达式保存到笔记本中

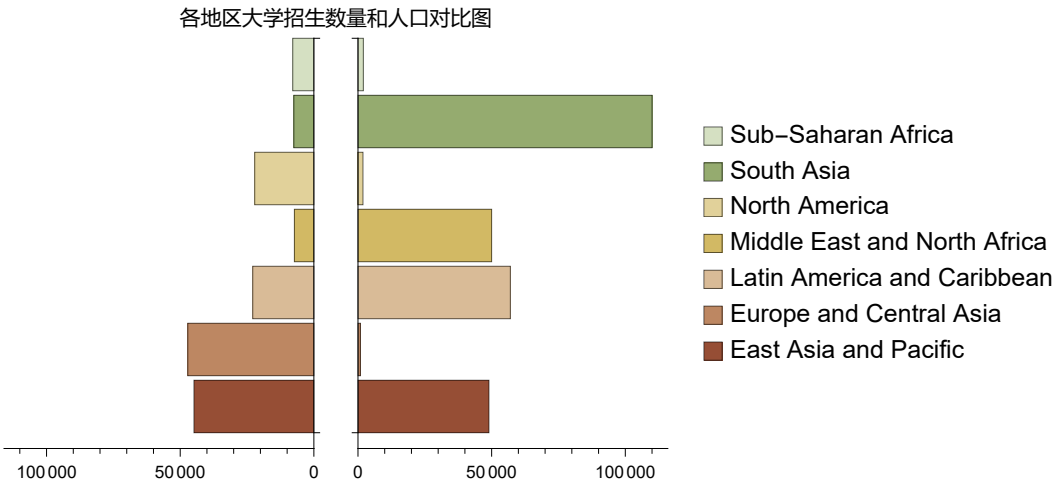
三、各地区招生大学数量和人口对比

data1为各地区大学数量统计，data2为搜集到的各地区人口数（单位：百万人）。绘制成对坐标图，其中左侧为大学数量，右侧为人口数量。

In[145]:=

```
data1 = {Count[data, {_, _, "East Asia and Pacific", ___}],
          计数
    Count[data, {_, _, "Europe and Central Asia", ___}],
    计数
    Count[data, {_, _, "Latin America and Caribbean", ___}],
    计数
    Count[data, {_, _, "Middle East and North Africa", ___}],
    计数
    Count[data, {_, _, "North America", ___}], Count[data, {_, _, "South Asia", ___}],
    计数                                        计数
    Count[data, {_, _, "Sub-Saharan Africa", ___}]};
    计数
data2 = {49 000, 920, 57 000, 50 000, 1877, 110 000, 2000};
PairedBarChart[data1, data2,
成对条形图
 ChartLegends → {"East Asia and Pacific", "Europe and Central Asia",
 图表图例
   "Latin America and Caribbean", "Middle East and North Africa",
   "North America", "South Asia", "Sub-Saharan Africa"},
 PlotLabel → "各地区大学招生数量和人口对比图" , ChartStyle → 33]
 绘图标签                                        图表样式
```

Out[147]=



可以看出，东亚和太平洋地区人口数中等，但大学数量较多。欧洲和中亚地区人口数量较少，但大学数量多，位居各地区榜首。北美地区和拉丁美洲和加勒比地区、中东和北非地区、南亚地区人口数多，但大学数都较少，其中南亚地区比例失衡最明显 。通过以上各地区国家数量和学校数量的对比，可以初步推测各地区教育资源质量以及人口的受教育程度。例如，北美、东亚和太平洋地区受教育程度较高，但亚撒哈拉地区、南亚、中东和北非地区教育资源少，受教育程度较低。

了解世界整体情况后，下面对各个大洲的录取情况作具体分析。

四、各地区随年份（1950-2020）招生人数变化

1.时间可视化

In[148]:=

```
region = {"East Asia and Pacific", "Europe and Central Asia",
    "Latin America and Caribbean", "Middle East and North Africa",
    "North America", "South Asia", "Sub-Saharan Africa"};
```

In[149]:=

```
time = {}; yearList = {}; yearCount = {};

time = Table[Select[data, MemberQ[#, region[[i]]] &], {i, Length[region]}];
       表格   选择          成员判定                    长度
yearList = Table[time[[i, All, 24]], {i, Length[region]}];
           表格          全部          长度
yearCount = Table[Tally[yearList[[i]]], {i, Length[region]}];
            表格   重复次数                  长度
```

In[153]:=

```
yearCount1 = Map[SortBy[#, First] &, yearCount];
             映射 排序函数    第一个
(*无序数据可能以出乎预料的方式显示，故按年份进行排序*)
```

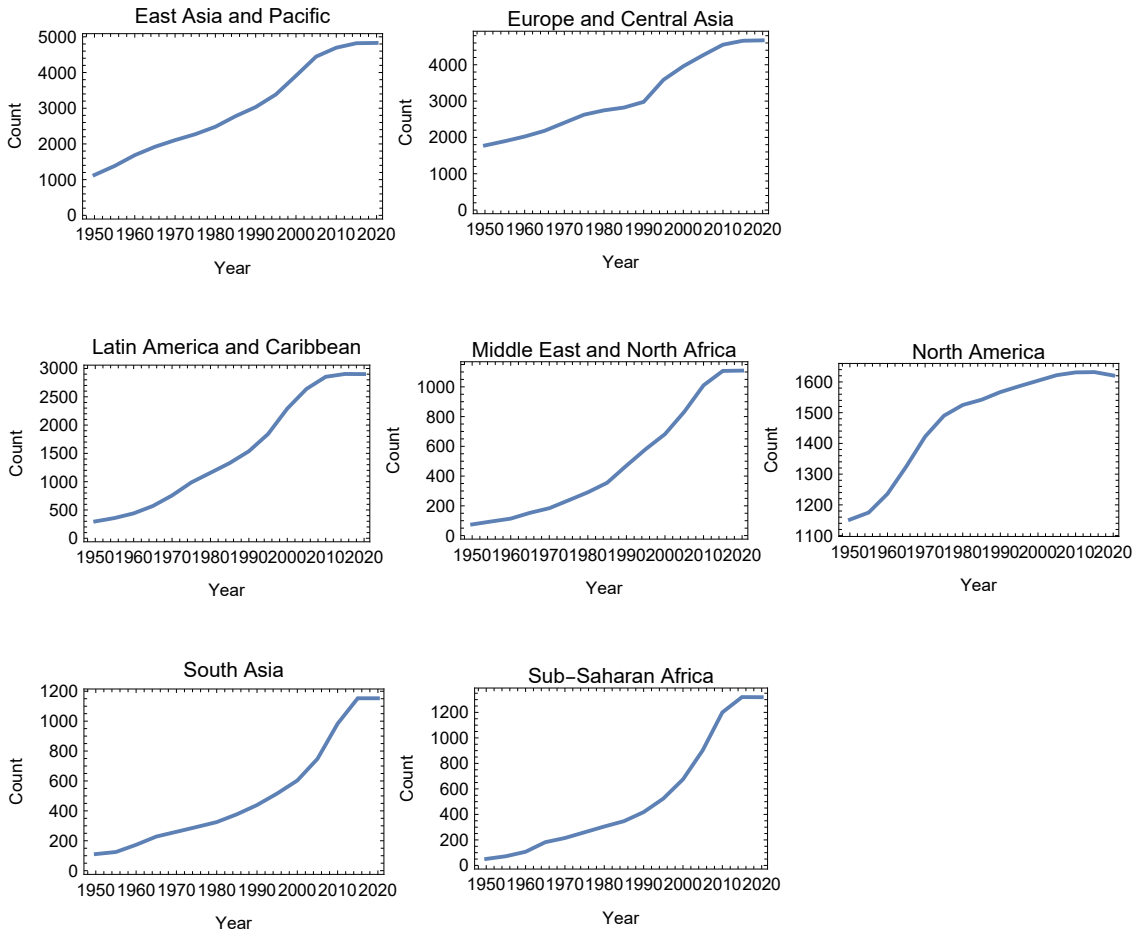
In[154]:=

```
plots = Table[ListLinePlot[yearCount1[[i]], PlotLabel → region[[i]],
        表格   绘制点集的线条                  绘图标签
    Frame → True, FrameLabel → {"Year", "Count"}], {i, Length[region]}];
    边框      真     边框标签                  计数          长度
```

In[221]:=

```
Row[plots, ImageSize → Full]
```
行 图像尺寸 全范围

Out[221]=



从以上7幅图中可以看出，各地区的大学录取人数均逐年上涨。相较于1950年，各地区大学录取人数均取得了较大飞跃。其中欧洲和中亚地区、拉丁美洲和加勒比地区在2010-2020年间涨幅极快。

2.地理可视化

下面进一步通过地理可视化来直观感受1950和2020年各个国家录取人数的情况

In[156]:=

```
data1950 = Select[data, IntegerQ[#[[24]]] && #[[24]] == 1950 &];
```
选择 整数判定

统计1950年各个国家大学数量

In[157]:=

```
countryCount = Counts[Transpose[data1950][[1]]];
```
关联计数 转置

In[158]:=

```
sublist = KeyValueMap[List, countryCount];
```
键值映射 列表

手动处理部分不规则的国家名称和数据

In[159]:=

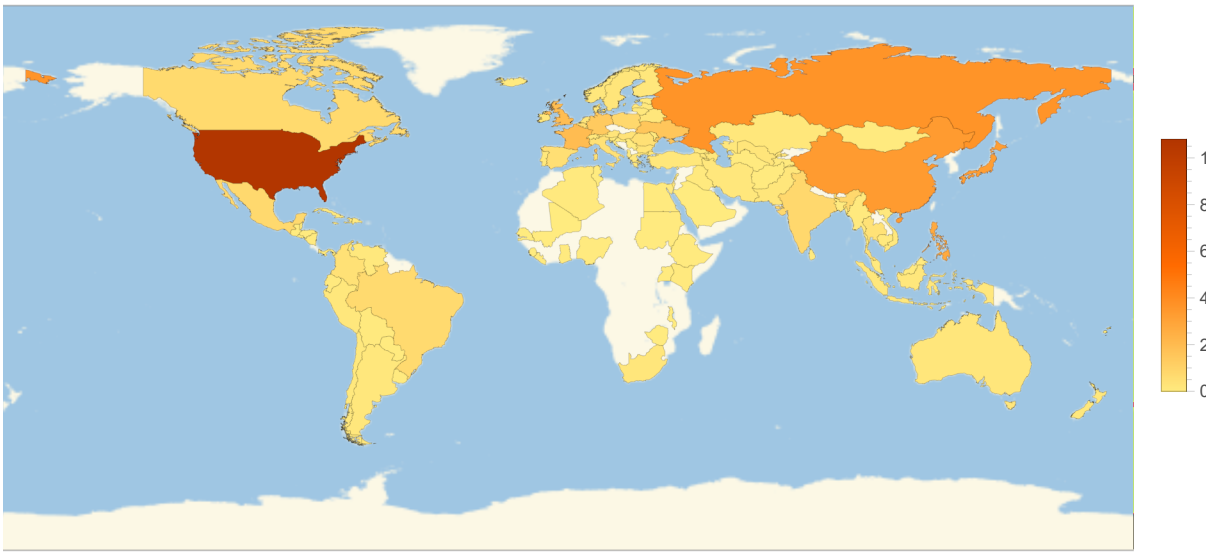
```
sublist = {{"Afghanistan", 3}, {"Albania", 2}, {"Algeria", 6}, {"Argentina", 14},
   {"Armenia", 15}, {"Australia", 21}, {"Austria", 26}, {"Azerbaijan", 17},
   {"Bangladesh", 5}, {"Belarus", 20}, {"Belgium", 48}, {"Belize", 1}, {"Bolivia", 8},
   {"BosniaAndHerzegovina", 1}, {"Brazil", 72}, {"Bulgaria", 27}, {"Cambodia", 6},
   {"Canada", 73}, {"Chile", 13}, {"China", 338}, {"Colombia", 41}, {"Congo", 1},
   {"Costa Rica", 3}, {"Croatia", 1}, {"Cuba", 6}, {"Czech Republic", 16},
   {"Denmark", 22}, {"DominicanRepublic", 2}, {"Ecuador", 8}, {"Egypt", 5},
   {"ElSalvador", 1}, {"Estonia", 5}, {"Eswatini", 1}, {"Ethiopia", 2}, {"Fiji", 2},
   {"Finland", 16}, {"France", 196}, {"Georgia", 13}, {"Germany", 140},
   {"Ghana", 3}, {"Greece", 14}, {"Guatemala", 1}, {"Haiti", 6}, {"Holy See", 16},
   {"Honduras", 3}, {"Hungary", 36}, {"Iceland", 5}, {"India", 79}, {"Indonesia", 15},
   {"Iran", 16}, {"Iraq", 7}, {"Ireland", 18}, {"Israel", 17}, {"Italy", 42},
   {"Jamaica", 3}, {"Japan", 325}, {"Kazakhstan", 18}, {"Kenya", 7}, {"Korea", 98},
   {"KyrgyzRepublic", 7}, {"Latvia", 11}, {"Lebanon", 10}, {"Lesotho", 1},
   {"Liberia", 2}, {"Lithuania", 12}, {"Luxembourg", 1}, {"Malawi", 1},
   {"Malaysia", 3}, {"Mali", 1}, {"Malta", 1}, {"Mexico", 77}, {"Moldova", 7},
   {"Mongolia", 4}, {"Mrocco", 5}, {"Myanmar", 9}, {"Netherlands", 22},
   {"NewZealand", 11}, {"Nicaragua", 4}, {"Nigeria", 2}, {"NorthMacedonia", 1},
   {"Norway", 16}, {"Pakistan", 20}, {"Palestine", 3}, {"Panama", 2}, {"Paraguay", 2},
   {"Peru", 15}, {"Philippines", 273}, {"Poland", 81}, {"Portugal", 11},
   {"Romania", 46}, {"Russia", 369}, {"SaudiArabia", 1}, {"Senegal", 1},
   {"Serbia", 1}, {"SierraLeone", 1}, {"Singapore", 3}, {"SlovakRepublic", 9},
   {"Slovenia", 1}, {"SouthAfrica", 20}, {"Spain", 49}, {"SriLanka", 4},
   {"Sudan", 4}, {"Sweden", 23}, {"Switzerland", 14}, {"SyrianArabRepublic", 3},
   {"Tajikistan", 8}, {"Thailand", 36}, {"TrinidadAndTobago", 2}, {"Tunisia", 1},
   {"Turkey", 18}, {"Turkmenistan", 5}, {"Uganda", 2}, {"Ukraine", 154},
   {"UnitedKingdom", 192}, {"UnitedStates", 1079}, {"Uruguay", 4},
   {"Uzbekistan", 24}, {"Venezuela", 10}, {"Vietnam", 13}, {"Zimbabwe", 1}};
```

In[160]:=

```
geoValues = Rule @@@ ({Entity["Country", #[[1]]], #[[2]]} & /@ sublist);
```
规则 实体

```
GeoRegionValuePlot[geoValues, GeoRange → "World"]
```
绘制地理区域值 地理范围

Out[161]=



统计2020年各个国家大学数量

In[162]:=

```
data2020 = Select[data, IntegerQ[#[[24]]] && #[[24]] == 2020 &];
```
选择 整数判定

In[163]:=

```
countryCount1 = Counts[Transpose[data2020][[1]]];
```
关联计数 转置

In[164]:=

```
sublist1 = KeyValueMap[List, countryCount1];
```
键值映射 列表

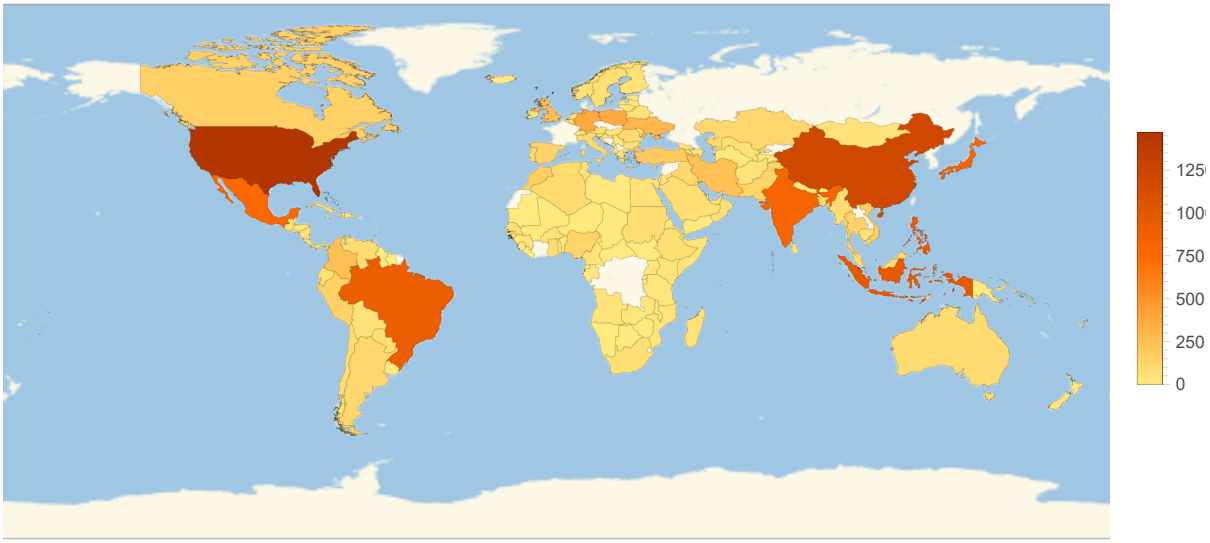
In[165]:=

```
sublist1 = {{"Afghanistan", 45}, {"Albania", 28}, {"Algeria", 97}, {"Andorra", 2},
    {"Angola", 46}, {"Argentina", 114}, {"Armenia", 59}, {"Aruba", 2},
    {"Australia", 85}, {"Austria", 64}, {"Azerbaijan", 45}, {"Bahamas", 1},
    {"Bahrain", 15}, {"Bangladesh", 120}, {"Barbados", 1}, {"Belarus", 50},
    {"Belgium", 103}, {"Belize", 5}, {"Benin", 32}, {"Bhutan", 3}, {"Bolivia", 51},
    {"BosniaAndHerzegovina", 39}, {"Botswana", 13}, {"Brazil", 919},
    {"BruneiDarussalam", 4}, {"Bulgaria", 62}, {"BurkinaFaso", 46}, {"Burundi", 6},
    {"CaboVerde", 8}, {"Cambodia", 45}, {"Cameroon", 42}, {"Canada", 155},
    {"CentralAfricanRepublic", 4}, {"Chad", 10}, {"Chile", 71}, {"China", 1197}, ,
    {"Colombia", 244}, {"Comoros", 1}, {"Congo", 55}, {"CostaRica", 54},
    {"CôteD'Ivoire", 97}, {"Croatia", 37}, {"Cuba", 53}, {"Curaçao", 1},
    {"Cyprus", 32}, {"czech republic", 46}, {"denmark", 46}, {"Djibouti", 1},
    {"DominicanRepublic", 37}, {"Ecuador", 60}, {"Egypt", 55}, {"ElSalvador", 30},
    {"EquatorialGuinea", 1}, {"Eritrea", 7}, {"Estonia", 11}, {"Eswatini", 4},
    {"Ethiopia", 66}, {"FaroeIslands", 1}, {"Fiji", 7}, {"Finland", 56}, {"france", 440},
    {"Gabon", 17}, {"Georgia", 49}, {"Germany", 383}, {"Ghana", 77}, {"Greece", 37},
    {"Grenada", 2}, {"Guatemala", 38}, {"Guinea", 39}, {"GuineaBissau", 7},
    {"Guyana", 4}, {"Haiti", 17}, {"HolySee", 21}, {"Honduras", 18}, {"Hungary", 58},
    {"Iceland", 10}, {"India", 813}, {"Indonesia", 965}, {"Iran", 237}, {"Iraq", 103},
    {"Ireland", 52}, {"Israel", 60}, {"Italy", 103}, {"Jamaica", 8}, {"Japan", 804},
    {"Jordan", 31}, {"Kazakhstan", 113}, {"Kenya", 51}, {"KoreaRepublicOf", 326},
    {"Kuwait", 11}, {"KyrgyzRepublic", 28}, {"LaoPeople'sDemocraticRepublic", 7},
    {"Latvia", 26}, {"lebanon", 41}, {"Lesotho", 2}, {"Liberia", 6}, {"Libya", 14},
    {"Liechtenstein", 3}, {"Lithuania", 22}, {"Luxembourg", 1}, {"Madagascar", 49},
    {"Malawi", 19}, {"Malaysia", 82}, {"Maldives", 7}, {"Mali", 8}, {"Malta", 3},
    {"Mauritania", 4}, {"Mauritius", 7}, {"Mexico", 776}, {"Moldova", 24},
    {"Monaco", 2}, {"Mongolia", 52}, {"Montenegro", 8}, {"Morocco", 157},
    {"Mozambique", 40}, {"Myanmar", 80}, {"Namibia", 4}, {"Nepal", 11},
    {"Netherlands", 77}, {"NewZealand", 30}, {"Nicaragua", 52}, {"Niger", 11},
    {"Nigeria", 128}, {"NorthMacedonia", 18}, {"Norway", 53}, {"Oman", 53},
    {"Pakistan", 128}, {"Palestine", 29}, {"Panama", 26}, {"PapuaNewGuinea", 6},
    {"Paraguay", 66}, {"Peru", 145}, {"Philippines", 944}, {"Poland", 368},
    {"Portugal", 95}, {"Qatar", 4}, {"Romania", 90}, {"RussianFederation", 754},
    {"Rwanda", 19}, {"SaintKittsAndNevis", 1}, {"Samoa", 2}, {"SanMarino", 1},
    {"SaoTomeAndPrincipe", 1}, {"SaudiArabia", 72}, {"Senegal", 68}, {"Serbia", 15},
    {"Seychelles", 1}, {"SierraLeone", 4}, {"Singapore", 11}, {"SlovakRepublic", 34},
    {"Slovenia", 42}, {"SolomonIslands", 2}, {"Somalia", 40}, {"SouthAfrica", 59},
    {"SouthSudan", 5}, {"Spain", 137}, {"SriLanka", 26}, {"Sudan", 78}, {"Suriname", 2},
    {"Sweden", 62}, {"Switzerland", 34}, {"SyrianArabRepublic", 20}, {"Tajikistan", 20},
    {"Tanzania", 35}, {"Thailand", 145}, {"Gambia", 1}, {"TimorLeste", 1}, {"Togo", 19},
    {"Tonga", 1}, {"TrinidadAndTobago", 6}, {"Tunisia", 42}, {"Turkey", 193},
    {"Turkmenistan", 16}, {"Uganda", 40}, {"Ukraine", 304}, {"UnitedArabEmirates", 52},
    {"UnitedKingdom", 265}, {"UnitedStates", 1466}, {"Uruguay", 16}, {"Uzbekistan", 63},
    {"Venezuela", 82}, {"Vietnam", 173}, {"Yemen", 12}, {"Zambia", 29}, {"Zimbabwe", 13}};
```

In[166]:=

```
geoValues1 = Rule @@@ ({Entity["Country", #[[1]]], #[[2]]} & /@ sublist1);
                       规则          实体
GeoRegionValuePlot[geoValues1, GeoRange → "World"]
绘制地理区域值                          地理范围
```

Out[167]=



3、2020年录取人数前十的大学

In[171]:=

```
sortedList = SortBy[data2020, -#[[27]] &];
                    排序函数
```

In[172]:=

```
top10 = Take[sortedList, 10];
        选取
```

In[173]:=

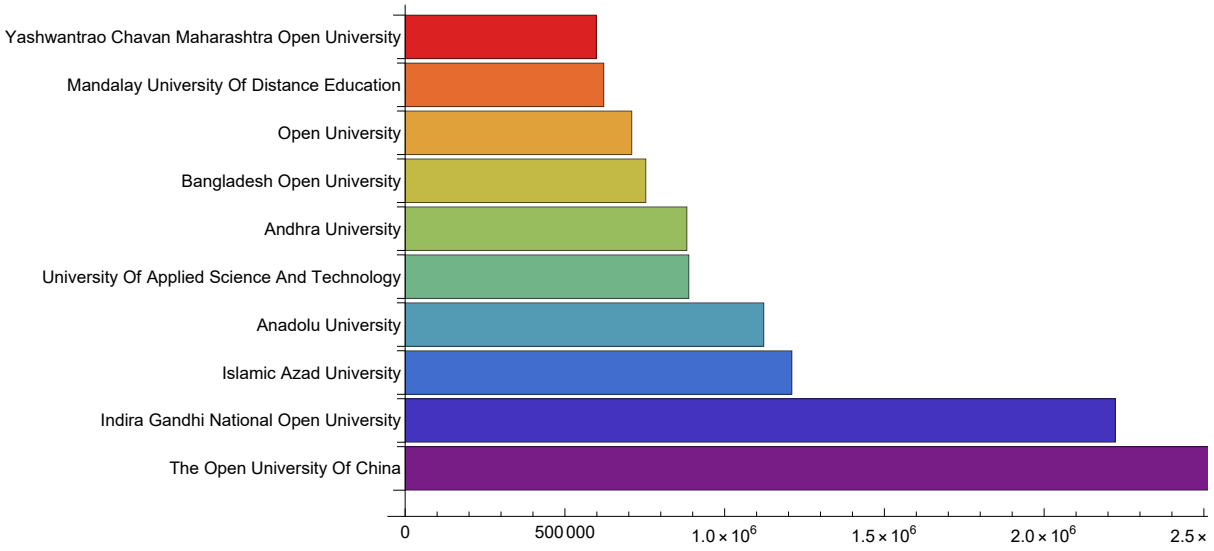
```
top10 = top10[[All, {7, 27}]];
                全部
```

In[174]:=

```
BarChart[top10[[All, 2]], ChartLabels → top10[[All, 1]],
 BarOrigin → Left, AxesOrigin → {0, 0}, ChartStyle → "Rainbow"]
```

条形图 全部 图表标签 全部
直条放置原点 左 坐标轴原点 图表样式

Out[174]=



五、各地区私立学校数变化趋势

In[175]:=

```
private = DeleteCases[data, x_ /; (x[[11]] == 0)];
```

删除匹配元素

```
time1 = Table[Select[private, MemberQ[#, region[[i]]] &], {i, Length[region]}];
```

表格 选择 成员判定 长度

```
yearList1 = Table[time1[[i, All, 24]], {i, Length[region]}];
```

表格 全部 长度

```
yearCount2 = Table[Tally[yearList1[[i]]], {i, Length[region]}];
```

表格 重复次数 长度

In[179]:=

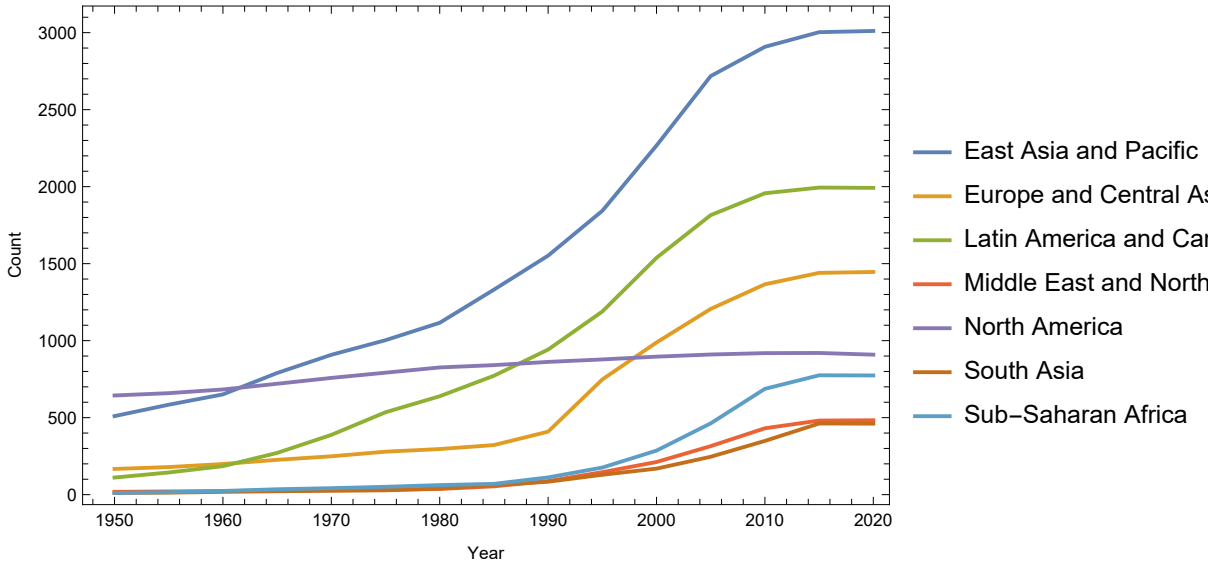
```
yearCount3 = Map[SortBy[#, First] &, yearCount2];
```

映射 排序函数 第一个

In[180]:=

```
ListLinePlot[yearCount3, PlotLegends → region,
 绘制点集的线条                  绘图的图例
 Frame → True, FrameLabel → {"Year", "Count"}]
 边框     真     边框标签                计数
```

Out[180]=



从上图可以看出，私立学校数量增加是全球化趋势。东亚和太平洋地区、拉丁美洲和加勒比地区、欧洲和中亚涨幅较为明显，中东和北非、南亚地区虽有上升但整体数量仍然较少。此结论与1、2中结论基本相吻合。分析原因，可能是与各地区收入情况有关。下面通过数据中income group进一步分析收入水平。

六、各地区收入水平

In[181]:=

```
income = Map[#[[{3, 4}]] &, data2020];
         映射
```

In[182]:=

```
income1 = Table[Select[income, MemberQ[#, region[[i]]] &], {i, Length[region]}];
          表格   选择              成员判定                          长度
```

In[183]:=

```
secondElements = Map[#[[All, 2]] &, income1];
                 映射    全部
counts = Counts /@ secondElements
         关联计数
```

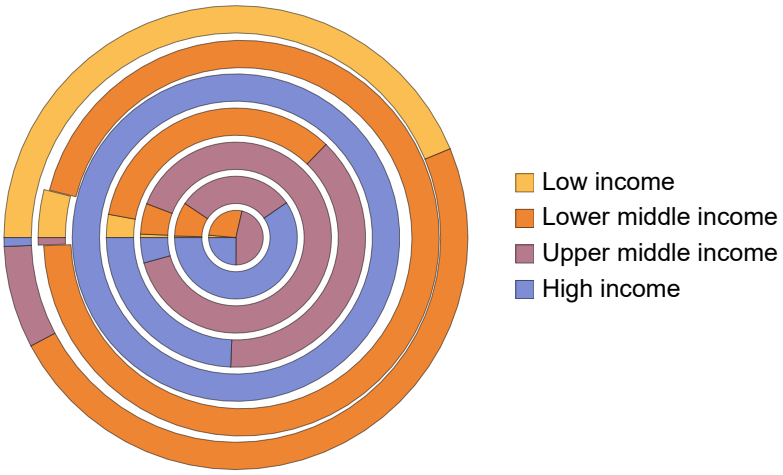
Out[184]=

```
{⟨|High income → 1205, Lower middle income → 1310,
  Upper middle income → 2244, Low income → 70|⟩, ⟨|Upper middle income → 1449,
  High income → 2784, Lower middle income → 419, Low income → 20|⟩,
 ⟨|Upper middle income → 2609, High income → 124, Lower middle income → 151,
  Low income → 17|⟩, ⟨|Lower middle income → 381, High income → 270,
  Upper middle income → 426, Low income → 32|⟩, ⟨|High income → 1621|⟩,
 ⟨|Low income → 45, Lower middle income → 1101, Upper middle income → 7|⟩,
 ⟨|Lower middle income → 640, Upper middle income → 94,
  Low income → 577, High income → 8|⟩}
```

In[185]:=
```
incomecounts = {{70, 1310, 2244, 1205}, {20, 419, 1449, 2784}, {17, 151, 2609, 124},
   {32, 381, 426, 270}, {0, 0, 0, 1621}, {45, 1101, 7, 0}, {577, 640, 94, 8}};
```

In[186]:=
```
PieChart[incomecounts, ChartLabels → Automatic,
 ChartLegends → {"Low income", "Lower middle income",
   "Upper middle income", "High income"}, ImageSize → 200]
```
饼图 图表标签 自动 图表图例 图像尺寸

Out[186]=



不同环形代表不同地区，从圆心到外分别是East Asia and Pacific , Europe and Central Asia , Latin America and Caribbean, Middle East and North Africa , North America , South Asia , Sub - Saharan Africa

以上内嵌环形图反映了各阶层数量所占比例大小。南亚地区没有高收入阶层，中下阶层密度较大，说明收入情况较差，与私立学校少的结论相符。中东和北非地区、亚撒哈拉地区各阶层分布较为均匀。欧洲和中亚地区、拉丁美洲和加勒比地区中上阶层、高阶层密度较大，说明收入情况较为乐观。北美洲只有高收入阶层，说明该地区经济情况好，可以解释私立学校多、大学录取人数多的结论。

综上，可以看出，各地区收入与大学数量、录取人数、私立大学数量基本呈正相关。

七、私立大学与公立大学在其余方面的差异

1、学院数与学位数

(1)学院数divisions（对应原始数据的第18列）

In[189]:=
```
department = data[[All, {11, 18}]];
```
全部
```
department = Drop[department, 1];
```
去掉元素

In[191]:=

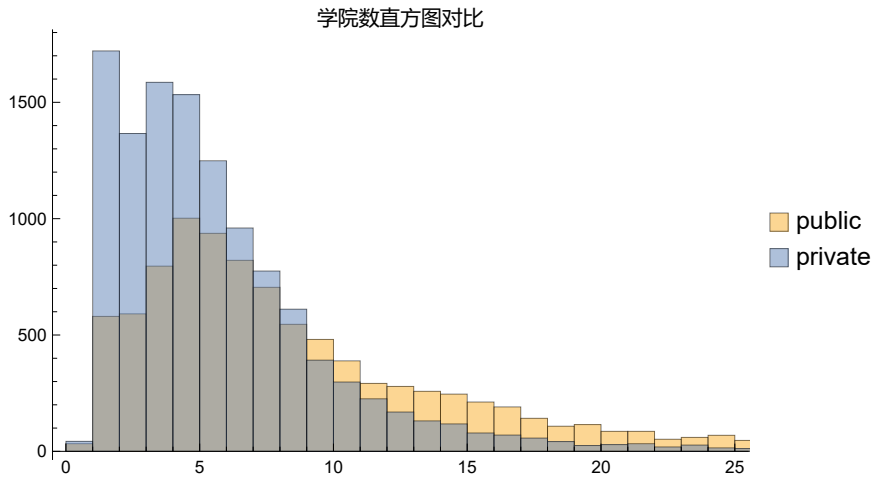
```
department = DeleteCases[department, {_, "0", ___}];
             删除匹配元素
(*删去第二个元素为“0”，即原始数据空缺的数据*)
```

In[192]:=

```
zeros = Select[department, First[#] == 0 &][[All, 2]];
        选择                 第一个          全部
ones = Select[department, First[#] == 1 &][[All, 2]];
       选择                 第一个          全部


Histogram[{zeros, ones}, ChartLabels → {"0", "1"}, ChartLegends → {"public", "private"},
直方图                   图表标签                  图表图例
 PlotLabel → HoldForm[学院数直方图对比], LabelStyle → {GrayLevel[0]}]
 绘图标签          保持表达式                标签样式          灰度级
```

Out[194]=



(2)学位数divisions（对应原始数据的第19列）

In[195]:=

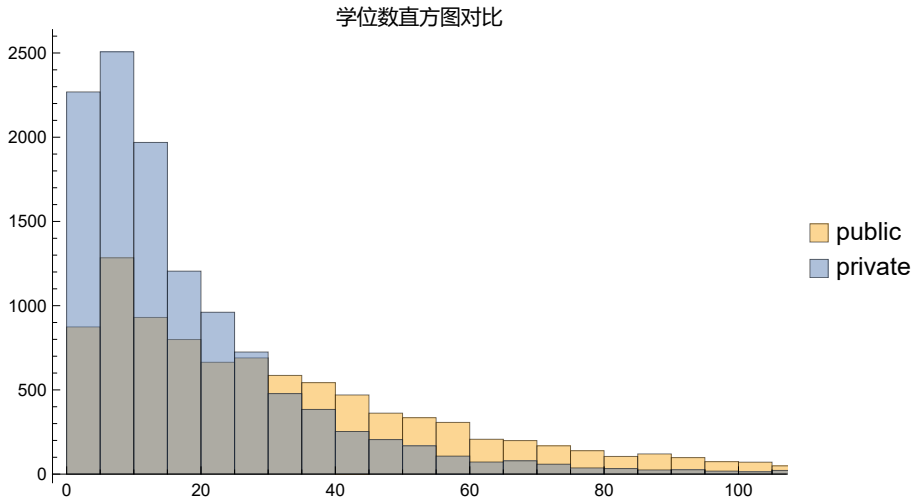
```
degree = data[[All, {11, 19}]];
                全部
degree = Drop[degree, 1];
         去掉元素
degree = DeleteCases[degree, {_, "0", ___}];
         删除匹配元素
```

In[198]:=

```
zeros1 = Select[degree, First[#] == 0 &][[All, 2]];
ones1 = Select[degree, First[#] == 1 &][[All, 2]];

Histogram[{zeros1, ones1}, ChartLabels → {"0", "1"},
 ChartLegends → {"public", "private"},
 PlotLabel → HoldForm[学位数直方图对比], LabelStyle → {GrayLevel[0]}]
```

Out[200]=



2、本科、硕士、博士招生

In[201]:=

```
bachelor = data[[All, {11, 17}]]; bachelor = Drop[bachelor, 1];
master = data[[All, {11, 16}]]; master = Drop[master, 1];
phd = data[[All, {11, 15}]];
phd = Drop[phd, 1];
```

In[204]:=

```
onesb = Select[bachelor, #[[1]] == 1 &][[All, 2]];
zerosb = Select[bachelor, #[[1]] == 0 &][[All, 2]];
count00b = Count[zerosb, 0];
count01b = Count[zerosb, 1];
count10b = Count[onesb, 0];
count11b = Count[onesb, 1];
```

In[206]:=

```
onesm = Select[master, #[[1]] == 1 &][[All, 2]];
        选择                          全部
zerosm = Select[master, #[[1]] == 0 &][[All, 2]];
         选择                          全部
count00m = Count[zerosm, 0];
           计数
count01m = Count[zerosm, 1];
           计数
count10m = Count[onesm, 0];
           计数
count11m = Count[onesm, 1];
           计数
onesp = Select[phd, #[[1]] == 1 &][[All, 2]];
        选择                        全部
zerosp = Select[phd, #[[1]] == 0 &][[All, 2]];
         选择                        全部
count00p = Count[zerosp, 0];
           计数
count01p = Count[zerosp, 1];
           计数
count10p = Count[onesp, 0];
           计数
count11p = Count[onesp, 1];
           计数
```

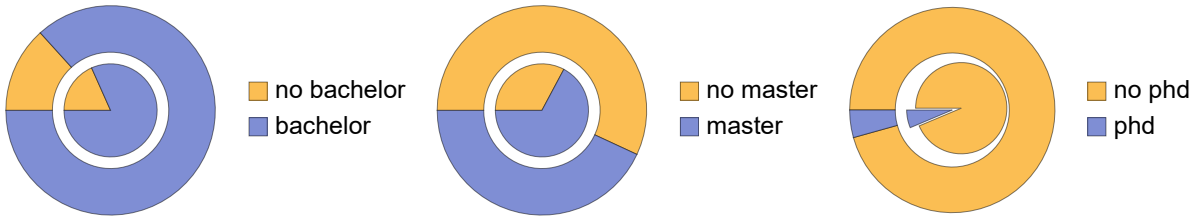
In[210]:=

```
pie1 = PieChart[{{count00b, count01b}, {count10b, count11b}},
       饼图
   ChartLegends → {"no bachelor", "bachelor"}];
   图表图例
pie2 = PieChart[{{count00m, count01m}, {count10m, count11m}},
       饼图
   ChartLegends → {"no master", "master"}];
   图表图例
pie3 = PieChart[{{count00p, count01p}, {count10p, count11p}},
       饼图
   ChartLegends → {"no phd", "phd"}];
   图表图例
```

In[213]:=

```
Grid[{{pie1, pie2, pie3}}]
格子
```

Out[213]=



其中内圈为公立学校，外圈为私立学校。从以上三个内嵌环形图可以看出：对于博士学位，公立校和私立校招生的比例均较小，相差不大；对于硕士学位，公立校中招生的学校占比过半，私立校中招生的占比不足一半，远少于公立校；对于本科学位，公立校和私立校招生的比例均较大，公立校略多于私立校。

以上（1）（2）的结论也符合我们通常的认知。公立大学一般拥有比私立大学更大的学生群体。美国学生群体最大的大学就是公立大学，相反，私立学校为保证教育质量，会尽量做到小班授课。这导致了两者在班级规模上有巨大差异。 在教学上，公立大学一般都是人山人海的大班lecture，私立大学则以小班研讨seminar为主。

八、总结

本次作业通过对1950-2020年间各国家和地区的大学的入学数据进行数据处理和可视化实践，先从全球角度概览大学数量，然后聚焦于各个地区，通过时间可视化展示了各地区随年份的招生人数变化，通过地理可视化展示了各国家在2020年的招生人数，并统计了2020年录取人数排在前十位的大学。之后着眼于私立学校和公立学校，先展现了私立学校数随时间的变化趋势，然后考虑到可能的影响因素为收入水平，又进行了进一步分析。最后探究了私立大学与公立大学在其余方面的差异。