

World University Rankings

Yasko

2022-10-21

World University Rankings

Open necessary datasets

```
cwurData <- read.csv("cwurData.csv")
educationExpenditure <- read.csv("education_expenditure_supplementary_data.csv")
educationalAttainment <- read.csv("educational_attainment_supplementary_data.csv")
schoolCountry <- read.csv("school_and_country_table.csv")
shanghaiData <- read.csv("shanghaiData.csv")
timesData <- read.csv("timesData.csv")
```

Getting basic information from tables

```
knitr::kable(head(cwurData,10), caption = "Central World University Rankings information (first 10 rows)")
```

Central World University Rankings

Table 1: Central World University Rankings information (first 10 rows)

world_rank	institution	country	national_rank	quality_of_education	international_reputation	academic_reputation	peer_reviews	research_income	research_income_per_faculty	research_income_per_faculty	research_income_per_faculty	research_income_per_faculty	research_income_per_faculty
1	Harvard University	USA	1	7	9	1	1	1	1	NA	5	100.00	2012
2	Massachusetts Institute of Technology	USA	2	9	17	3	12	4	4	NA	1	91.67	2012
3	Stanford University	USA	3	17	11	5	4	2	2	NA	15	89.50	2012
4	University of Cambridge	United Kingdom	1	10	24	4	16	16	11	NA	50	86.17	2012
5	California Institute of Technology	USA	4	2	29	7	37	22	22	NA	18	85.21	2012
6	Princeton University	USA	5	8	14	2	53	33	26	NA	101	82.50	2012
7	University of Oxford	United Kingdom	2	13	28	9	15	13	19	NA	26	82.34	2012
8	Yale University	USA	6	14	31	12	14	6	15	NA	66	79.14	2012

world_rank	institution	country	national_rank	quality_of_education	quality_of_employment	publications	international_students	hoad	papers	score	year	
9	Columbia University	USA	7	23	21	10	13	12	14	NA	5	78.862012
10	University of California, Berkeley	USA	8	16	52	6	6	5	3	NA	16	78.552012

```
knitr::kable(head(shanghaiData,10),caption="Shanghai Ranking information (first 10 rows)")
```

Shanghai Rankings

Table 2: Shanghai Ranking information (first 10 rows)

world_rank	university_name	national_rank	total_score	alumni	award	hici	ns	pub	pcp	year
1	Harvard University	1	100.0	100.0	100.0	100.0	100.0	100.0	72.4	2005
2	University of Cambridge	1	73.6	99.8	93.4	53.3	56.6	70.9	66.9	2005
3	Stanford University	2	73.4	41.1	72.2	88.5	70.9	72.3	65.0	2005
4	University of California, Berkeley	3	72.8	71.8	76.0	69.4	73.9	72.2	52.7	2005
5	Massachusetts Institute of Technology (MIT)	4	70.1	74.0	80.6	66.7	65.8	64.3	53.0	2005
6	California Institute of Technology	5	67.1	59.2	68.6	59.8	65.8	52.5	100.0	2005
7	Columbia University	6	62.3	79.4	60.6	56.1	54.2	69.5	45.4	2005
8	Princeton University	7	60.9	63.4	76.8	60.9	48.7	48.5	59.1	2005
9	University of Chicago	8	60.1	75.6	81.9	50.3	44.7	56.4	42.2	2005
10	University of Oxford	2	59.7	64.3	59.1	48.4	55.6	68.4	53.2	2005

```
knitr::kable(head(educationalAttainment,10),caption="Education attainment information (first 10 rows)")
```

Education attainment

Table 3: Education attainment information (first 10 rows)

country	series	name	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Afghanistan	Lee:	Average years of primary schooling, age 15+, female	0.33	NAN	0.4	NAN	NAN	0.5	NAN	NAN	NAN	0.7	NAN	NAN	NAN	0.8	NAN	NAN	NAN	0.8	NAN	NAN	NAN	1.2	NAN	NAN	NAN	NAN	NAN	NAN	NAN	NAN	NAN

country	year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Afghanistan	Lee: Average years of primary schooling, age 15+, total	1.03	NANA	1.26	NANA	NANA	1.54	NANA	NANA	NANA	2.01	NANA	NANA	NANA	2.18	NANA	NANA	NANA	2.64	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA
Afghanistan	Lee: Average years of primary schooling, age 15-19, female	0.83	NANA	0.95	NANA	NANA	1.26	NANA	NANA	NANA	1.92	NANA	NANA	NANA	1.01	NANA	NANA	NANA	2.45	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA
Afghanistan	Lee: Average years of primary schooling, age 15-19, total	2.34	NANA	2.22	NANA	NANA	2.37	NANA	NANA	NANA	3.83	NANA	NANA	NANA	2.26	NANA	NANA	NANA	3.55	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA
Afghanistan	Lee: Average years of primary schooling, age 20-24, female	0.54	NANA	0.92	NANA	NANA	0.94	NANA	NANA	NANA	1.26	NANA	NANA	NANA	2.00	NANA	NANA	NANA	1.29	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA
Afghanistan	Lee: Average years of primary schooling, age 20-24, total	1.52	NANA	2.51	NANA	NANA	2.27	NANA	NANA	NANA	2.48	NANA	NANA	NANA	3.93	NANA	NANA	NANA	2.64	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA

country	institute_name	X1985	X1986	X1987	X1989	X1990	X1991	X1992	X1993	X1995	X1996	X1997	X1998	X1999	X2000	X2001	X2002	X2003	X2004	X2005	X2006	X2007	X2008	X2009	X2010	X2011	X2012	X2013	X2014	X2015
Afghanistan	Lee: Average years of primary schooling, age 25+, female	0.17	NANA	0.25	NANA	NANA	0.37	NANA	NANA	NANA	0.48	NANA	NANA	NANA	0.63	NANA	NANA	NANA	0.8	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA
Afghanistan	Lee: Average years of primary schooling, age 25+, total	0.66	NANA	0.85	NANA	NANA	1.14	NANA	NANA	NANA	1.38	NANA	NANA	NANA	1.69	NANA	NANA	NANA	2.19	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA
Afghanistan	Lee: Average years of primary schooling, age 25-29, female	0.44	NANA	0.54	NANA	NANA	0.92	NANA	NANA	NANA	0.94	NANA	NANA	NANA	1.26	NANA	NANA	NANA	1.92	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA
Afghanistan	Lee: Average years of primary schooling, age 25-29, total	1.28	NANA	1.52	NANA	NANA	2.51	NANA	NANA	NANA	2.27	NANA	NANA	NANA	2.48	NANA	NANA	NANA	3.93	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA	NANA

```
knitr::kable(head(educationExpenditure,10),caption="Education expenditure information (first 10 rows)")
```

Education expenditure

Table 4: Education expenditure information (first 10 rows)

country	institute_type	direct_expenditure_type	X1995	X2000	X2005	X2009	X2010	X2011
OECD	All Institutions	Public	4.9	4.9	5.0	5.4	5.4	5.3
Average								
Australia	All Institutions	Public	4.5	4.6	4.3	4.5	4.6	4.3
Austria	All Institutions	Public	5.3	5.4	5.2	5.7	5.6	5.5
Belgium	All Institutions	Public	5.0	5.1	5.8	6.4	6.4	6.4
Canada	All Institutions	Public	5.8	5.2	4.8	5.0	5.2	NA

country	institute_type	direct_expenditure_type	X1995	X2000	X2005	X2009	X2010	X2011
Chile	All Institutions	Public	NA	4.2	3.3	4.1	4.3	3.9
Czech Republic	All Institutions	Public	4.8	4.2	4.1	4.2	4.1	4.4
Denmark	All Institutions	Public	6.5	6.4	6.8	7.5	7.6	7.5
Estonia	All Institutions	Public	NA	NA	4.7	5.9	5.6	5.2
Finland	All Institutions	Public	6.6	5.5	5.9	6.3	6.4	6.3

```
knitr::kable(head(timesData,10),caption="Times Higher Education World University Rankings data informat.
```

Times Education Rankings

Table 5: Times Higher Education World University Rankings data information (first 10 rows)

world_rank	university_name	country	teaching_international	research_citations	international_score	total_score	students_staff_ratio	international_students_ratio	year				
1	Harvard University	United States of America	99.7	72.4	98.7	98.8	34.5	96.1	20,152	8.9	25%		2011
2	California Institute of Technology	United States of America	97.7	54.6	98.0	99.9	83.7	96.0	2,243	6.9	27%	33 : 67	2011
3	Massachusetts Institute of Technology	United States of America	97.8	82.3	91.4	99.9	87.5	95.6	11,074	9.0	33%	37 : 63	2011
4	Stanford University	United States of America	98.3	29.5	98.1	99.2	64.3	94.3	15,596	7.8	22%	42 : 58	2011
5	Princeton University	United States of America	90.9	70.3	95.4	99.9	-	94.2	7,929	8.4	27%	45 : 55	2011
6	University of Cambridge	United Kingdom	90.5	77.7	94.1	94.0	57.0	91.2	18,812	11.8	34%	46 : 54	2011
6	University of Oxford	United Kingdom	88.2	77.2	93.9	95.1	73.5	91.2	19,919	11.6	34%	46 : 54	2011
8	University of California, Berkeley	United States of America	84.2	39.6	99.3	97.8	-	91.1	36,186	16.4	15%	50 : 50	2011
9	Imperial College London	United Kingdom	89.2	90.0	94.5	88.3	92.9	90.6	15,060	11.7	51%	37 : 63	2011

world_rank	university_name	country	teaching	international	research	citations	international	total_score	students	staff	ratio	female	students	year	ratio
10	Yale University	United States of America	92.1	59.2	89.7	91.5	-	89.5	11,751	4.4	20%	50 : 50		2011	

```
knitr::kable(head(schoolCountry,10),caption="School & country information (first 10 rows)")
```

School & Country

Table 6: School & country information (first 10 rows)

school_name	country
Harvard University	United States of America
California Institute of Technology	United States of America
Massachusetts Institute of Technology	United States of America
Stanford University	United States of America
Princeton University	United States of America
University of Cambridge	United Kingdom
University of Oxford	United Kingdom
University of California, Berkeley	United States of America
Imperial College London	United Kingdom
Yale University	United States of America

Review and reveal interesting facts

```
glimpse(cwurData)
```

```
## Rows: 2,200
## Columns: 14
## $ world_rank      <int> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15~
## $ institution     <chr> "Harvard University", "Massachusetts Institute of~
## $ country         <chr> "USA", "USA", "USA", "United Kingdom", "USA", "US~
## $ national_rank   <int> 1, 2, 3, 1, 4, 5, 2, 6, 7, 8, 9, 10, 11, 1, 12, 1~
## $ quality_of_education <int> 7, 9, 17, 10, 2, 8, 13, 14, 23, 16, 15, 21, 31, 3~
## $ alumni_employment <int> 9, 17, 11, 24, 29, 14, 28, 31, 21, 52, 26, 42, 16~
## $ quality_of_faculty <int> 1, 3, 5, 4, 7, 2, 9, 12, 10, 6, 8, 14, 24, 31, 20~
## $ publications    <int> 1, 12, 4, 16, 37, 53, 15, 14, 13, 6, 34, 22, 9, 8~
## $ influence        <int> 1, 4, 2, 16, 22, 33, 13, 6, 12, 5, 20, 21, 10, 19~
## $ citations        <int> 1, 4, 2, 11, 22, 26, 19, 15, 14, 3, 28, 16, 8, 23~
## $ broad_impact     <int> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, N~
## $ patents          <int> 5, 1, 15, 50, 18, 101, 26, 66, 5, 16, 101, 10, 9,~
## $ score            <dbl> 100.00, 91.67, 89.50, 86.17, 85.21, 82.50, 82.34,~
## $ year             <int> 2012, 2012, 2012, 2012, 2012, 2012, 2012, 2012, 2~
```

```
cwurData %>% group_by(year) %>%
```

```
  select(year,institution,world_rank) %>% top_n(-5, wt = world_rank) -> cwurTop5
```

```
plot_ly(cwurTop5, x = ~year) %>%
```

```
  add_trace(y = cwurTop5$world_rank, name = cwurTop5$institution, showlegend=TRUE, type = 'scatter', mode = 'lines')
```

```
  layout(title="World Ranked Universities by CWUR (2012-2015)",
```

```

axis = list(showticklabels = TRUE, tickangle = 0, tickfont = list(size = 8)),
yaxis = list(title = "World rank"),
hovermode = 'compare')

```

```

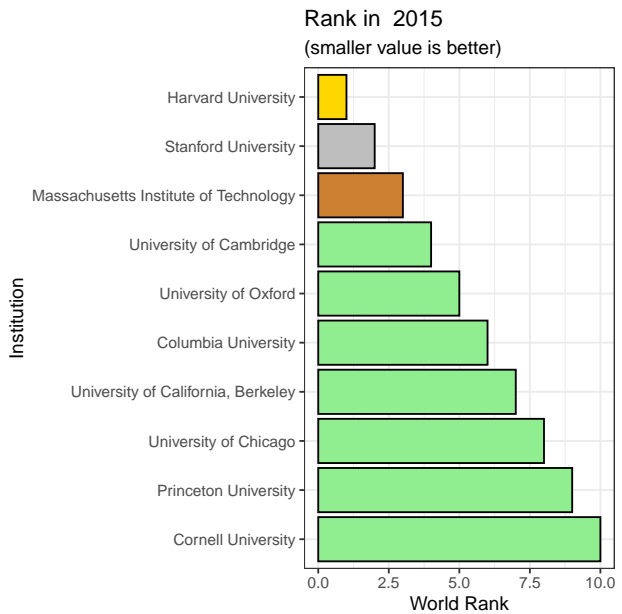
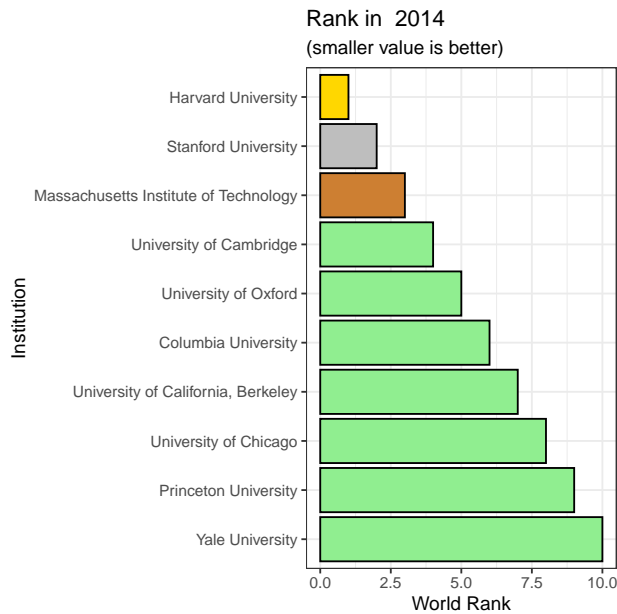
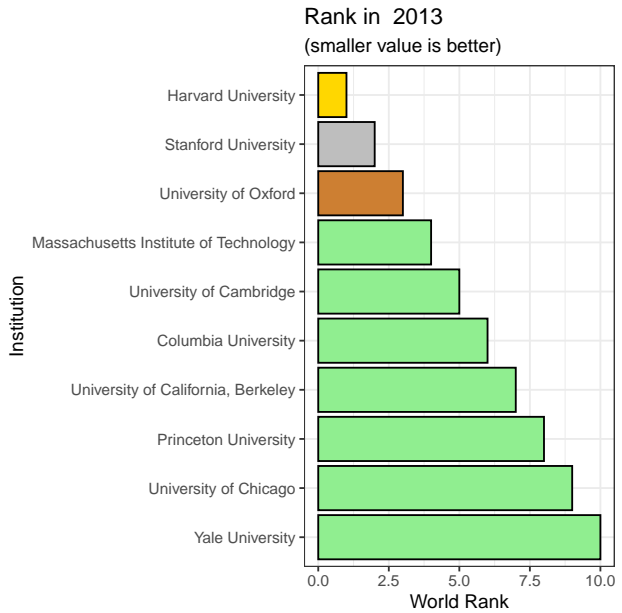
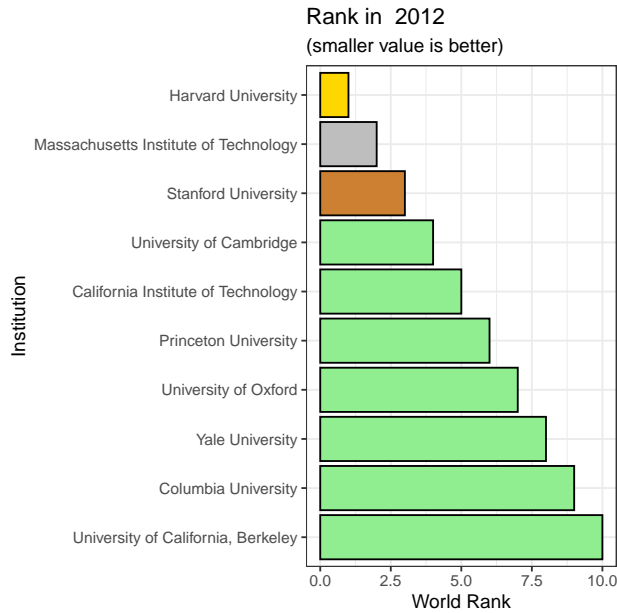
cwurPlotYear <- function(nYear) {
  cwurData %>% filter(year==nYear) %>% top_n(10,-world_rank) %>%
  ggplot(aes(x=reorder(institution,-world_rank), y=world_rank)) + geom_bar(stat="identity", aes(fill=re
  theme_bw() + coord_flip() + scale_fill_manual(values=c(rep("lightgreen",7), "#CD7F32", "grey", "go
  labs(x="Institution", y="World Rank",
        title=paste("Rank in ",nYear), subtitle="(smaller value is better)")
}

```

```

cwurPlotYear(2012) -> d1
cwurPlotYear(2013) -> d2
cwurPlotYear(2014) -> d3
cwurPlotYear(2015) -> d4
grid.arrange(d1,d2,d3,d4, ncol=2)

```



```

cwurData %>% group_by(country) %>% summarise(n = length(publications)) %>% top_n(10,n) %>% ungroup() ->
cwurData %>% filter(country %in% c$country) %>%
ggplot(aes(x=country, y=publications, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Rank by publication",
        title="Rank by publication", subtitle="Grouped by country, smaller value is better") + theme(text
cwurData %>% filter(country %in% c$country) %>%
ggplot(aes(x=country, y=citations, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Rank by citations",
        title="Rank by citations", subtitle="Grouped by country, smaller value is better") + theme(text =
cwurData %>% filter(country %in% c$country) %>%
ggplot(aes(x=country, y=patents, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +

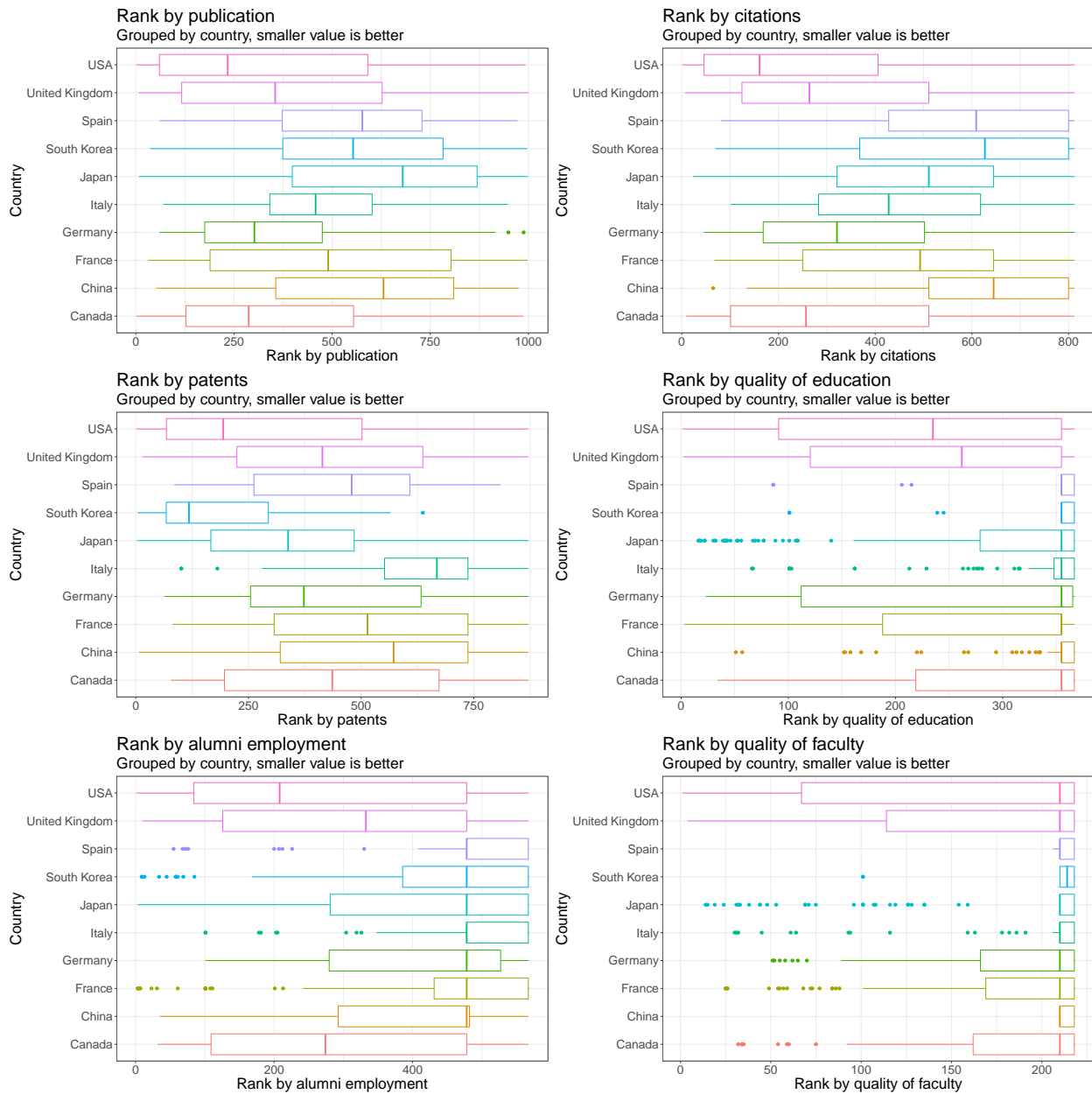
```



```

    labs(x="Country", y="Rank by patents",
         title="Rank by patents", subtitle="Grouped by country, smaller value is better") + theme(text = e
  cwurData %>% filter(country %in% c$country) %>%
  ggplot(aes(x=country, y=quality_of_education, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Rank by quality of education",
       title="Rank by quality of education", subtitle="Grouped by country, smaller value is better") + t
  cwurData %>% filter(country %in% c$country) %>%
  ggplot(aes(x=country, y=alumni_employment, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Rank by alumni employment",
       title="Rank by alumni employment", subtitle="Grouped by country, smaller value is better") + them
  cwurData %>% filter(country %in% c$country) %>%
  ggplot(aes(x=country, y=quality_of_faculty, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Rank by quality of faculty",
       title="Rank by quality of faculty", subtitle="Grouped by country, smaller value is better") + ther
  grid.arrange(d1,d2,d3,d4,d5,d6, ncol=2)

```



```

ccwurData %>% group_by(country,year) %>%
  summarise(nr = length(world_rank), minw=min(world_rank), maxw=max(world_rank), avgw=round(mean(world_rank), 2)),
  select(country, year, nr, minw, maxw, avgw) %>% ungroup() -> ccwur
# light grey boundaries
l <- list(color = toRGB("grey"), width = 0.5)
ccwur$hover <- with(ccwur,
  paste("Country: ", country, "<br>",
        "Year: ", year, "<br>",
        "Universities in top: ", nr, "<br>",
        "Min rank in top: ", minw, "<br>",
        "Max rank in top: ", maxw, "<br>",
        "Mean rank in top: ", avgw, "<br>"
  ))
g <- list(

```

```

    showframe = TRUE,
    showcoastlines = TRUE,
    projection = list(type = 'orthogonal')
  )
plot_geo(ccwur, locationmode = 'country names') %>%
  add_trace(
    z = ~nr, color = ~nr, colors = 'Spectral', frame = ~year,
    text = ~hover, locations=~country, marker = list(line = 1)
  ) %>%
  colorbar(title = 'Number of\nuniversities in top', tickprefix = '') %>%
  layout(
    title = with(ccwur, paste('Number of universities in top<br>Source:<a href="http://cwur.org/">Council of World University Rankings'))
    geo = g
  )

```

Check Shanghai Data

```

shanghaiDataCld = shanghaiData
shanghaiDataCld$total_score =
  0.1 * shanghaiDataCld$alumni + 0.2 * shanghaiDataCld$award + 0.2 * shanghaiDataCld$hici +
  0.2 * shanghaiDataCld$ns + 0.2 * shanghaiDataCld$pub + 0.1 * shanghaiDataCld$pcp
shanghaiDataCld$total_score[is.na(shanghaiDataCld$total_score)] = shanghaiDataCld$total_score[is.na(shanghaiDataCld$total_score)]

shanghaiDataCld = shanghaiDataCld[complete.cases(shanghaiDataCld),]

#Fix the duplicate name for University of California-Berkeley
shanghaiDataCld$university_name[shanghaiDataCld$university_name=="University of California-Berkeley"] <- "University of California-Berkeley"
shanghaiDataCld %>% group_by(year) %>%
  top_n(10, wt = total_score) %>% select(year,university_name,total_score,alumni, award, hici, ns, pub, pc)

#draw with plotly

plot_ly(top10univ, x = ~year) %>%
  add_trace(y = top10univ$total_score, name = top10univ$university_name, showlegend=TRUE, type = 'scatter')
  layout(title="Shanghai (ARWU) World Ranks (2005-2015)<br>Best ranked universities based on total score",
    xaxis = list(showticklabels = TRUE, tickangle = 0, tickfont = list(size = 8)),
    yaxis = list(title = "Total score"),
    hovermode = 'compare')

```

Shanghai Top Universities by Year

```

top10SpiderWebYear <- function(nYear) {
  top10univ %>% filter(year==nYear) %>% ungroup() -> top10u
  top10 <- as.data.frame(cbind(top10u[,c(3,4,5,6,7,8,9)]))
  colnames(top10) <- c("Total Score", "Alumni with Nobel", "Awarded Nobel", "Highly Cited",
    "Nature&Science", "Publications", "PCAP")
  rownames(top10) <- top10u$university_name
  rmin <- apply(top10,2,min); rmax <- apply(top10,2,max)
  rmax <- 100
  rmin <- 0
  colors_border=c( "tomato", "blue", "gold", "green", "magenta",
    "yellow", "grey", "lightblue", "brown", "red", "lightgreen", "cyan" )
  par(mfrow=c(4,3))
}

```

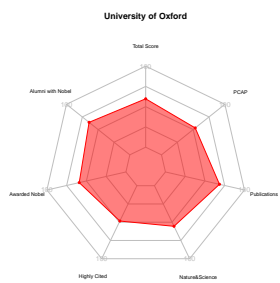
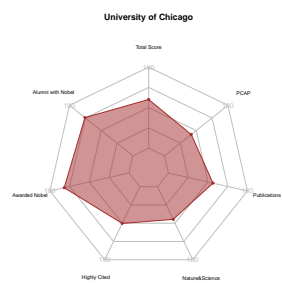
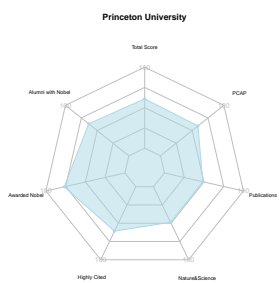
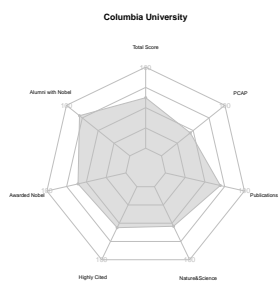
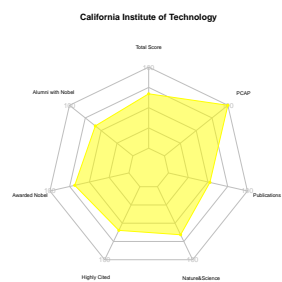
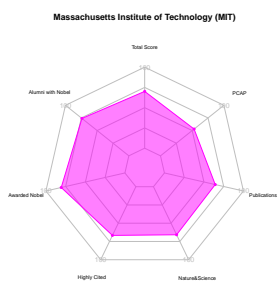
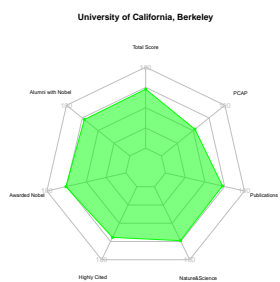
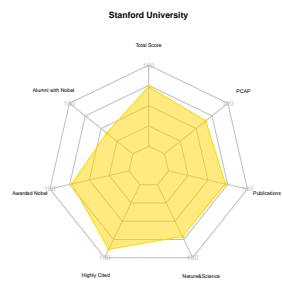
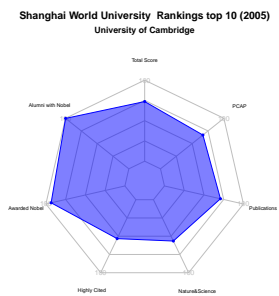
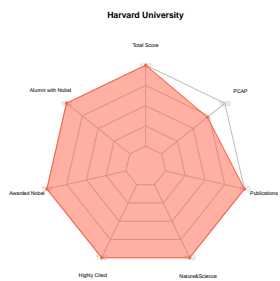
```

par(mar=c(1,1,5,1))
for(i in 1:nrow(top10)){
  colorValue<-(col2rgb(as.character(colors_border[i])))%>% as.integer())/255
  radarchart(rbind(rmax,rmin,top10[i,]),
    axistype=2 ,
    pcol=rgb(colorValue[1],colorValue[2],colorValue[3], alpha = 1),
    pfc=rgb(colorValue[1],colorValue[2],colorValue[3], alpha = 0.5),
    plwd=1 , plty=1,cglcol="grey", cglty=1, axislabcol="grey", cglwd=0.5,vlcex=0.7,
    title=rownames(top10[i,]))
}
title(paste0('\nShanghai World University Rankings top 10 (',nYear,')'),outer=TRUE,col.main='black')
}

```

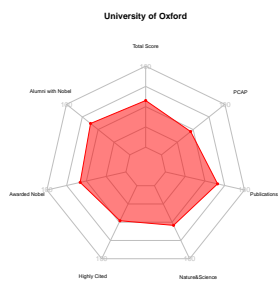
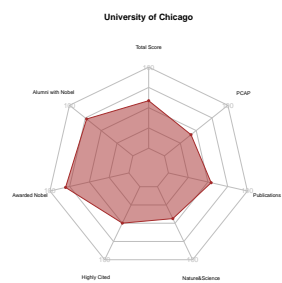
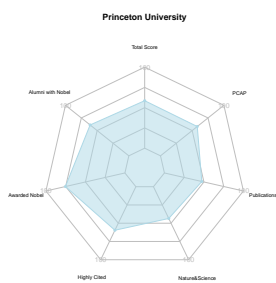
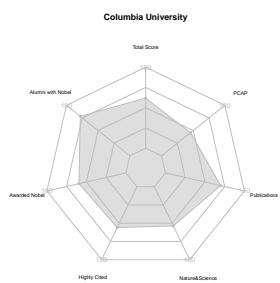
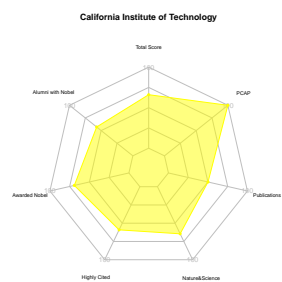
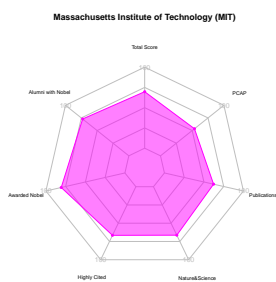
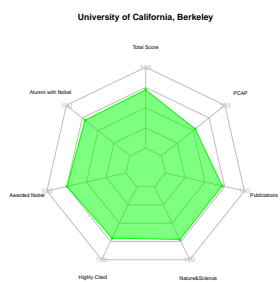
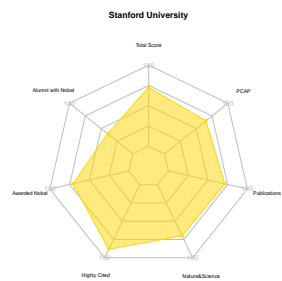
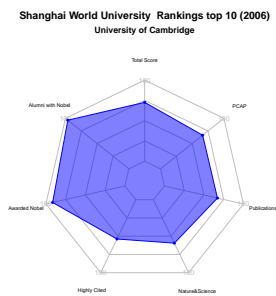
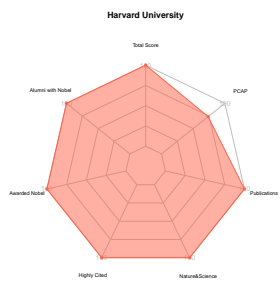
Shanghai World University Rankings by Year

```
top10SpiderWebYear(2005)
```



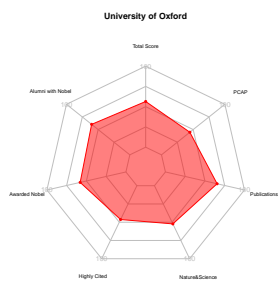
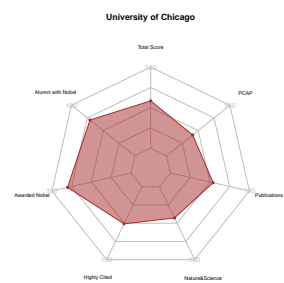
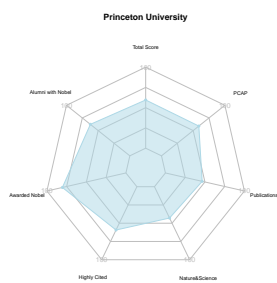
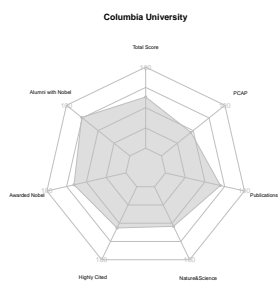
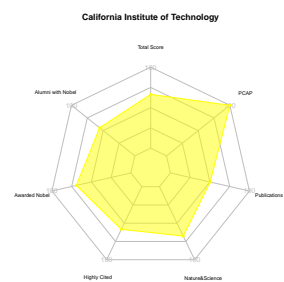
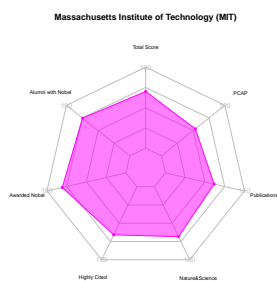
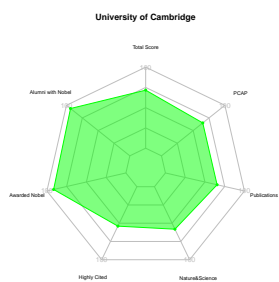
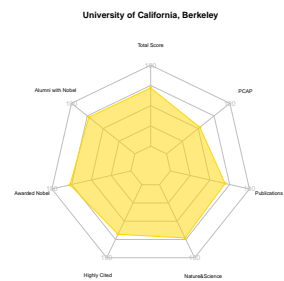
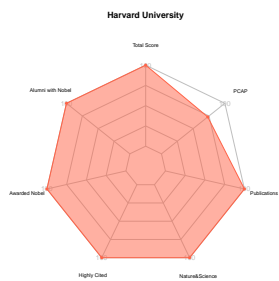
2005

top10SpiderWebYear(2006)



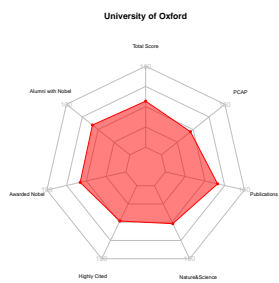
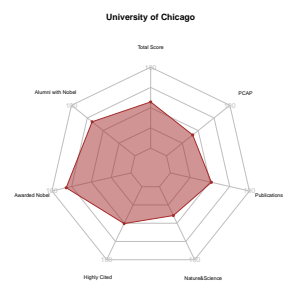
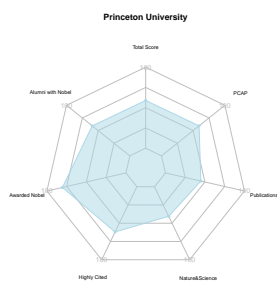
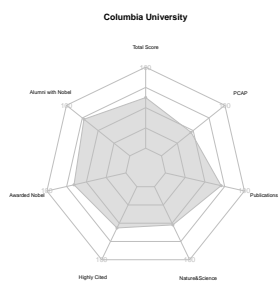
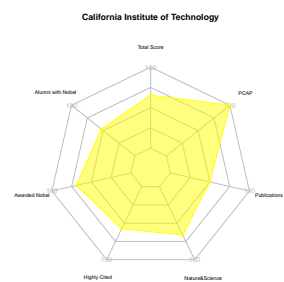
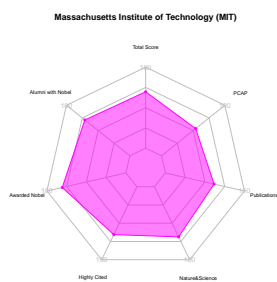
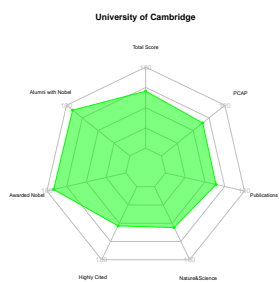
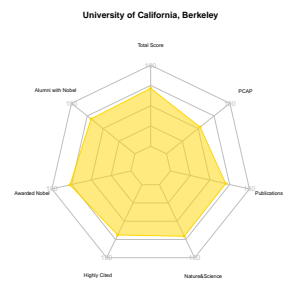
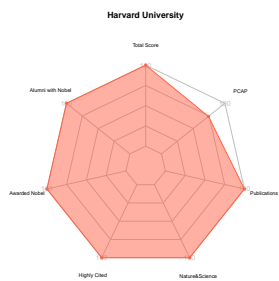
2006

top10SpiderWebYear(2007)



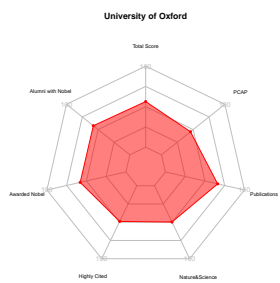
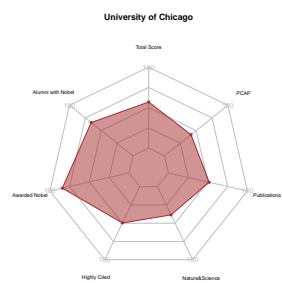
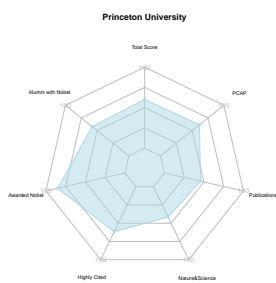
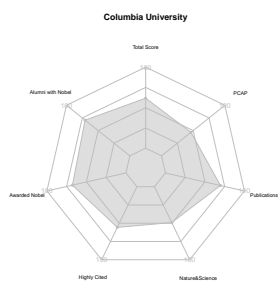
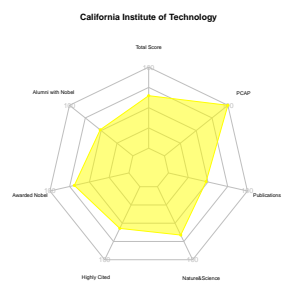
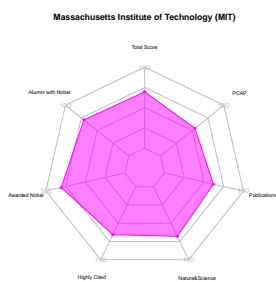
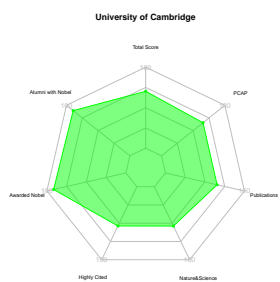
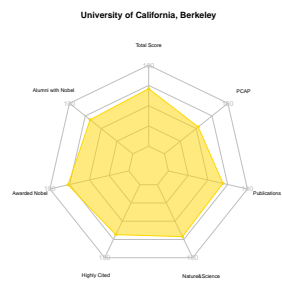
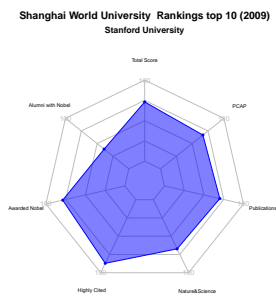
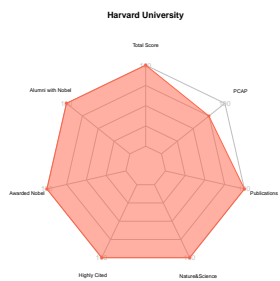
2007

top10SpiderWebYear(2008)



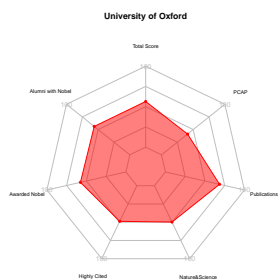
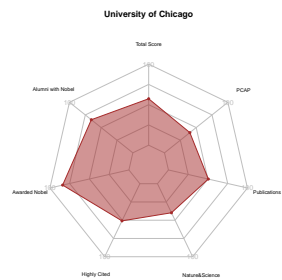
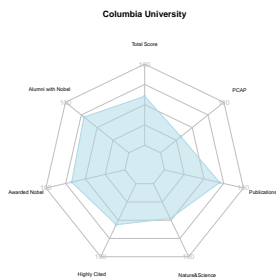
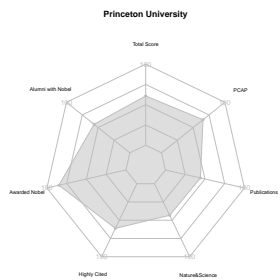
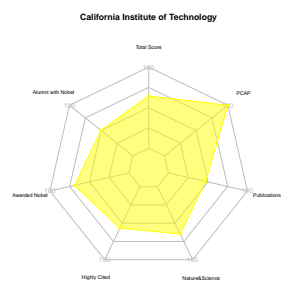
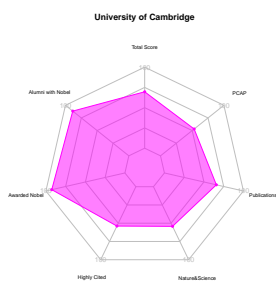
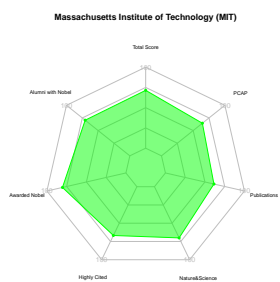
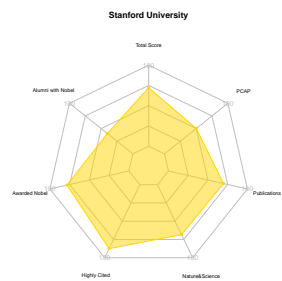
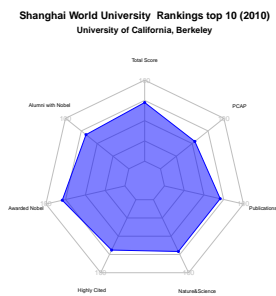
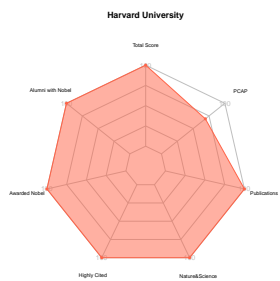
2008

top10SpiderWebYear(2009)



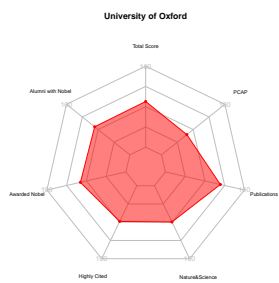
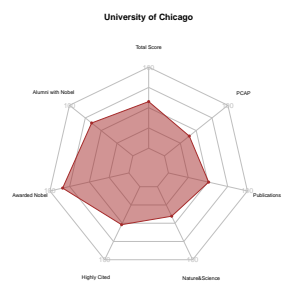
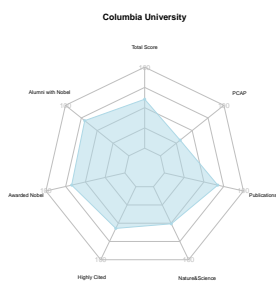
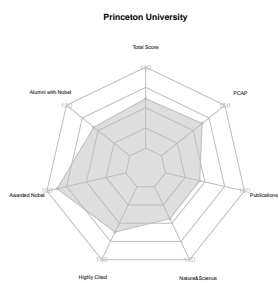
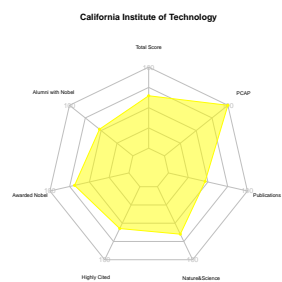
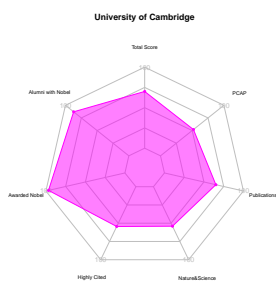
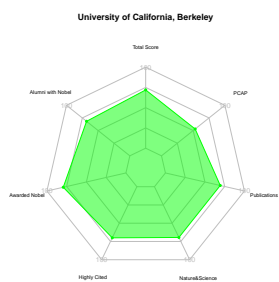
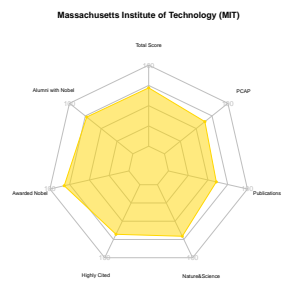
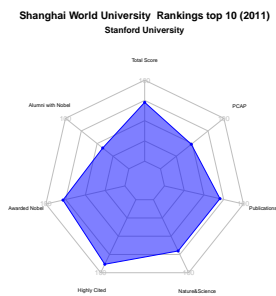
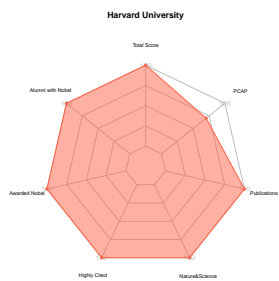
2009

top10SpiderWebYear(2010)



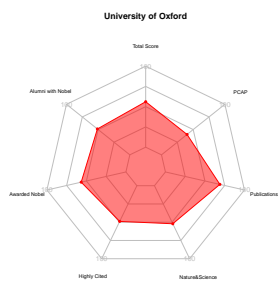
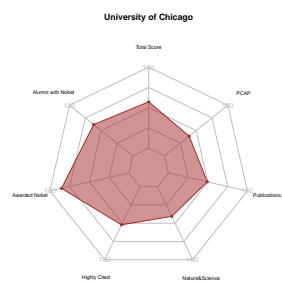
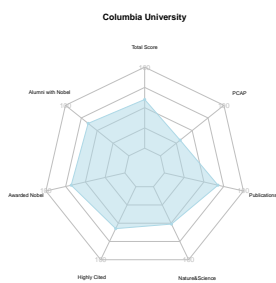
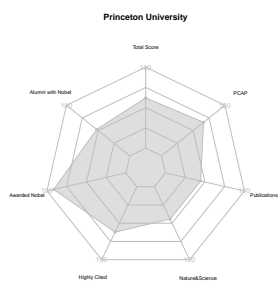
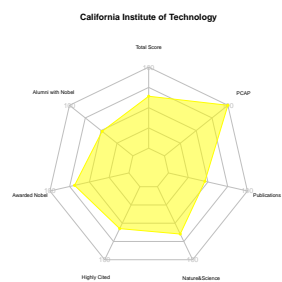
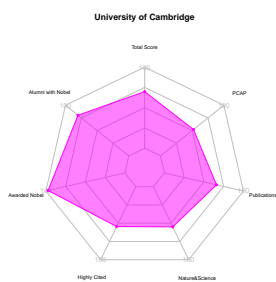
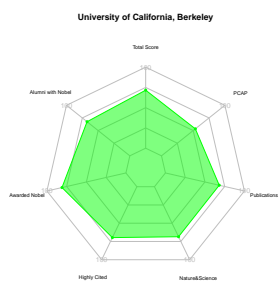
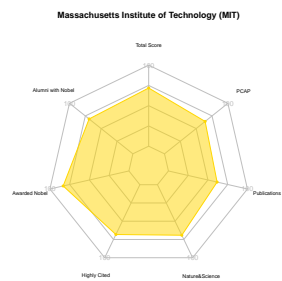
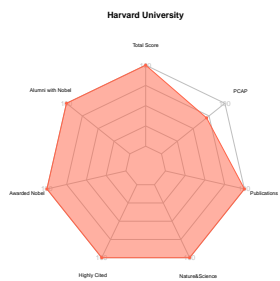
2010

top10SpiderWebYear(2011)



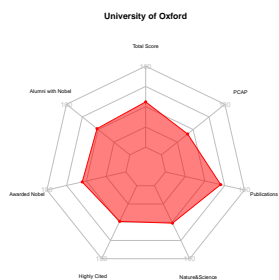
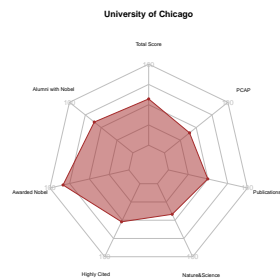
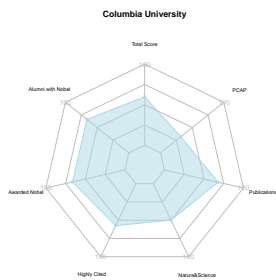
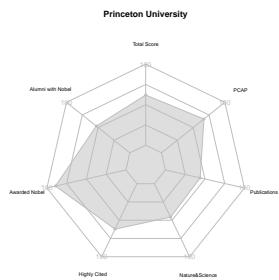
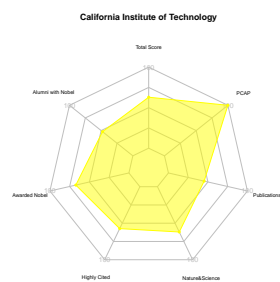
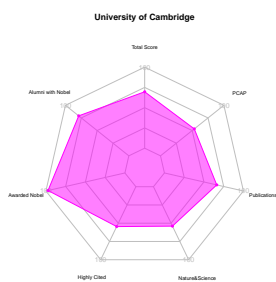
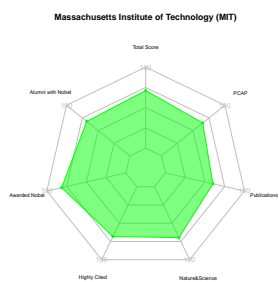
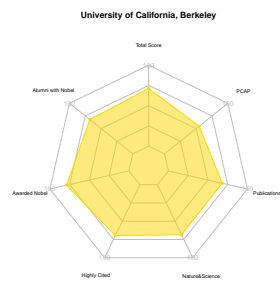
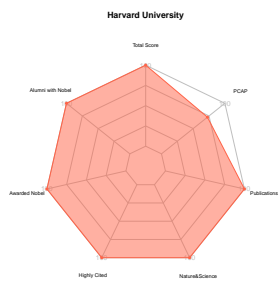
2011

top10SpiderWebYear(2012)



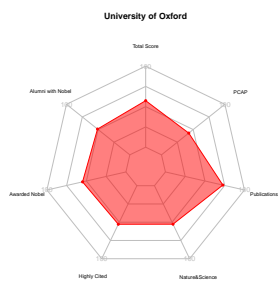
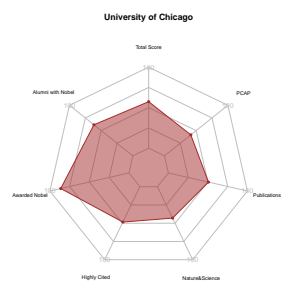
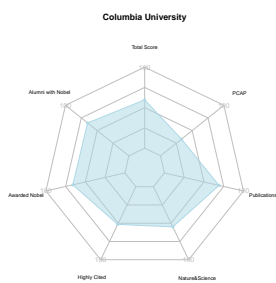
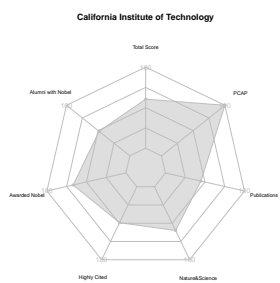
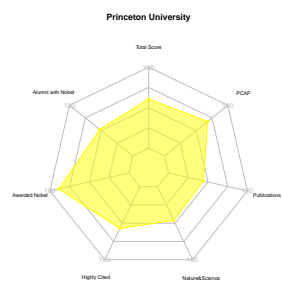
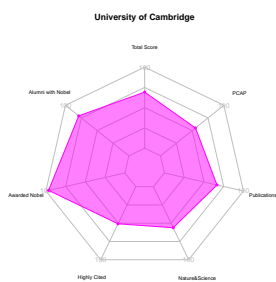
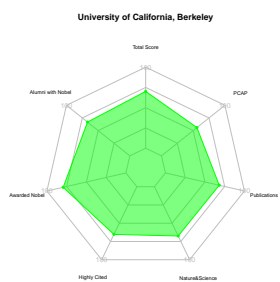
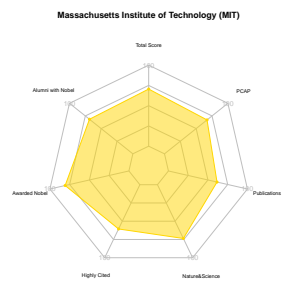
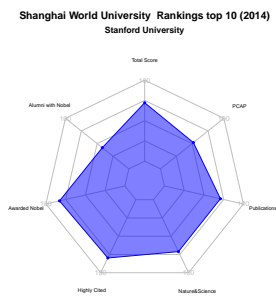
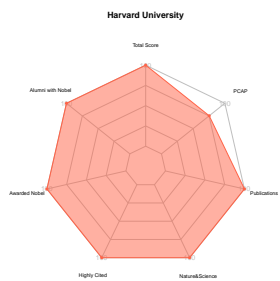
2012

top10SpiderWebYear(2013)



2013

top10SpiderWebYear(2014)



2014

top10SpiderWebYear(2015)



2015

Rankings by All Countries

```
merge(shanghaiDataCld,schoolCountry, by.x="university_name", by.y="school_name") -> scData

scData %>% group_by(country) %>% summarise(n = length(alumni)) %>% top_n(10,n) %>% ungroup() -> cs

scData %>% filter(country %in% cs$country) %>%
ggplot(aes(x=country, y=alumni, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Alumni with Nobel (score)",
       title="Alumni with Nobel (score)", subtitle="Grouped by country") -> d1

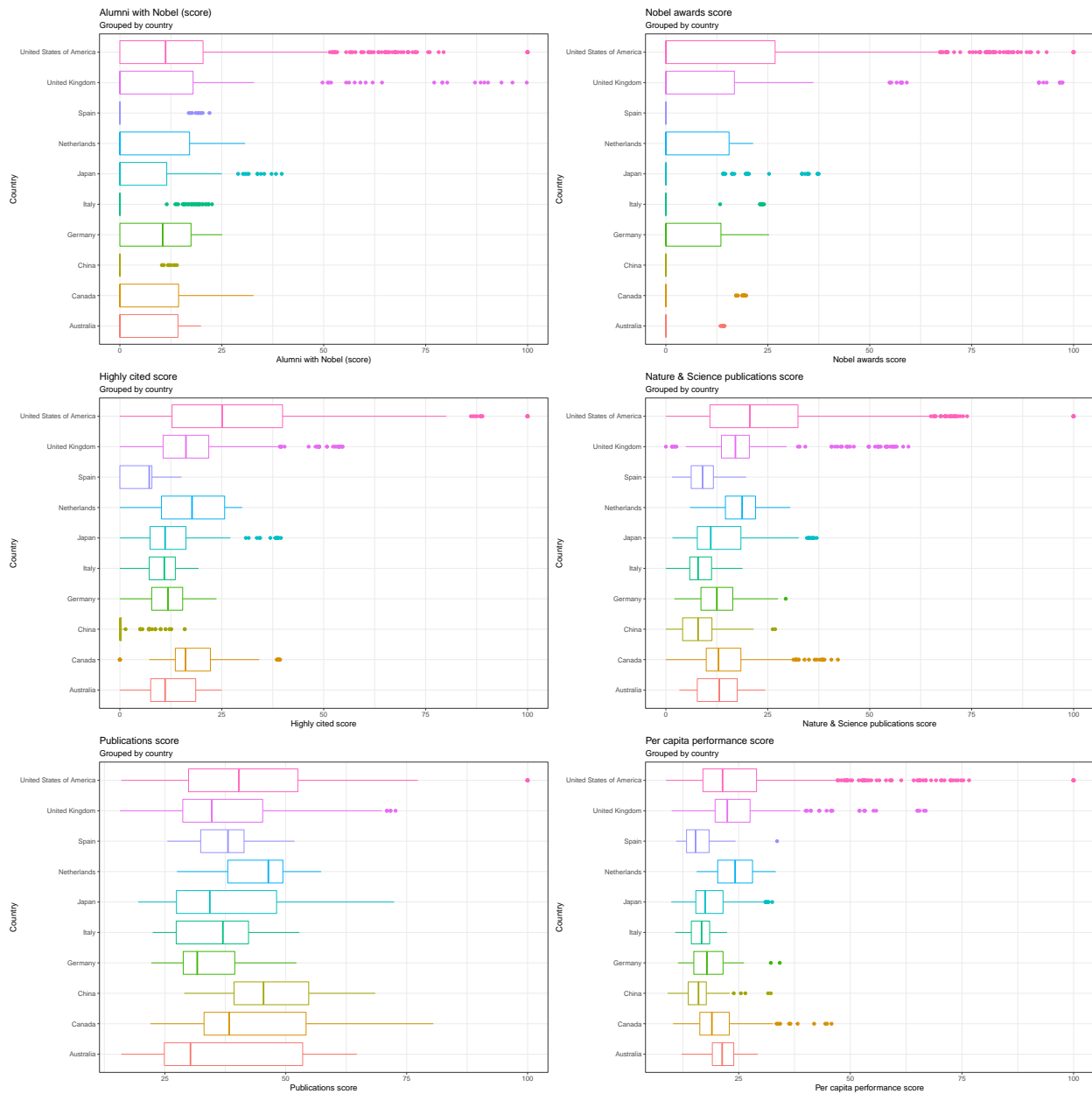
scData %>% filter(country %in% cs$country) %>%
ggplot(aes(x=country, y=award, col=country)) + guides(col=FALSE) +
```

```

geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Nobel awards score",
        title="Nobel awards score", subtitle="Grouped by country") -> d2
scData %>% filter(country %in% cs$country) %>%
ggplot(aes(x=country, y=hici, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Highly cited score",
        title="Highly cited score", subtitle="Grouped by country") -> d3
scData %>% filter(country %in% cs$country) %>%
ggplot(aes(x=country, y=ns, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Nature & Science publications score",
        title="Nature & Science publications score", subtitle="Grouped by country") -> d4
scData %>% filter(country %in% cs$country) %>%
ggplot(aes(x=country, y=pub, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Publications score",
        title="Publications score", subtitle="Grouped by country") -> d5
scData %>% filter(country %in% cs$country) %>%
ggplot(aes(x=country, y=pcp, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Per capita performance score",
        title="Per capita performance score", subtitle="Grouped by country") -> d6

grid.arrange(d1,d2,d3, d4, d5, d6, ncol=2)

```

```
scData %>% group_by(country, year) %>%
  summarise(nr = length(total_score), minw=min(total_score), maxw=max(total_score), avgw=round(mean(total_score), 2))
select(country, year, nr, minw, maxw, avgw) %>% ungroup() -> swur
# light grey boundaries
l <- list(color = toRGB("grey"), width = 0.5)
swur$hover <- with(swur,
  paste("Country: ", country, "<br>",
        "Year: ", year, "<br>",
        "Universities: ", nr, "<br>",
        "Min total score: ", minw, "<br>",
        "Max total score: ", maxw, "<br>",
        "Mean total score: ", avgw, "<br>"
  ))
# specify map projection/options
```

```

g <- list(
  showframe = TRUE,
  showcoastlines = TRUE,
  projection = list(type = 'Mercator')
)
plot_geo(swur, locationmode = 'country names') %>%
add_trace(
  z = ~nr, color = ~nr, colors = 'Spectral', frame = ~year,
  text = ~hover, locations=~country, marker = list(line = 1)
) %>%
colorbar(title = 'Number of\nuniversities', tickprefix = '') %>%
layout(
  title = with(swur, paste('Number of universities<br>Source:<a href="http://www.shanghairanking.com">S
  geo = g
)

```

Times Higher Education University Rankings

```

#replace first the missing values (`-`) with NA
timesData$teaching[timesData$teaching=='-'] <- NA
timesData$international[timesData$international=='-'] <- NA
timesData$research[timesData$research=='-'] <- NA
timesData$citations[timesData$citations=='-'] <- NA
timesData$income[timesData$income=='-'] <- NA
timesData$total_score[timesData$total_score=='-'] <- NA

#replace factors with numeric
timesData$teaching <- as.numeric(as.character(timesData$teaching))
timesData$international <- as.numeric(as.character(timesData$international))
timesData$research <- as.numeric(as.character(timesData$research))
timesData$citations <- as.numeric(as.character(timesData$citations))
timesData$income <- as.numeric(as.character(timesData$income))
timesData$total_score <- as.numeric(as.character(timesData$total_score))

# replace NAs with 0
timesData$income[is.na(timesData$income)] <- 0
timesData$international[is.na(timesData$international)] <- 0

#calculate the total score
timesData$total_score =
  0.3 * as.numeric(as.character(timesData$teaching)) +
  0.075 * as.numeric(as.character(timesData$international)) +
  0.3 * as.numeric(as.character(timesData$research)) +
  0.3 * as.numeric(as.character(timesData$citations)) +
  0.025 * as.numeric(as.character(timesData$income))

#replace the total_score where missing with the calculated value
timesData$total_score[is.na(timesData$total_score)] <- timesData$total_score[is.na(timesData$total_score)]
timesData$wr = as.numeric(as.character(timesData$world_rank))

## Warning: NA

thePlotYear <- function(nYear) {
  timesData %>% filter(year==nYear) %>% top_n(10,-wr) %>%

```

```

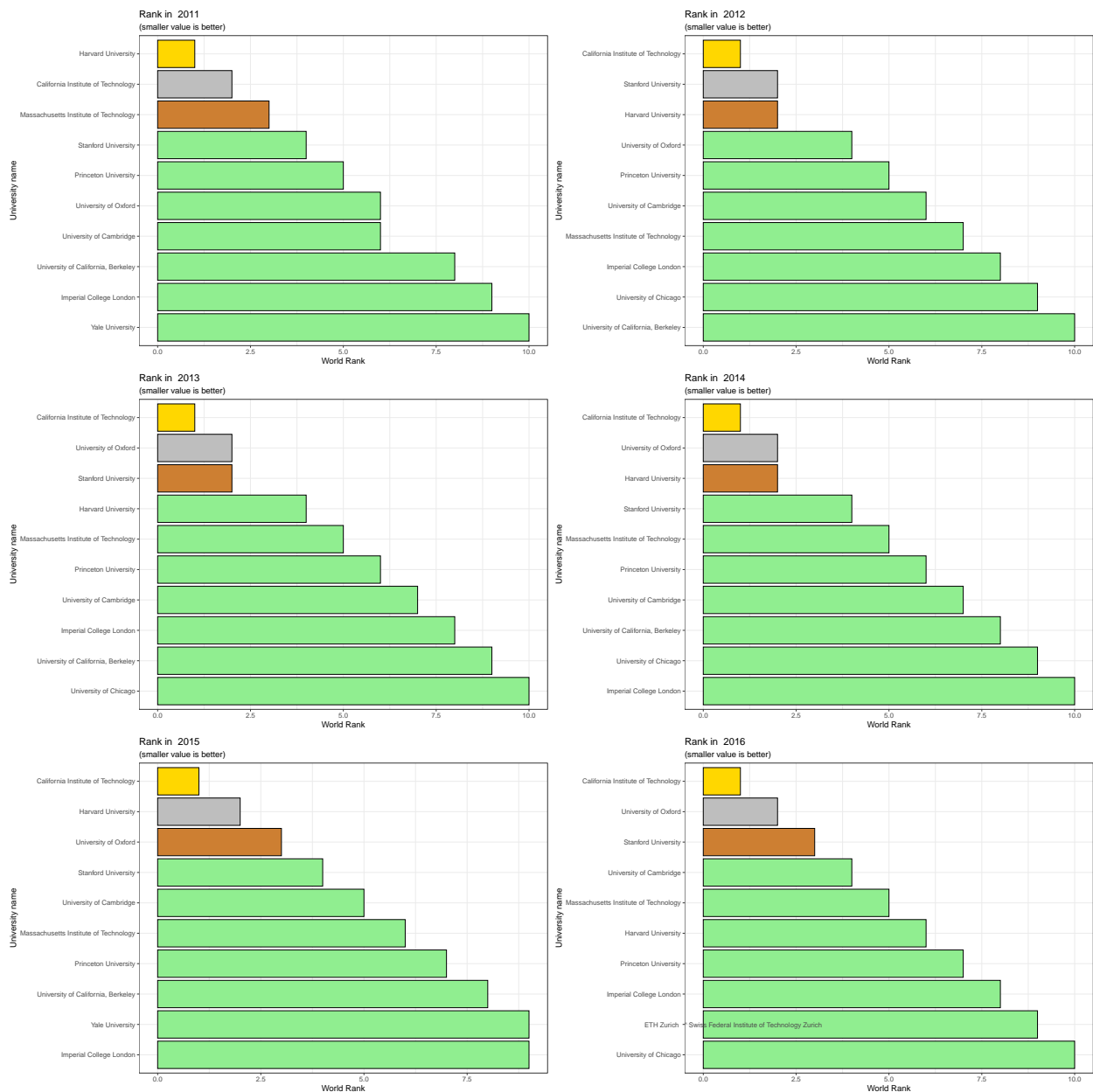
ggplot(aes(x=reorder(university_name,-wr), y=wr)) + geom_bar(stat="identity", aes(fill=reorder(university_name, wr))) +
  theme_bw() + coord_flip() + scale_fill_manual(values=c(rep("lightgreen",7), "#CD7F32", "grey", "gold")) +
  labs(x="University name", y="World Rank",
       title=paste("Rank in ",nYear), subtitle="(smaller value is better)")
}

```

```

thePlotYear(2011) -> d1
thePlotYear(2012) -> d2
thePlotYear(2013) -> d3
thePlotYear(2014) -> d4
thePlotYear(2015) -> d5
thePlotYear(2016) -> d6
grid.arrange(d1,d2,d3,d4,d5,d6, ncol=2)

```



Ranks by Year

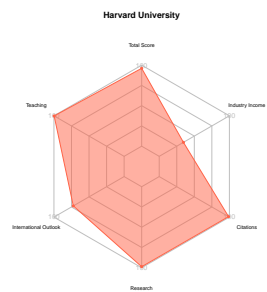
```
timesData %>% group_by(year) %>%
  top_n(10, wt = total_score) %>%
  select(year,university_name,total_score,teaching, international, research, citations, income) %>% ungroup()
theTop10SpiderWebYear <- function(nYear) {
  top10univ %>% filter(year==nYear) %>% ungroup() -> top10u
  top10 <- as.data.frame(cbind(top10u[,c(3,4,5,6,7,8)]))
  colnames(top10) <- c("Total Score", "Teaching", "International Outlook", "Research",
    "Citations","Industry Income")
  rownames(top10) <- top10u$university_name

  rmin <- apply(top10,2,min); rmax <- apply(top10,2,max)
  rmax <- 100
  rmin <- 0

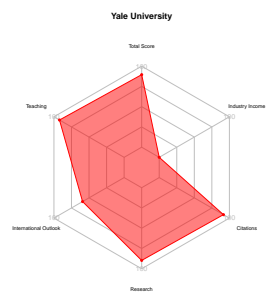
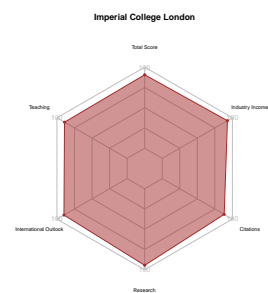
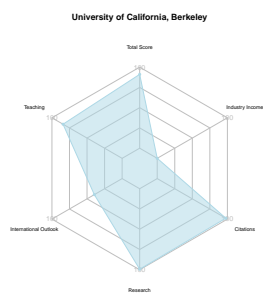
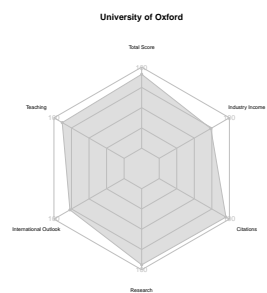
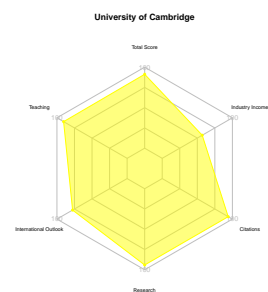
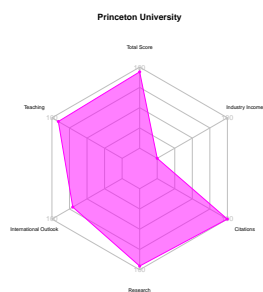
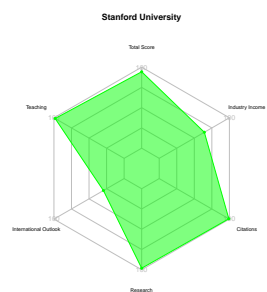
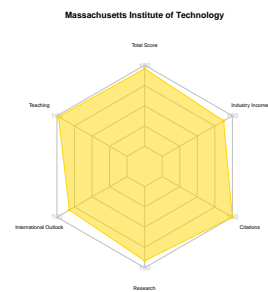
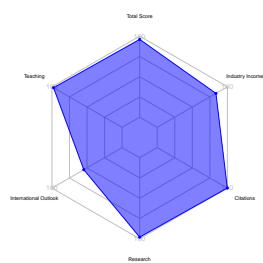
  colors_border=c( "tomato", "blue", "gold", "green", "magenta",
    "yellow", "grey", "lightblue", "brown", "red", "lightgreen", "cyan" )

  par(mfrow=c(4,3))
  par(mar=c(1,1,5,1))
  for(i in 1:nrow(top10)){
    colorValue<-(col2rgb(as.character(colors_border[i])))%>% as.integer())/255
    radarchart(rbind(rmax,rmin,top10[i,]),
      axistype=2 ,
      pcol=rgb(colorValue[1],colorValue[2],colorValue[3], alpha = 1),
      pfc=rgb(colorValue[1],colorValue[2],colorValue[3], alpha = 0.5),
      plwd=1 , plty=1,cglcol="grey", cglty=1, axislabcol="grey", cglwd=0.5,vlcex=0.7,
      title=rownames(top10[i,]))
  }
  title(paste0('\nTimes Higher Education World University Rankings top 10 (',nYear,')'),outer=TRUE,col="black")
}
```

```
theTop10SpiderWebYear(2011)
```

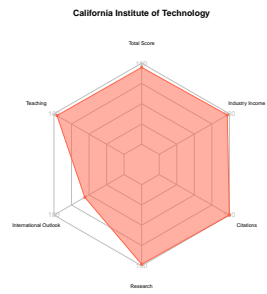


Times Higher Education World University Rankings top 10 (2011)
California Institute of Technology

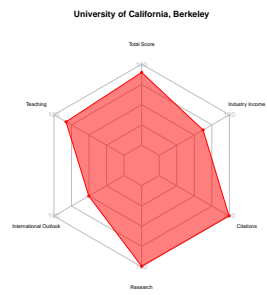
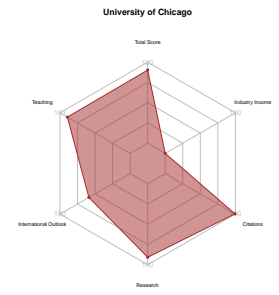
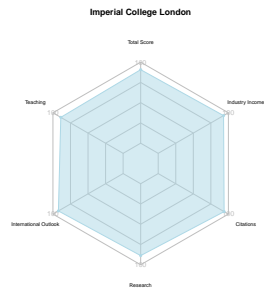
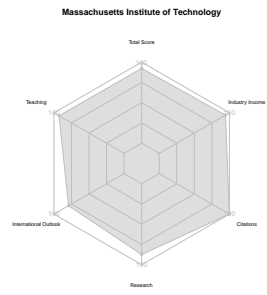
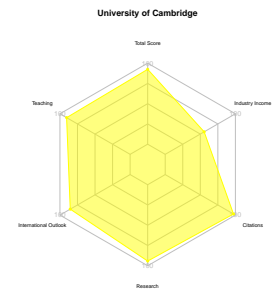
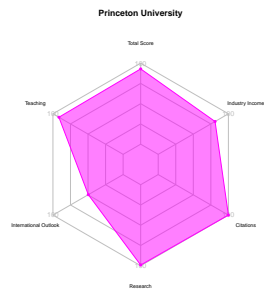
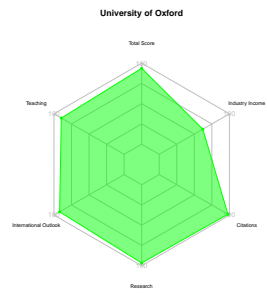
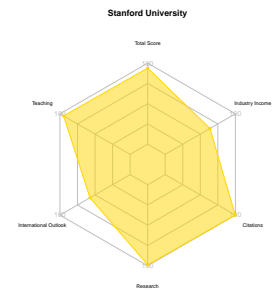
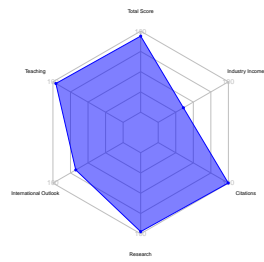


2011

theTop10SpiderWebYear(2012)

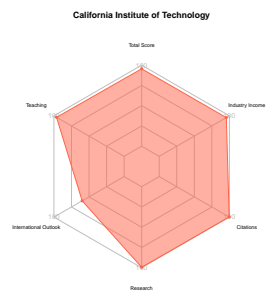


Times Higher Education World University Rankings top 10 (2012)
Harvard University

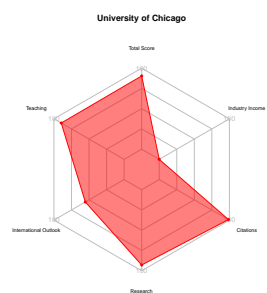
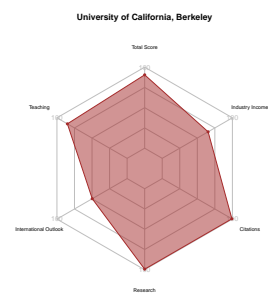
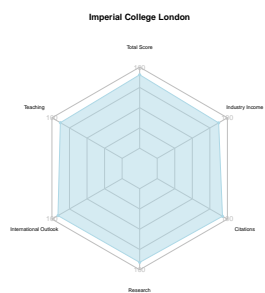
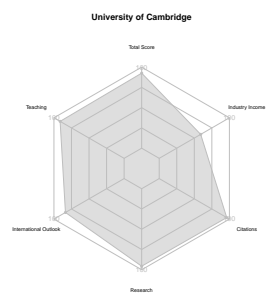
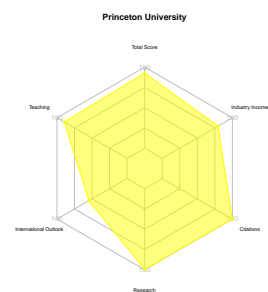
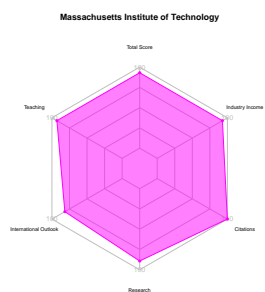
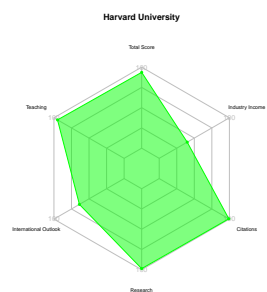
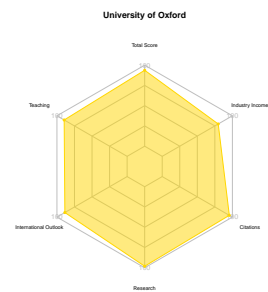
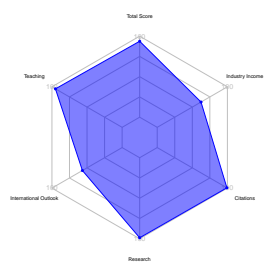


2012

theTop10SpiderWebYear(2013)

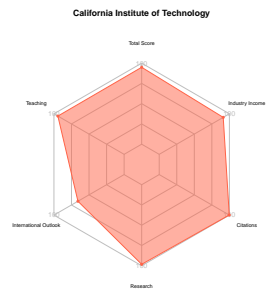


Times Higher Education World University Rankings top 10 (2013)

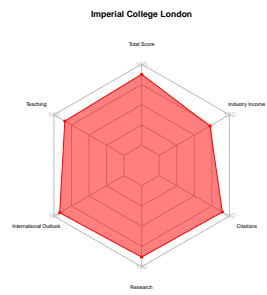
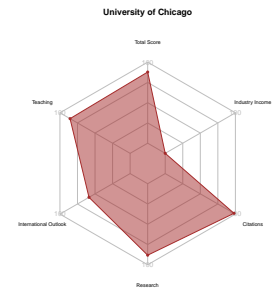
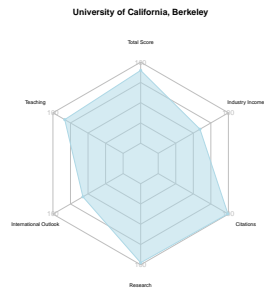
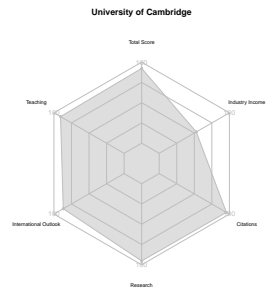
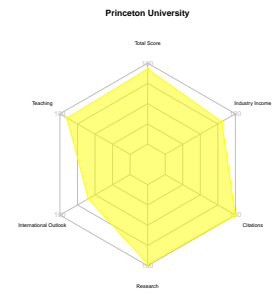
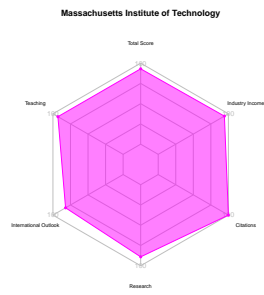
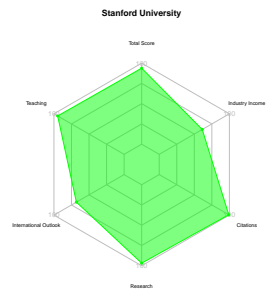
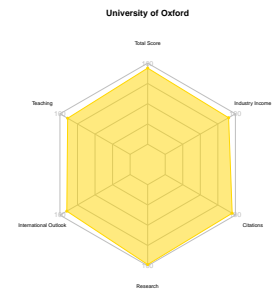
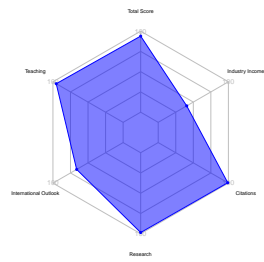


2013

theTop10SpiderWebYear(2014)

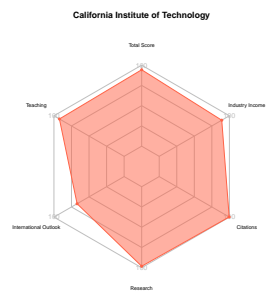


Times Higher Education World University Rankings top 10 (2014)
Harvard University

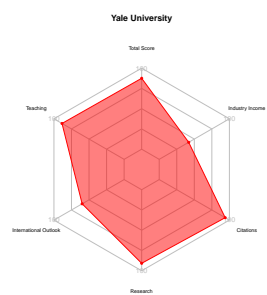
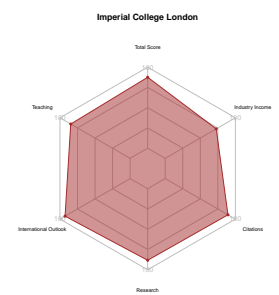
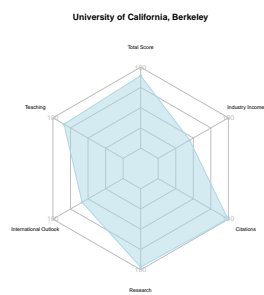
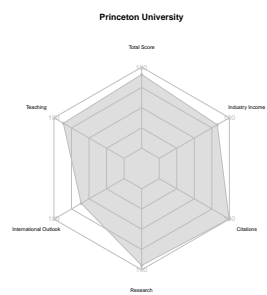
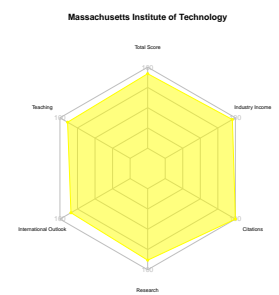
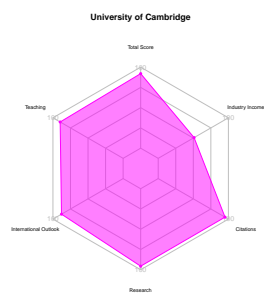
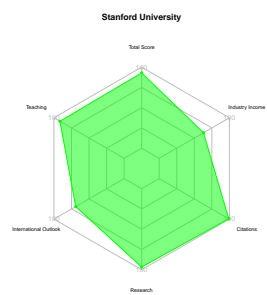
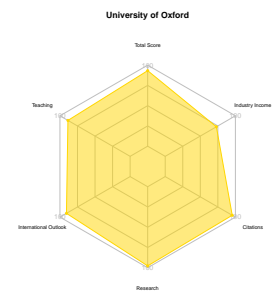
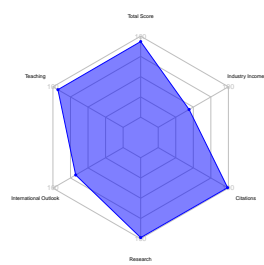


2014

theTop10SpiderWebYear(2015)



Times Higher Education World University Rankings top 10 (2015)
Harvard University



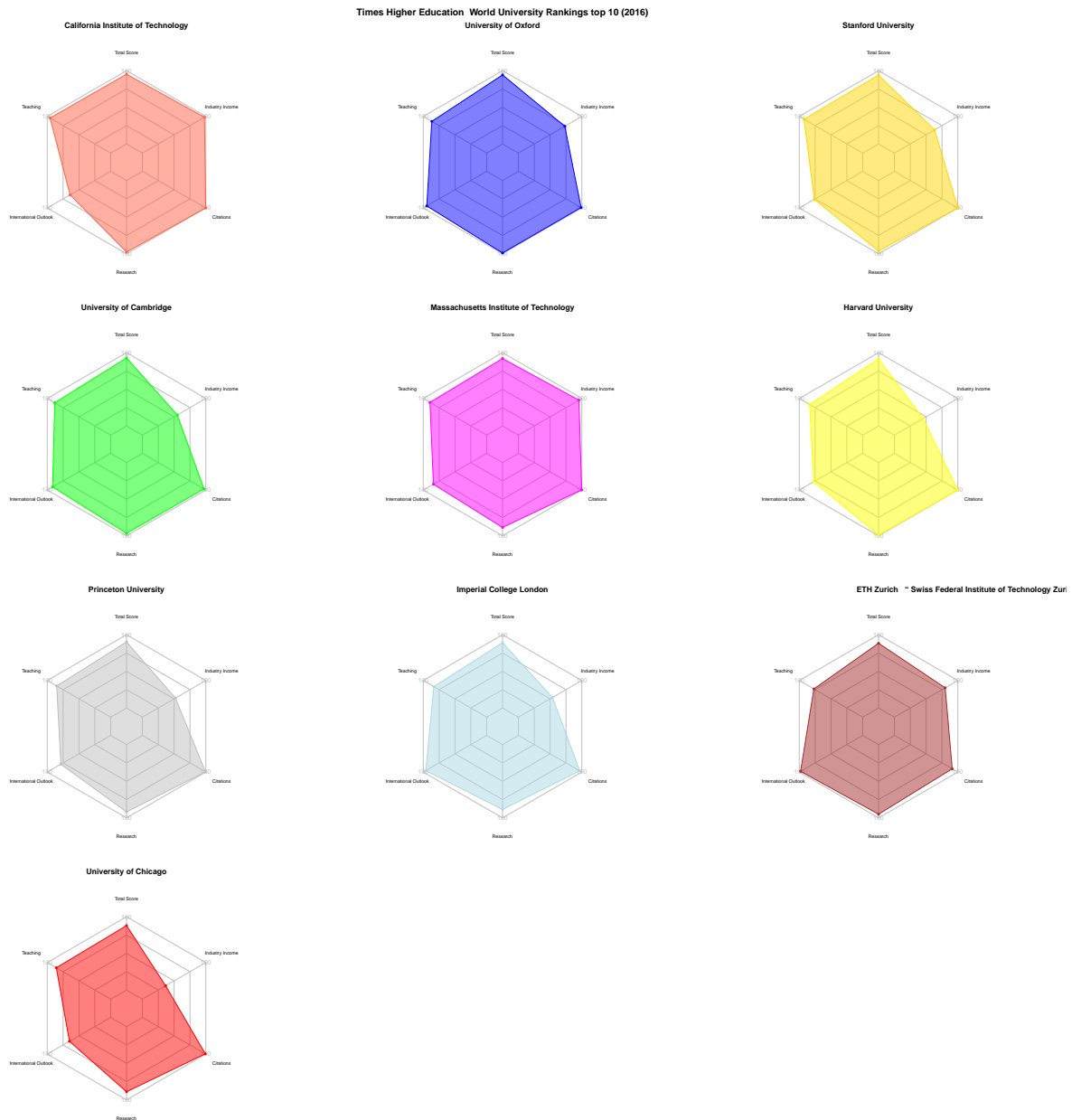
2015

theTop10SpiderWebYear(2016)

2016

Warning in title(...):

0xe2



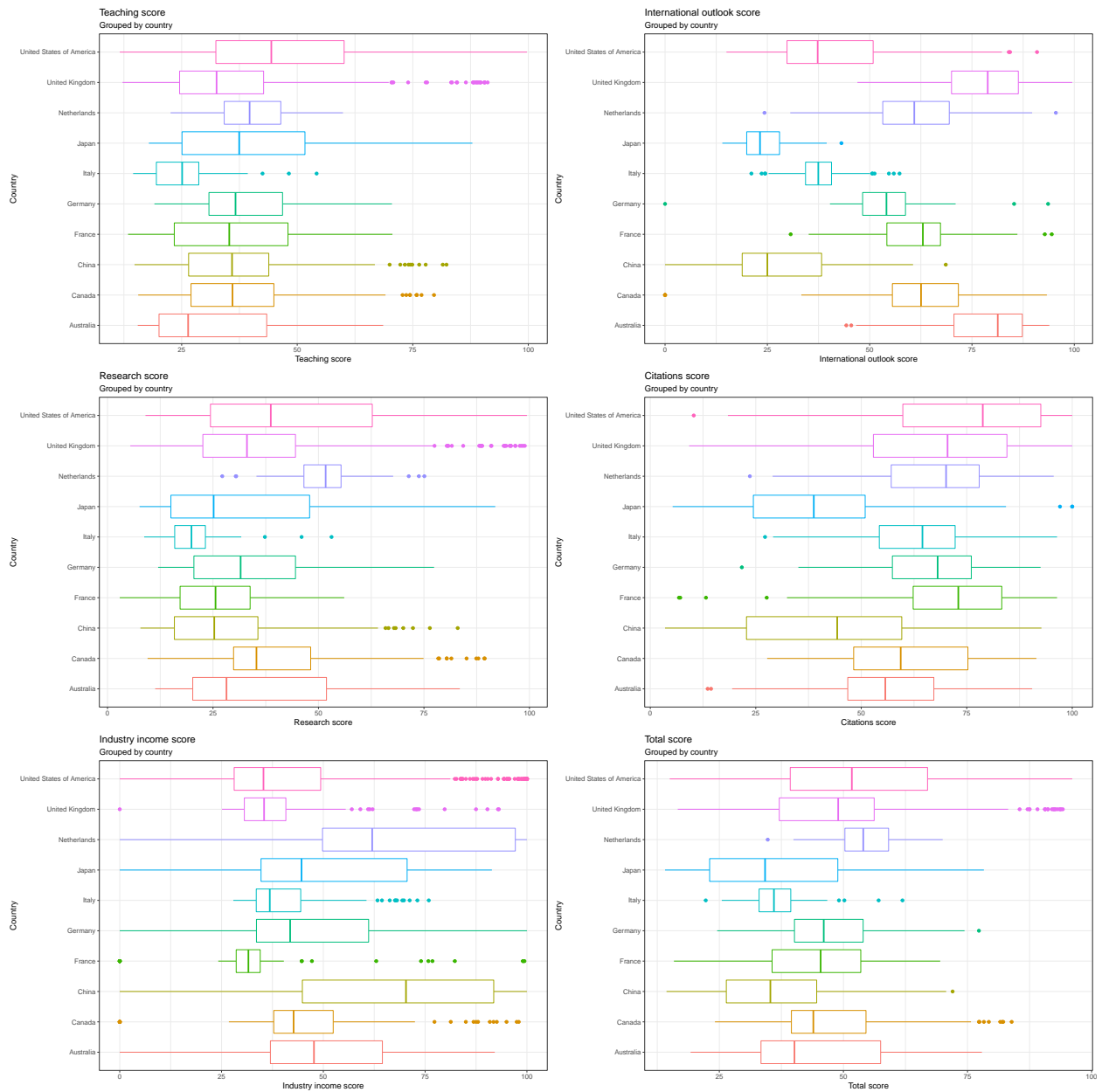
All countries total scores and counts

```
timesData %>% group_by(country) %>% summarise(n = length(teaching)) %>% top_n(10,n) %>% ungroup() -> ct
timesData %>% filter(country %in% ct$country) %>%
ggplot(aes(x=country, y=teaching, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Teaching score",
       title="Teaching score", subtitle="Grouped by country") -> d1
timesData %>% filter(country %in% ct$country) %>%
ggplot(aes(x=country, y=international, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="International outlook score",
       title="International outlook score", subtitle="Grouped by country") -> d2
```

```

timesData %>% filter(country %in% ct$country) %>%
ggplot(aes(x=country, y=research, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Research score",
        title="Research score", subtitle="Grouped by country") -> d3
timesData %>% filter(country %in% ct$country) %>%
ggplot(aes(x=country, y=citations, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Citations score",
        title="Citations score", subtitle="Grouped by country") -> d4
timesData %>% filter(country %in% ct$country) %>%
ggplot(aes(x=country, y=income, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Industry income score",
        title="Industry income score", subtitle="Grouped by country") -> d5
timesData %>% filter(country %in% ct$country) %>%
ggplot(aes(x=country, y=total_score, col=country)) + guides(col=FALSE) +
  geom_boxplot() + theme_bw() + coord_flip() +
  labs(x="Country", y="Total score",
        title="Total score", subtitle="Grouped by country") -> d6
grid.arrange(d1,d2,d3,d4, d5, d6, ncol=2)

```



```
timesData$total_score = as.numeric(as.character(timesData$total_score))
#replace with 0 the missing total_score values - this will affect the aggregated values
```

```
timesData %>% group_by(country,year) %>%
summarise(nr = length(total_score), minw=min(total_score), maxw=max(total_score), avgw=round(mean(total_score),2))
select(country, year, nr, minw, maxw, avgw) %>% ungroup() -> ther
```

```
# light grey boundaries
l <- list(color = toRGB("grey"), width = 0.5)
```

```
ther$hover <- with(ther,
  paste("Country: ", country, '<br>',
        "Year: ",year, "<br>",
        "Universities: ", nr, "<br>"),
```

```

        "Min total score: ", minw, "<br>",
        "Max total score: ", maxw, "<br>",
        "Mean total score: ", avgw, "<br>"
    ))
# specify map projection/options
g <- list(
  showframe = TRUE,
  showcoastlines = TRUE,
  projection = list(type = 'Mercator')
)
plot_geo(ther, locationmode = 'country names') %>%
add_trace(
  z = ~nr, color = ~nr, colors = 'Spectral', frame = ~year,
  text = ~hover, locations=~country, marker = list(line = 1)
) %>%
colorbar(title = 'Number of\nuniversities', tickprefix = '') %>%
layout(
  title = with(ther, paste('Number of universities<br>Source:<a href="https://www.timeshighereducation.'
  geo = g
)

```

#The output of strsplit() is a list. The "[" addresses the elements of the list, and the 2 indicates the second element of the list.

```

timesData$female_ratio <-
  sapply(strsplit(as.character(timesData$female_male_ratio), ":"), "[", 1)
timesData$female_ratio

```

```

##      [1] NA      "33 " "37 " "42 " "45 " "46 " "46 " "50 " "37 " "50 "
##     [11] "52 " "42 " "50 " "48 " "31 " "48 " NA     NA     "51 " "39 "
##     [21] "53 " "56 " "53 " "49 " "48 " NA     "31 " "20 " "52 " "54 "
##     [31] "58 " "48 " "47 " "49 " "56 " "55 " NA     NA     "18 " "58 "
##     [41] NA      "46 " "52 " "70 " "51 " NA     "44 " "27 " "52 " NA
##     [51] "52 " "52 " "54 " "54 " NA     "49 " NA     "32 " "58 " "55 "
##     [61] "56 " "62 " "44 " "51 " "48 " "49 " "45 " "53 " "53 " "53 "
##     [71] "57 " "52 " "48 " "52 " "54 " "57 " "61 " "50 " "20 " "54 "
##     [81] "53 " NA     "55 " "45 " "54 " NA     "52 " "57 " NA     "53 "
##     [91] "57 " "51 " "53 " NA     "56 " "52 " "54 " "48 " "47 " "49 "
##    [101] "33 " "66 " "56 " "30 " "51 " "42 " "33 " "53 " "46 " NA
##    [111] "61 " NA     "13 " "19 " "39 " NA     "51 " "61 " "54 " "46 "
##    [121] "52 " "51 " "27 " "57 " "52 " "59 " "55 " "57 " "62 " "31 "
##    [131] "56 " "25 " "52 " "52 " "60 " NA     "50 " "57 " "56 " "48 "
##    [141] "60 " "62 " "59 " "56 " "54 " "54 " "46 " "57 " "51 " "54 "
##    [151] "26 " "55 " "50 " "47 " "59 " "53 " "44 " NA     "48 " "56 "
##    [161] "50 " "54 " "37 " "53 " "53 " "52 " "54 " "58 " "57 " "52 "
##    [171] "51 " "60 " "57 " "48 " "58 " "54 " "67 " NA     "56 " "55 "
##    [181] "27 " "31 " "44 " "54 " "37 " "54 " "26 " "54 " "58 " "48 "
##    [191] "54 " NA     "55 " "30 " "67 " "58 " "53 " "41 " "55 " "67 "
##    [201] "33 " NA     "42 " "46 " "45 " "46 " "37 " "37 " "42 " "50 "
##    [211] "50 " NA     "52 " "50 " "31 " "51 " "56 " "48 " NA     "48 "
##    [221] "39 " "49 " "54 " "31 " "53 " "48 " "51 " "56 " "51 " NA
##    [231] "47 " "70 " "48 " "53 " "52 " "58 " "55 " "52 " "54 " "49 "
##    [241] NA      "52 " "58 " "55 " "62 " "27 " NA     "52 " NA     NA
##    [251] "46 " NA     "20 " "58 " "52 " "61 " "49 " "57 " "51 " "46 "
##    [261] "57 " NA     "18 " "49 " "53 " "53 " "54 " "59 " "51 " "52 "
##    [271] "32 " "44 " "55 " "53 " "56 " "56 " "54 " "45 " "59 " NA

```

```

## [281] "51 " "49 " "54 " "48 " "56 " "52 " "57 " "33 " "44 " "47 "
## [291] "66 " "53 " "48 " "20 " "48 " "51 " "52 " "42 " "54 " "55 "
## [301] "50 " "57 " "53 " "26 " "57 " "57 " "57 " "13 " NA "53 "
## [311] "54 " "54 " "45 " "50 " "19 " NA "56 " "57 " "31 " "25 "
## [321] "55 " NA "53 " NA "54 " "54 " "50 " "52 " "53 " "61 "
## [331] "52 " "62 " "58 " "52 " "56 " "67 " "52 " "53 " "67 " "54 "
## [341] "52 " "49 " "51 " "30 " "58 " "50 " "54 " "54 " "55 " "55 "
## [351] "53 " "58 " "54 " "39 " "53 " "54 " "48 " "48 " "58 " NA
## [361] "56 " NA "51 " "47 " "55 " NA "53 " "31 " "48 " "63 "
## [371] "54 " "50 " "58 " "54 " "47 " "60 " "56 " "27 " "48 " "56 "
## [381] "60 " "52 " NA "44 " "60 " "59 " "30 " "58 " "52 " "50 "
## [391] "60 " NA "51 " "54 " "54 " "26 " NA "56 " "54 " "37 "
## [401] "59 " NA "57 " "26 " "29 " "33 " "50 " "35 " "56 " "47 "
## [411] "60 " "47 " "48 " "62 " "54 " "55 " "57 " NA "54 " NA
## [421] "57 " "55 " "58 " "45 " "54 " "57 " "54 " "47 " "30 " "52 "
## [431] "57 " "55 " "48 " "50 " NA "55 " "27 " "55 " "51 " "67 "
## [441] "35 " "56 " "53 " NA "60 " "60 " "53 " "56 " "56 " NA
## [451] "55 " "57 " "46 " "51 " "48 " "28 " "46 " "37 " "46 " "54 "
## [461] "48 " "53 " "49 " "42 " "46 " "65 " NA "53 " "52 " "44 "
## [471] "56 " "38 " "50 " "55 " "42 " "57 " "48 " "56 " "29 " "61 "
## [481] "34 " "43 " "44 " "51 " "54 " "48 " "51 " "28 " "51 " "60 "
## [491] "56 " "63 " "60 " "66 " NA NA "53 " "56 " "48 " "51 "
## [501] "59 " "48 " "32 " "46 " "59 " "48 " "50 " "67 " "62 " "54 "
## [511] "16 " "67 " "55 " "32 " "58 " "44 " "52 " "34 " "52 " "34 "
## [521] "59 " "37 " "27 " "39 " "55 " "51 " "51 " "64 " "56 " "54 "
## [531] "50 " "52 " "54 " "55 " "46 " "54 " NA "52 " "54 " NA
## [541] "61 " "55 " "66 " "57 " "60 " "57 " "67 " "27 " "55 " "50 "
## [551] "41 " NA "51 " "46 " "53 " "60 " "63 " "59 " NA "29 "
## [561] "41 " "36 " "50 " "33 " NA "63 " "41 " "52 " "38 " "63 "
## [571] "62 " NA "31 " "30 " "56 " "55 " "25 " "49 " NA "12 "
## [581] "29 " "36 " NA "60 " "49 " "44 " "27 " "65 " "55 " "47 "
## [591] "53 " "60 " "64 " "59 " "50 " "66 " "61 " NA "55 " "35 "
## [601] NA "43 " "33 " "42 " "46 " NA "37 " "45 " "46 " "37 "
## [611] "50 " "42 " "50 " "31 " "52 " NA "51 " "50 " "56 " "48 "
## [621] "48 " "48 " NA "39 " "49 " "53 " "31 " "51 " NA "55 "
## [631] "49 " "54 " "51 " "58 " "47 " "56 " "52 " "53 " "52 " "48 "
## [641] NA "27 " "55 " "70 " "58 " "54 " NA NA "52 " "62 "
## [651] "52 " "20 " NA "32 " "49 " "58 " NA "52 " "61 " "54 "
## [661] NA "46 " "46 " "57 " "18 " "59 " NA "53 " "59 " "20 "
## [671] "42 " "51 " "56 " "48 " "49 " "53 " "44 " "51 " "26 " "55 "
## [681] "56 " "54 " "48 " NA "53 " "57 " "47 " "48 " "54 " "53 "
## [691] "52 " "57 " "45 " NA "57 " "51 " "44 " "52 " "48 " "52 "
## [701] NA "56 " "51 " "49 " NA "48 " "33 " "57 " "52 " "56 "
## [711] "66 " "57 " "50 " "54 " "53 " "19 " "56 " "54 " "62 " "52 "
## [721] "57 " "54 " "55 " "53 " "54 " "53 " "47 " "48 " "58 " "58 "
## [731] "13 " "67 " NA "53 " "61 " "53 " "39 " "45 " "55 " "25 "
## [741] "57 " "30 " "56 " "54 " "58 " "52 " "52 " "52 " "31 " "50 "
## [751] "27 " "54 " "26 " "54 " "54 " "31 " "51 " "47 " "53 " NA
## [761] "54 " "48 " "54 " "50 " "67 " "54 " "56 " "63 " "44 " "56 "
## [771] "52 " "49 " "55 " "52 " "60 " "53 " "30 " "54 " "48 " "58 "
## [781] "55 " NA "50 " "51 " NA "26 " "53 " "54 " NA "37 "
## [791] NA "50 " "51 " "56 " "44 " "35 " "50 " "54 " "56 " "47 "
## [801] "60 " "55 " "59 " "55 " "57 " "50 " "58 " "43 " "44 " "29 "
## [811] "50 " "59 " "58 " "61 " "39 " "49 " "62 " "60 " "49 " "57 "

```

##	[821]	NA	"54 "	"54 "	NA	NA	"58 "	"58 "	NA	"47 "	"30 "
##	[831]	"34 "	NA	"15 "	NA	"52 "	NA	"28 "	"29 "	"33 "	"55 "
##	[841]	"28 "	"56 "	"60 "	"53 "	"54 "	"53 "	"57 "	NA	"56 "	"45 "
##	[851]	"54 "	"57 "	"54 "	"32 "	"55 "	"51 "	"16 "	"55 "	"46 "	"27 "
##	[861]	"46 "	"54 "	"48 "	"53 "	"35 "	"60 "	"51 "	"55 "	"66 "	"53 "
##	[871]	"60 "	"60 "	"53 "	"52 "	"56 "	"55 "	"27 "	"48 "	"55 "	"46 "
##	[881]	"57 "	"50 "	"52 "	"48 "	"34 "	"51 "	"47 "	"54 "	"48 "	"37 "
##	[891]	"67 "	"51 "	"42 "	"46 "	"56 "	NA	"54 "	"56 "	"55 "	"52 "
##	[901]	"51 "	"62 "	"42 "	"56 "	"46 "	"62 "	"50 "	"57 "	"29 "	"61 "
##	[911]	"48 "	"57 "	"28 "	"52 "	"50 "	"59 "	"36 "	"37 "	"56 "	"44 "
##	[921]	"34 "	NA	"59 "	"27 "	"51 "	"51 "	"60 "	"55 "	"51 "	"63 "
##	[931]	"64 "	"58 "	"65 "	"60 "	NA	"55 "	"46 "	"56 "	"56 "	"52 "
##	[941]	"45 "	"59 "	"66 "	"38 "	NA	"57 "	"50 "	"55 "	"50 "	"57 "
##	[951]	"59 "	"41 "	"48 "	"48 "	"67 "	"60 "	"63 "	"54 "	"41 "	"17 "
##	[961]	"67 "	"55 "	"32 "	"42 "	"44 "	"41 "	"38 "	"62 "	"51 "	"31 "
##	[971]	"34 "	"55 "	"53 "	"36 "	NA	"51 "	"51 "	"49 "	"56 "	"54 "
##	[981]	"50 "	"62 "	"58 "	"54 "	"52 "	"54 "	NA	"54 "	"64 "	"61 "
##	[991]	"50 "	"55 "	"66 "	"57 "	"53 "	"48 "	"44 "	"60 "	"51 "	"67 "
##	[1001]	NA	"35 "	"33 "	NA	"46 "	"42 "	"37 "	"45 "	"46 "	"50 "
##	[1011]	"42 "	"37 "	"50 "	"52 "	NA	"31 "	"50 "	"51 "	"49 "	"48 "
##	[1021]	"48 "	NA	"56 "	"48 "	NA	"39 "	"53 "	"49 "	"51 "	"31 "
##	[1031]	"47 "	"51 "	"54 "	NA	"52 "	"55 "	"56 "	"70 "	"27 "	"61 "
##	[1041]	"58 "	"55 "	"48 "	NA	"53 "	NA	NA	"52 "	"58 "	"52 "
##	[1051]	"46 "	"58 "	"32 "	NA	NA	"54 "	"62 "	"20 "	NA	"52 "
##	[1061]	"49 "	"20 "	"54 "	"42 "	"53 "	"51 "	"44 "	"46 "	"59 "	"55 "
##	[1071]	"26 "	"52 "	"18 "	"57 "	"48 "	"54 "	"59 "	"48 "	"56 "	"51 "
##	[1081]	"53 "	"54 "	"56 "	"54 "	"51 "	"53 "	"57 "	"58 "	"33 "	"48 "
##	[1091]	"52 "	"44 "	"56 "	"53 "	"52 "	NA	"49 "	"48 "	"45 "	"56 "
##	[1101]	"52 "	"66 "	NA	"57 "	"51 "	"62 "	"52 "	"19 "	"57 "	"48 "
##	[1111]	"53 "	"55 "	"57 "	"50 "	"52 "	NA	"52 "	"47 "	"30 "	"27 "
##	[1121]	"57 "	"56 "	"54 "	"57 "	NA	"61 "	"13 "	"47 "	"53 "	"54 "
##	[1131]	"31 "	"57 "	"58 "	"53 "	NA	"49 "	"54 "	"53 "	"52 "	"54 "
##	[1141]	"26 "	"58 "	"48 "	"39 "	"45 "	"31 "	"56 "	"50 "	"53 "	"51 "
##	[1151]	"54 "	"25 "	"67 "	"52 "	"54 "	"26 "	NA	"49 "	"54 "	"54 "
##	[1161]	"47 "	"53 "	NA	"52 "	"54 "	"55 "	"59 "	"56 "	"54 "	"50 "
##	[1171]	"52 "	"37 "	"67 "	"54 "	"53 "	"56 "	"58 "	"47 "	"54 "	"63 "
##	[1181]	"50 "	"51 "	"30 "	"55 "	"44 "	"50 "	"50 "	NA	"60 "	"54 "
##	[1191]	"44 "	NA	"55 "	"53 "	"28 "	"56 "	"55 "	"60 "	"34 "	"50 "
##	[1201]	"50 "	NA	"55 "	"57 "	"51 "	"50 "	"60 "	"34 "	NA	NA
##	[1211]	"44 "	"29 "	"61 "	"39 "	"35 "	"35 "	"47 "	"48 "	"60 "	"53 "
##	[1221]	NA	"54 "	NA	"58 "	"51 "	"58 "	"56 "	"54 "	"59 "	NA
##	[1231]	NA	"43 "	"46 "	"58 "	NA	"55 "	"28 "	"49 "	"56 "	"62 "
##	[1241]	"54 "	"49 "	"53 "	"54 "	"60 "	"53 "	"57 "	"48 "	"56 "	"56 "
##	[1251]	"62 "	"45 "	"54 "	"57 "	"27 "	"46 "	"55 "	"51 "	"50 "	"51 "
##	[1261]	"46 "	"27 "	"33 "	"46 "	"54 "	"27 "	"67 "	"42 "	"60 "	"55 "
##	[1271]	"66 "	"46 "	"56 "	"56 "	"55 "	"44 "	"55 "	"47 "	"30 "	"52 "
##	[1281]	"57 "	"52 "	"55 "	"52 "	"34 "	"54 "	"51 "	"55 "	"53 "	"46 "
##	[1291]	"56 "	"58 "	"57 "	NA	"60 "	"54 "	NA	"52 "	"50 "	"55 "
##	[1301]	"42 "	"59 "	"48 "	"32 "	"48 "	"56 "	"55 "	"46 "	"57 "	"50 "
##	[1311]	"60 "	"48 "	"41 "	"29 "	"61 "	"50 "	"55 "	"42 "	"28 "	"44 "
##	[1321]	"52 "	"59 "	"36 "	"37 "	"56 "	"47 "	"59 "	"37 "	"48 "	"51 "
##	[1331]	"53 "	"60 "	"51 "	"51 "	"63 "	"64 "	"54 "	"50 "	"54 "	"55 "
##	[1341]	"53 "	"56 "	"52 "	"64 "	"59 "	"66 "	"53 "	"38 "	NA	"57 "
##	[1351]	"67 "	"50 "	"57 "	"31 "	"41 "	"67 "	"62 "	"53 "	"54 "	NA

```

## [1361] "18 " "13 " "15 " "17 " "48 " "57 " NA "41 " "52 " "38 "
## [1371] "31 " "34 " "55 " NA "36 " "48 " "57 " "51 " "44 " "51 "
## [1381] "60 " "65 " "49 " "56 " "59 " "65 " "60 " "62 " "46 " "52 "
## [1391] "52 " NA "54 " "45 " "61 " "61 " "55 " "66 " "57 " "60 "
## [1401] "51 " NA "33 " NA "46 " "42 " "46 " "37 " "45 " "50 "
## [1411] "37 " "50 " "42 " "52 " "31 " NA "50 " "51 " "48 " "49 "
## [1421] "48 " NA "48 " "56 " NA "39 " "49 " "53 " "31 " "51 "
## [1431] "62 " "47 " "51 " "54 " "55 " NA "27 " "58 " "52 " "55 "
## [1441] "56 " "61 " "48 " NA "53 " "70 " "52 " "52 " "58 " NA
## [1451] "32 " NA NA "20 " "52 " NA "54 " "54 " "58 " "46 "
## [1461] NA "57 " "48 " "18 " "28 " "59 " "53 " "20 " "51 " "49 "
## [1471] "44 " "55 " "26 " "48 " "56 " "53 " "54 " "52 " "53 " "46 "
## [1481] "59 " NA "58 " "51 " "54 " "56 " "44 " "52 " "44 " "54 "
## [1491] "52 " "57 " "49 " "51 " "56 " "53 " "57 " "52 " "45 " "62 "
## [1501] "33 " "57 " "56 " "42 " "48 " "66 " "48 " "57 " "52 " "61 "
## [1511] "53 " "47 " "56 " "54 " "57 " "58 " NA "48 " "52 " "57 "
## [1521] NA NA "27 " "49 " "50 " "55 " "53 " "54 " "30 " "54 "
## [1531] "53 " "52 " "52 " "54 " "48 " "53 " "42 " NA "56 " "57 "
## [1541] "50 " "58 " "26 " "47 " "13 " "19 " "51 " "58 " "55 " "39 "
## [1551] "54 " "53 " "51 " "47 " "54 " "54 " "39 " "31 " "31 " "52 "
## [1561] "50 " "67 " "49 " "45 " "52 " "48 " "34 " "26 " "59 " "25 "
## [1571] "50 " "56 " "54 " "54 " "53 " "56 " "54 " "52 " "55 " NA
## [1581] "54 " "63 " "56 " "50 " "39 " "67 " "50 " NA "53 " "50 "
## [1591] NA "60 " "47 " "51 " "50 " "44 " "55 " "43 " "61 " "58 "
## [1601] "54 " "34 " "56 " NA "57 " "60 " "55 " "51 " NA "50 "
## [1611] "35 " "47 " "62 " "60 " "60 " "53 " "54 " "55 " NA "58 "
## [1621] "48 " "44 " "56 " "37 " "54 " "51 " "54 " NA "59 " "55 "
## [1631] "46 " "47 " "55 " NA "28 " "29 " "30 " "55 " "51 " NA
## [1641] "35 " NA "53 " NA "53 " "54 " "60 " "53 " "54 " "57 "
## [1651] "27 " "59 " "32 " "24 " "50 " "46 " "33 " "56 " "58 " "54 "
## [1661] "67 " "28 " "50 " NA "66 " "53 " NA "56 " "57 " "56 "
## [1671] "64 " NA "44 " "56 " "51 " "62 " "45 " "30 " "52 " "19 "
## [1681] "31 " "51 " "27 " "46 " "46 " "52 " "54 " "37 " "53 " "49 "
## [1691] "51 " "55 " "56 " "54 " "49 " "58 " "57 " "58 " "60 " "46 "
## [1701] "59 " "55 " "50 " "55 " "42 " "56 " "55 " "67 " "62 " "57 "
## [1711] "60 " "48 " "61 " NA "50 " "52 " "55 " "52 " "47 " "34 "
## [1721] NA "57 " "59 " "27 " "48 " "51 " "56 " "46 " "51 " "60 "
## [1731] "51 " "63 " "49 " "55 " "50 " "62 " NA "55 " "46 " "54 "
## [1741] "67 " NA "56 " "52 " "52 " "61 " "31 " "66 " "38 " "60 "
## [1751] "67 " "57 " "41 " "48 " "48 " NA "46 " "57 " "50 " "53 "
## [1761] "100 " "54 " NA "29 " "16 " "17 " "39 " "42 " "28 " "44 "
## [1771] "52 " "59 " "36 " "37 " "34 " "55 " "48 " "44 " "60 " "60 "
## [1781] "65 " "64 " "56 " "59 " "65 " "54 " "51 " "54 " "52 " "53 "
## [1791] "52 " "45 " "59 " "36 " "61 " NA "57 " "55 " "35 " "50 "
## [1801] "56 " NA "31 " "33 " "46 " "42 " "46 " "37 " NA "45 "
## [1811] "37 " "31 " "42 " "50 " "50 " "50 " "56 " NA "52 " "51 "
## [1821] "48 " NA "49 " "48 " "39 " NA "58 " "48 " "49 " "61 "
## [1831] "70 " "62 " "55 " "27 " "53 " "55 " "54 " "54 " "47 " "55 "
## [1841] "56 " "48 " "52 " "31 " NA NA "54 " "53 " "51 " "32 "
## [1851] "56 " NA "51 " NA "52 " "33 " "46 " "48 " "52 " "57 "
## [1861] "53 " NA "53 " NA "59 " "58 " "58 " "26 " "52 " "59 "
## [1871] "52 " "53 " "54 " "48 " "58 " "56 " "52 " "46 " "57 " "66 "
## [1881] "58 " "51 " "48 " "57 " "67 " "47 " "52 " NA "56 " "52 "
## [1891] NA "56 " "56 " NA "49 " "54 " "55 " "53 " "53 " "50 "

```



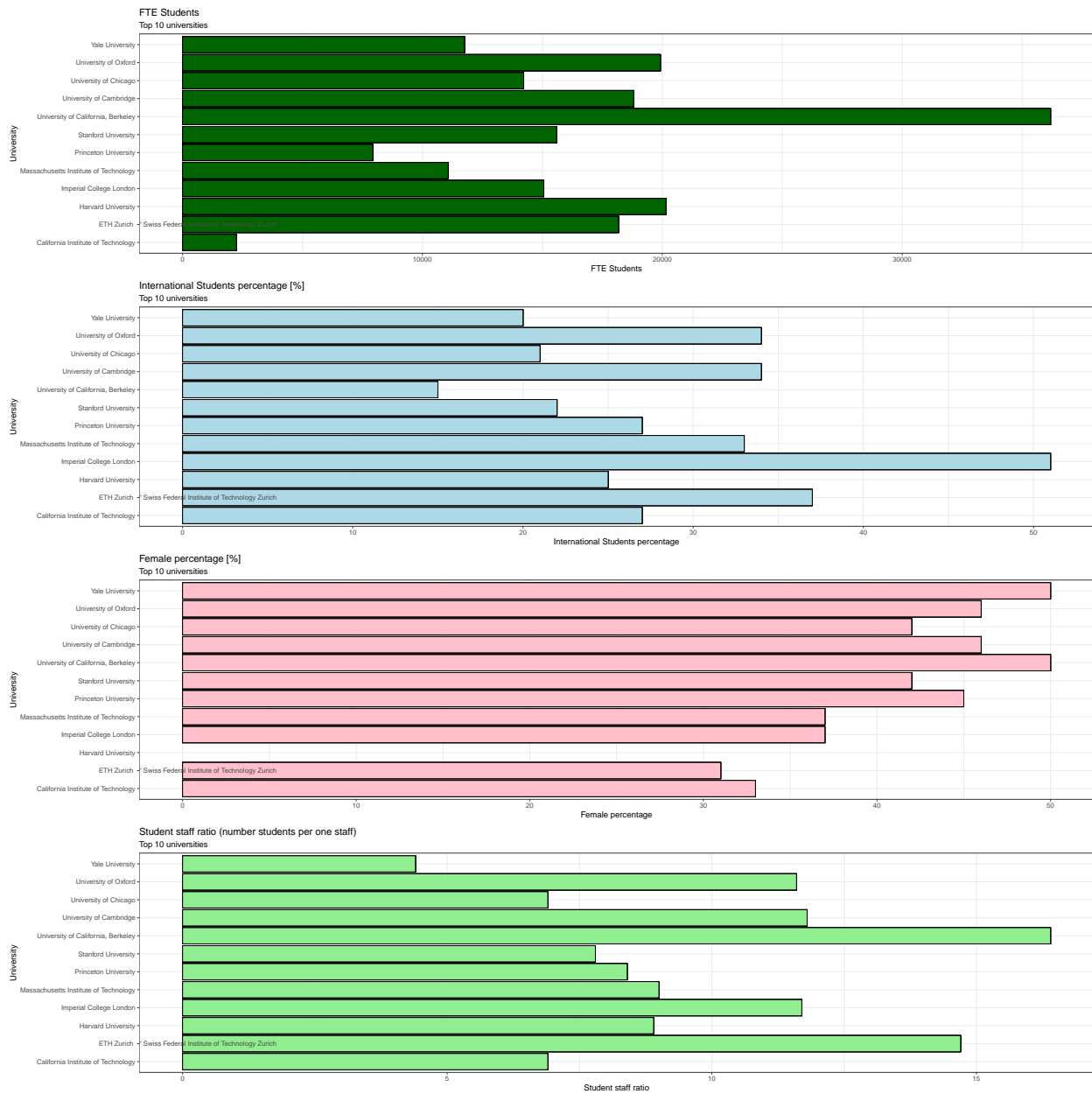
```

## [1901] "52 " "51 " "51 " "54 " "18 " "44 " "47 " "57 " "54 " "52 "
## [1911] "55 " "44 " "50 " "31 " "53 " "28 " "57 " "48 " "42 " "20 "
## [1921] "48 " "57 " "54 " "54 " "53 " "54 " "49 " "51 " "53 " "58 "
## [1931] "45 " "54 " "57 " "52 " "61 " NA "48 " "58 " NA "62 "
## [1941] "55 " "53 " "26 " "54 " "49 " "67 " "54 " "53 " NA "59 "
## [1951] "52 " "20 " "48 " "58 " "37 " "39 " "56 " "30 " "60 " "52 "
## [1961] "42 " "49 " "57 " "43 " "50 " "52 " "59 " "55 " "53 " "51 "
## [1971] "54 " "39 " "27 " "54 " "54 " "54 " "62 " "54 " "19 " NA
## [1981] "55 " "45 " NA "35 " "60 " "57 " "45 " "55 " "60 " "57 "
## [1991] NA "50 " "56 " "54 " "47 " "50 " "47 " "64 " "50 " "61 "
## [2001] "51 " "63 " "54 " "48 " "55 " "56 " "47 " "53 " "30 " "51 "
## [2011] "48 " "55 " "49 " "49 " "55 " "58 " "50 " "56 " "60 " NA
## [2021] "51 " "53 " "53 " "52 " "58 " NA "53 " NA "50 " "50 "
## [2031] "65 " "57 " "60 " "63 " "40 " "34 " "77 " "71 " "59 " NA
## [2041] NA "50 " "31 " "67 " "28 " "53 " NA "44 " "49 " "25 "
## [2051] "13 " "56 " "51 " "54 " "54 " "56 " "32 " "61 " "46 " "46 "
## [2061] "57 " "58 " "67 " "26 " "52 " "56 " "63 " "57 " NA "66 "
## [2071] "19 " "44 " "63 " "62 " "57 " "52 " NA "54 " "52 " "46 "
## [2081] "33 " "56 " "56 " "44 " "47 " "31 " "58 " "54 " "30 " "55 "
## [2091] "48 " "58 " "48 " "55 " "55 " "55 " "57 " NA "39 " "56 "
## [2101] "60 " "27 " "42 " "50 " "41 " "48 " "53 " "56 " "55 " "50 "
## [2111] "54 " "51 " "60 " "55 " "54 " "55 " "25 " "56 " "54 " "69 "
## [2121] "53 " "41 " "55 " "48 " "60 " "60 " "51 " "29 " NA "27 "
## [2131] "29 " "34 " "52 " "46 " "61 " "52 " "56 " "56 " "52 " "37 "
## [2141] "52 " "53 " "58 " "47 " "35 " "59 " "56 " "62 " "61 " "55 "
## [2151] "49 " NA "59 " NA "48 " "63 " "69 " "48 " "64 " "59 "
## [2161] "32 " "22 " "60 " NA "61 " "50 " "16 " "27 " "62 " "63 "
## [2171] "38 " "55 " "53 " "54 " "54 " "55 " "67 " NA "46 " "49 "
## [2181] "59 " "29 " "59 " "39 " "57 " "59 " "55 " "61 " "48 " "61 "
## [2191] "51 " "49 " "44 " "66 " "51 " "48 " "60 " "54 " "58 " "55 "
## [2201] "65 " "55 " "50 " "57 " "60 " NA "51 " "65 " "59 " "53 "
## [2211] "48 " "27 " "46 " "66 " "62 " "51 " NA "62 " "53 " "55 "
## [2221] "50 " "55 " "62 " "50 " "53 " "51 " NA "100 " "24 " "56 "
## [2231] "56 " "56 " "59 " "65 " "41 " "29 " "65 " "52 " "47 " "18 "
## [2241] "15 " "19 " "58 " "24 " "48 " "36 " "55 " "58 " NA "28 "
## [2251] "44 " "52 " "58 " "50 " "45 " "46 " "59 " "56 " "61 " "51 "
## [2261] "36 " "31 " "48 " "59 " "49 " "56 " "52 " "61 " "57 " "60 "
## [2271] "56 " "52 " "12 " NA "54 " "45 " "47 " "52 " "61 " "60 "
## [2281] "64 " "63 " "57 " "27 " "59 " "66 " "51 " "50 " "66 " "23 "
## [2291] "51 " "35 " "38 " NA "55 " "61 " "43 " "61 " "60 " "57 "
## [2301] "56 " NA "52 " "51 " "34 " "44 " "50 " "51 " "67 " "53 "
## [2311] "23 " "49 " "55 " "50 " "54 " "54 " "47 " "61 " "59 " "47 "
## [2321] "57 " "45 " "-" "57 " "63 " "61 " "54 " "56 " "65 " "29 "
## [2331] "54 " "36 " "34 " "14 " "13 " "17 " "39 " "34 " "30 " "36 "
## [2341] "50 " "32 " "58 " "-" NA "58 " "31 " "46 " "51 " "52 "
## [2351] "63 " "57 " NA "62 " "62 " "59 " "44 " "52 " "23 " "46 "
## [2361] "40 " "31 " "37 " "57 " "36 " "25 " "54 " "66 " "49 " "36 "
## [2371] "42 " "54 " "70 " "46 " "53 " "49 " "54 " "57 " "51 " "53 "
## [2381] "61 " NA "50 " "58 " "63 " "64 " "55 " "54 " "78 " "33 "
## [2391] "44 " "62 " "60 " NA "27 " "50 " "38 " "43 " "76 " "67 "
## [2401] "52 " "34 " "55 " "52 " "71 " "-" "33 " "53 " "46 " "63 "
## [2411] "17 " "48 " NA "78 " "36 " "50 " "52 " "53 " "47 " "58 "
## [2421] "47 " NA "69 " "60 " "22 " "53 " "52 " "58 " "70 " "32 "
## [2431] "47 " NA "58 " "70 " "56 " "57 " "53 " "42 " "43 " NA

```

```
## [2441] "19 " "37 " NA NA "45 " NA "41 " "59 " "41 " NA
## [2451] "46 " "54 " "47 " "33 " "57 " "50 " "34 " "41 " "39 " "21 "
## [2461] NA "46 " "47 " "55 " NA "50 " "48 " NA "70 " "53 "
## [2471] "36 " "34 " "59 " "39 " "41 " "35 " "60 " "53 " "56 " "54 "
## [2481] "43 " "45 " "51 " "36 " "45 " "44 " "67 " "46 " "67 " "55 "
## [2491] "52 " "32 " "56 " "62 " "42 " "53 " NA "33 " "47 " "37 "
## [2501] "42 " "11 " "68 " "41 " "54 " "60 " "46 " "53 " "59 " NA
## [2511] "62 " "36 " "40 " "57 " NA "39 " "25 " "30 " "62 " "43 "
## [2521] "27 " "37 " "55 " "25 " "55 " "60 " "40 " "50 " "38 " "36 "
## [2531] "55 " "60 " "69 " "46 " NA "36 " "1 " "50 " "45 " "69 "
## [2541] "74 " "46 " "34 " "33 " "51 " "39 " "52 " "25 " "36 " "43 "
## [2551] "36 " "52 " "48 " "48 " "53 " NA "57 " "48 " "65 " "31 "
## [2561] "43 " "53 " "65 " "56 " "63 " "55 " "65 " "50 " "50 " "58 "
## [2571] "58 " "45 " "32 " "45 " "54 " "46 " "27 " "34 " "34 " "20 "
## [2581] "60 " "34 " "9 " "62 " "63 " "61 " "65 " "48 " "53 " "51 "
## [2591] "65 " "34 " "35 " "52 " "53 " "62 " "57 " "29 " "48 " "36 "
## [2601] NA "28 " "43 "
```

```
timesData %>% filter(university_name %in% top10univ$university_name) %>%
ggplot(aes(x=university_name, y=as.numeric(as.character(gsub("%","",num_students))))),fill=year) + guides(
  geom_bar(stat="identity", fill="darkgreen", colour="black", position="dodge")+ theme_bw() + coord_flip()
labs(x="University", y="FTE Students",
      title="FTE Students", subtitle="Top 10 universities") -> d1
timesData %>% filter(university_name %in% top10univ$university_name) %>%
ggplot(aes(x=university_name, y=as.numeric(as.character(gsub("%","",international_students))))),fill=year) + guides(
  geom_bar(stat="identity", fill="lightblue", colour="black", position=position_dodge(0.2))+ theme_bw()
labs(x="University", y="International Students percentage",
      title="International Students percentage [%]", subtitle="Top 10 universities") -> d2
timesData %>% filter(university_name %in% top10univ$university_name) %>%
ggplot(aes(x=university_name, y=as.numeric(as.character(female_ratio))))),fill=year) + guides(fill=FALSE)
  geom_bar(stat="identity", fill="pink", colour="black", position=position_dodge(0.2))+ theme_bw() + coord_flip()
labs(x="University", y="Female percentage",
      title="Female percentage [%]", subtitle="Top 10 universities") -> d3
timesData %>% filter(university_name %in% top10univ$university_name) %>%
ggplot(aes(x=university_name, y=as.numeric(as.character(student_staff_ratio))))),fill=year) + guides(fill=FALSE)
  geom_bar(stat="identity", fill="lightgreen", colour="black", position=position_dodge(0.2))+ theme_bw()
labs(x="University", y="Student staff ratio",
      title="Student staff ratio (number students per one staff)", subtitle="Top 10 universities") -> d4
grid.arrange(d1,d2,d3,d4,ncol=1)
```



Additional metrics

#There are no Ukrainian universities in these rankings

```
cwurData %>% filter(country=="Poland") %>%
```

```
knitr::kable(caption="Center of World University Ranking information: Polish Universities presence")
```

Table 7: Center of World University Ranking information: Polish Universities presence

world_rank	institution	country	international_students	quality_of_education	employment	publications	research_income	board_members	papers	score	year	
419	University of Warsaw	Poland	1	119	478	145	400	488	363	402	637	45.452014


```
timesData %>% filter(country=="Ukraine") %>%
  knitr::kable(caption="Times New Education World University Ranking information: Ukrainian Universities")
```

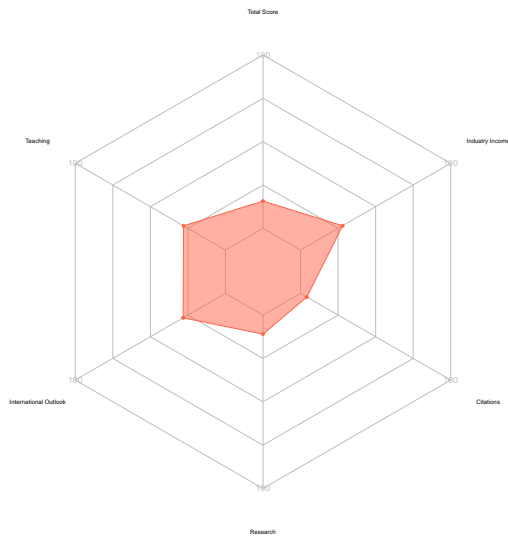
Table 8: Times New Education World University Ranking information: Ukrainian Universities presence

world_rank	university_name	country	teaching	international	research	citations	income	total_score	students	international_students	international_students_ratio	female_ratio
601-800	Taras Shevchenko National University of Kyiv	Ukraine	27.9	28.2	11.0	4.2	28.0	15.745	22,686	8.2	2%	45 : 55
601-800	V.N. Karazin Kharkiv National University	Ukraine	21.7	48.4	8.9	1.7	28.8	14.041	14,410	9.7	22%	53 : 47

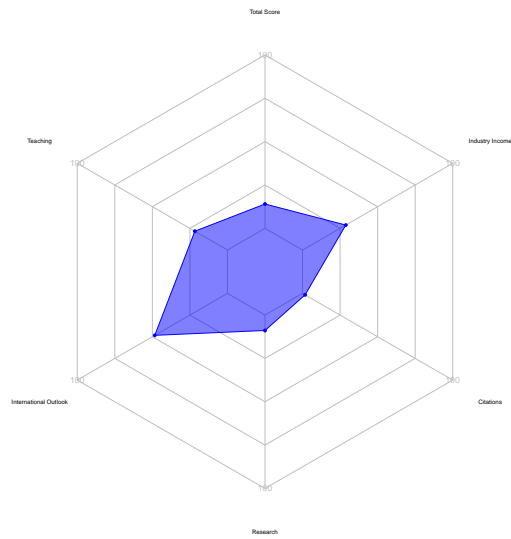
```
timesData %>% filter(country=="Ukraine") %>%
  select(year,university_name,total_score,teaching, international, research, citations, income) -> theUkData
timesData %>% group_by(year) %>%
  top_n(2, wt = total_score) %>%
  select(year,university_name,total_score,teaching, international, research, citations, income) %>% ungroup()
top2univ <- rbind(theUkData,top2univ)
theTop2SpiderWebYear <- function(nYear) {
  top2univ %>% filter(year==nYear) %>% ungroup() -> top2u
  top2 <- as.data.frame(cbind(top2u[,c(3,4,5,6,7,8)]))
  colnames(top2) <- c("Total Score", "Teaching", "International Outlook", "Research",
    "Citations","Industry Income")
  rownames(top2) <- top2u$university_name
  rmin <- apply(top2,2,min); rmax <- apply(top2,2,max)
  rmax <- 100
  rmin <- 0
  colors_border=c( "tomato", "blue", "gold", "green", "magenta",
    "yellow", "grey", "lightblue", "brown", "red", "lightgreen", "cyan" )
  par(mfrow=c(2,2))
  par(mar=c(1,1,5,1))
  for(i in 1:nrow(top2)){
    colorValue<-(col2rgb(as.character(colors_border[i])))%>% as.integer())/255
    radarchart(rbind(rmax,rmin,top2[i,]),
      axistype=2 ,
      pcol=rgb(colorValue[1],colorValue[2],colorValue[3], alpha = 1),
      pfcol=rgb(colorValue[1],colorValue[2],colorValue[3], alpha = 0.5),
      plwd=1 , plty=1,cglcol="grey", cglty=1, axislabcol="grey", cglwd=0.5,vlcex=0.7,
      title=rownames(top2[i,]))
  }
  title(paste0('\nTHE World University Rankings top 2 vs Ukrainian Univ. (',nYear,')'),outer=TRUE,col="black")
}
```

```
theTop2SpiderWebYear(2016)
```

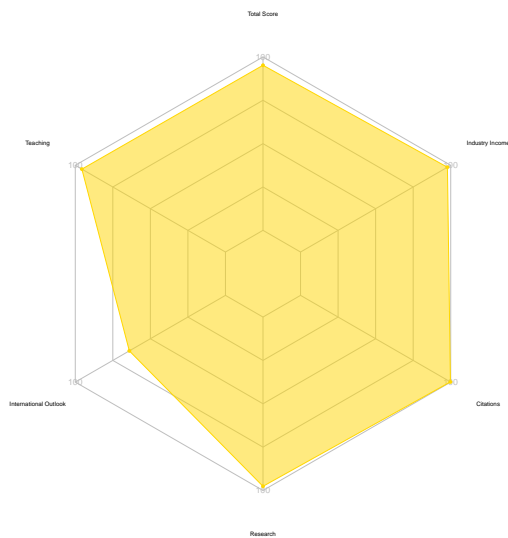
THE World University Rankings top 2 vs Ukrainian Univ. (2016)
Taras Shevchenko National University of Kyiv



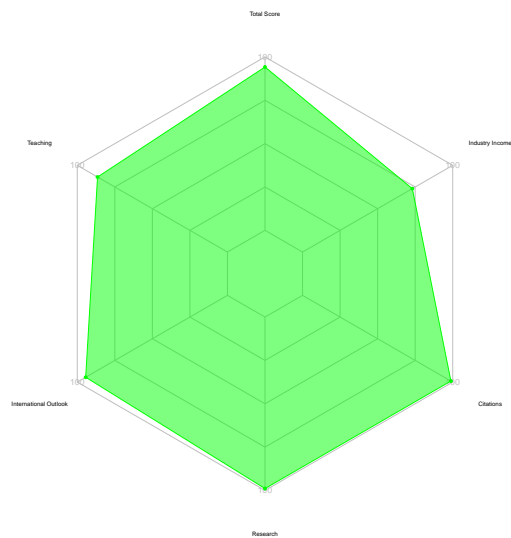
V.N. Karazin Kharkiv National University



California Institute of Technology



University of Oxford

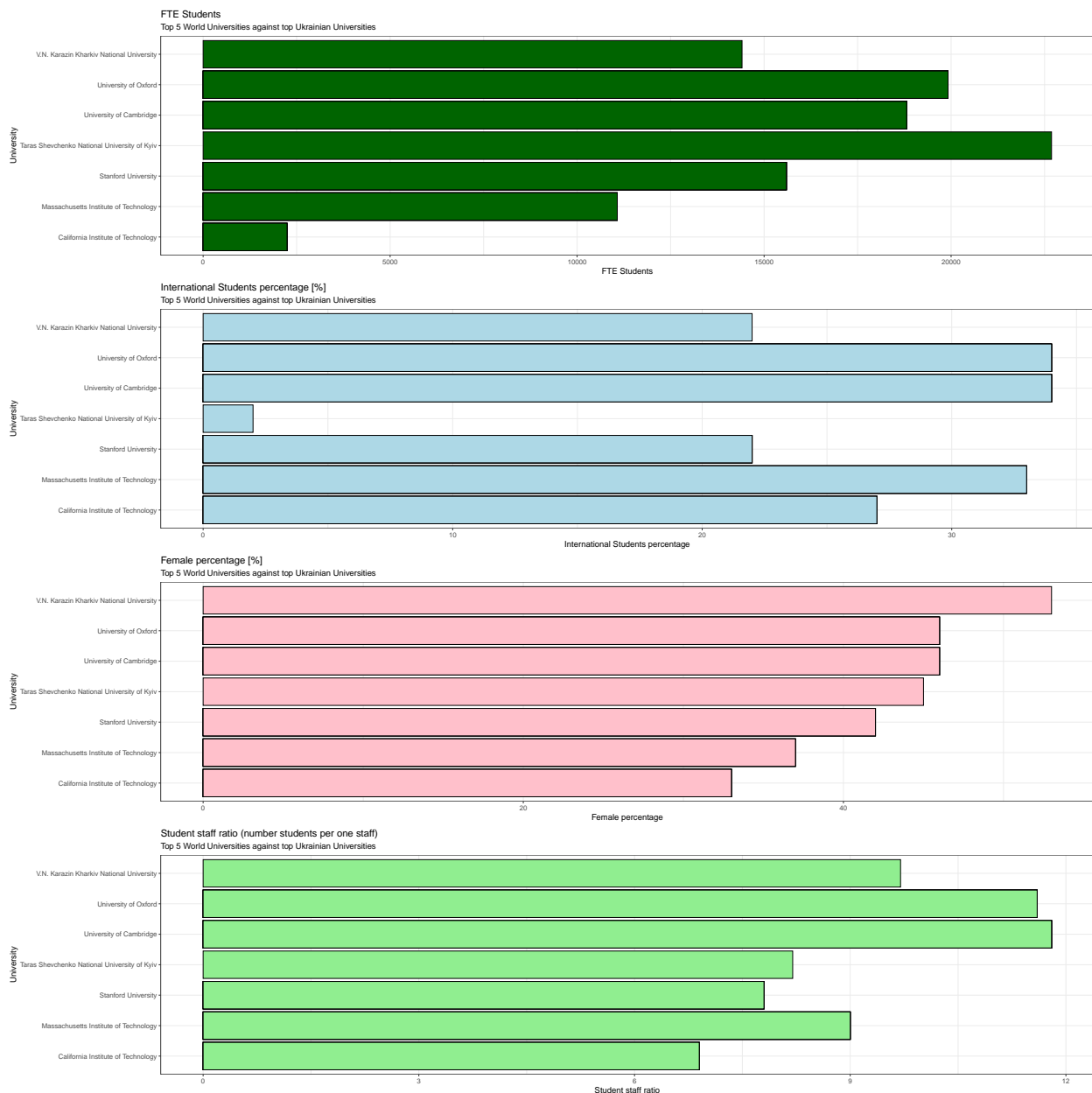


```
timesData %>% filter(country=="Ukraine") %>%
  select(university_name,num_students, international_students,female_ratio, student_staff_ratio) -> the
timesData %>% filter(year==2016) %>% top_n(5, wt = total_score) %>%
  select(university_name,num_students, international_students,female_ratio, student_staff_ratio) %>% un
top5univ <- rbind(theUkData,top5univ)
timesData %>% filter(university_name %in% top5univ$university_name) %>%
ggplot(aes(x=university_name, y=as.numeric(as.character(gsub(",","",num_students))))) ,fill=year) + guide
geom_bar(stat="identity", fill="darkgreen", colour="black", position="dodge")+ theme_bw() + coord_fli
labs(x="University", y="FTE Students",
      title="FTE Students", subtitle="Top 5 World Universities against top Ukrainian Universities") -> c
timesData %>% filter(university_name %in% top5univ$university_name) %>%
ggplot(aes(x=university_name, y=as.numeric(as.character(gsub("%","",international_students))))) ,fill=year
geom_bar(stat="identity", fill="lightblue", colour="black", position=position_dodge(0.2))+ theme_bw()
labs(x="University", y="International Students percentage",
```

```

    title="International Students percentage [%]", subtitle="Top 5 World Universities against top Ukr
timesData %>% filter(university_name %in% top5univ$university_name) %>%
ggplot(aes(x=university_name, y=as.numeric(as.character(female_ratio))),fill=year) + guides(fill=FALSE)
geom_bar(stat="identity", fill="pink", colour="black", position=position_dodge(0.2))+ theme_bw() + co
labs(x="University", y="Female percentage",
    title="Female percentage [%]", subtitle="Top 5 World Universities against top Ukrainian Universit
timesData %>% filter(university_name %in% top5univ$university_name) %>%
ggplot(aes(x=university_name, y=as.numeric(as.character(student_staff_ratio))),fill=year) + guides(fill
geom_bar(stat="identity", fill="lightgreen", colour="black", position=position_dodge(0.2))+ theme_bw(
labs(x="University", y="Student staff ratio",
    title="Student staff ratio (number students per one staff)", subtitle="Top 5 World Universities aga
grid.arrange(d1,d2,d3,d4,ncol=1)

```



```

timesData %>% filter(country %in% c("Ukraine", "Bulgaria", "Poland", "Slovakia", "Slovenia")) %>%
  select(year, university_name, total_score, teaching, international, research, citations, income) -> theE
theEESpiderWebYear <- function(nYear) {
  theEEData %>% filter(year==nYear) %>% ungroup() -> top5u
  top5 <- as.data.frame(cbind(top5u[,c(3,4,5,6,7,8)]))
  colnames(top5) <- c("Total Score", "Teaching", "International Outlook", "Research",
    "Citations", "Industry Income")
  rownames(top5) <- top5u$university_name
  rmin <- apply(top5, 2, min); rmax <- apply(top5, 2, max)
  rmax <- 100
  rmin <- 0
  colors_border=c( "tomato", "blue", "gold", "green", "magenta",
    "yellow", "grey", "lightblue", "brown", "red",
    "lightgreen", "cyan", "tomato", "blue", "gold" )
  par(mfrow=c(5,3))
  par(mar=c(1,1,5,1))
  for(i in 1:nrow(top5)){
    colorValue<-(col2rgb(as.character(colors_border[i])))%>% as.integer())/255
    radarchart(rbind(rmax,rmin,top5[i,]),
      axistype=2 ,
      pcol=rgb(colorValue[1],colorValue[2],colorValue[3], alpha = 1),
      pfcol=rgb(colorValue[1],colorValue[2],colorValue[3], alpha = 0.5),
      plwd=1 , plty=1,cglcol="grey", cglty=1, axislabcol="grey", cglwd=0.5,vlcex=0.7,
      title=rownames(top5[i,]))
  }
  title(paste0('\nTHE World University Rankings Former Communist Countries (',nYear,')'),outer=TRUE,c
}

```

```
theEESpiderWebYear(2016)
```

```
## Warning in title(...): 0xc5
```

```
## Warning in title(...): 0xc6
```


THE World University Rankings Former Communist Countries (2016)

