In [161]:

```
from functools import reduce
import pandas as pd
import calendar
import seaborn as sns
sns.set_style('whitegrid')
import matplotlib.pyplot as plt
plt.close('all')
```

In [162]:

```
# I analyze some dataset about the COVID pandemic.
# I want to understand if the trend of cases/deaths has been impacted by different g
overnment measures.
# Particularly if the different time when they have been implemented had an impact o
n the trend in the different countries.
# I used three different dataset: 1- Measures governement dataset provided by ACAPS;
2- Time series of confirmed cases provided
# by CSSE (John Hopkins); 3- Time series of deaths provided by CSSE (John Hopkins)

# loading the 3 files in dataframe

measures = pd.read_csv('C:\\Users\\Romina\\Desktop\\DBSCourse\\ProgrammingBigData\\C
A4\\acaps_covid19_government_measures_dataset.csv', sep = ';', encoding = 'latin1')
cases = pd.read_csv('C:\\Users\\Romina\\Desktop\\DBSCourse\\ProgrammingBigData\\CA4
\\time_series_covid19_confirmed_global.csv')
deaths = pd.read_csv('C:\\Users\\Romina\\Desktop\\DBSCourse\\ProgrammingBigData\\CA4
\\time_series_covid19_deaths_global.csv')
```

In [163]:

```
# Let's have a look at the measures dataset
measures.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 11200 entries, 0 to 11199
Data columns (total 17 columns):
 #   Column              Non-Null Count  Dtype  
---  ------              --------------  -----  
 0   ID                  11200 non-null  int64  
 1   COUNTRY             11200 non-null  object 
 2   ISO                 11200 non-null  object 
 3   ADMIN_LEVEL_NAME    1192 non-null   object 
 4   PCODE               0 non-null      float64
 5   REGION              11200 non-null  object 
 6   LOG_TYPE            11200 non-null  object 
 7   CATEGORY            11200 non-null  object 
 8   MEASURE             11200 non-null  object 
 9   TARGETED_POP_GROUP  11200 non-null  object 
 10  COMMENTS            11056 non-null  object 
 11  NON_COMPLIANCE      9969 non-null   object 
 12  DATE_IMPLEMENTED    10924 non-null  object 
 13  SOURCE              11181 non-null  object 
 14  SOURCE_TYPE         11187 non-null  object 
 15  LINK                11169 non-null  object 
 16  ENTRY_DATE          11200 non-null  object 
dtypes: float64(1), int64(1), object(15)
memory usage: 1.5+ MB
```

In [164]:

```
# In the dataset there are two different types of measures (attribute LOG_TYPE): 1- 'Introduction/extensions of measures' ,
# 2- Phase-out measures. I decided to analyze the first type because they are that ones implemented to stop/slow the spread

measures = measures[measures['LOG_TYPE'].isin(['Introduction / extension of measures'])]

# The measures falls in 6 different categories (attribute CATEGORY)
measures.CATEGORY.unique()
```

Out[164]:

```
array(['Public health measures', 'Governance and socio-economic measures',
       'Social distancing', 'Movement restrictions', 'Lockdown',
       'Humanitarian exemption'], dtype=object)
```

In [165]:

```
# In the dataframe information I see that some rows have the 'Date Implemented' attribute empty (10924 non-null over 11200 total rows)
# I decided to filter out the rows with empty Date_implemented because this attribute is strategic for my analysis

measures = measures.dropna(axis=0, subset=['DATE_IMPLEMENTED'])
```

In [166]:

```
# I isolate the attribute I'm interested in (country, region, date implementation, measure category)

measures_by_country = measures.filter(['COUNTRY','REGION','CATEGORY','DATE_IMPLEMENTED'], axis=1)
measures_by_country.head(5)
```

Out[166]:

	COUNTRY	REGION	CATEGORY	DATE_IMPLEMENTED
0	Afghanistan	Asia	Public health measures	12/02/2020
1	Afghanistan	Asia	Public health measures	12/02/2020
2	Afghanistan	Asia	Public health measures	12/02/2020
3	Afghanistan	Asia	Governance and socio-economic measures	12/02/2020
4	Afghanistan	Asia	Social distancing	12/03/2020

In [167]:

```
# I calculate the measures frequency for each category, country and date_implemented
measures_by_country = measures_by_country.groupby(['COUNTRY','REGION','DATE_IMPLEMENTED','CATEGORY']).size().unstack(fill_value=0)
```

In [168]:

```
measures_by_country.head(5)
```

Out[168]:

		CATEGORY	Governance and socio-economic measures	Humanitarian exemption	Lockdown	Movement restrictions
COUNTRY	**REGION**	**DATE_IMPLEMENTED**				
Afghanistan	**Asia**	**01/02/2020**	0	0	0	1
		01/03/2020	1	0	0	1
		01/04/2020	0	0	0	1
		02/02/2020	0	0	0	0
		02/03/2020	0	0	0	0

In [169]:

```
# I rename some columns and reset the index of dataframe

measures_by_country = measures_by_country.reset_index().rename_axis(None, axis=1)
measures_by_country = measures_by_country.rename(str.lower, axis='columns')
measures_by_country = measures_by_country.rename(columns={"date_implemented": "date"})
```

In [170]:

```
# Let's have a look at the cases and deaths dataframe

cases.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 266 entries, 0 to 265
Columns: 129 entries, Province/State to 5/25/20
dtypes: float64(2), int64(125), object(2)
memory usage: 268.2+ KB
```

In [171]:

```
deaths.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 266 entries, 0 to 265
Columns: 129 entries, Province/State to 5/25/20
dtypes: float64(2), int64(125), object(2)
memory usage: 268.2+ KB
```

In [172]:

```
cases.head(5)
```

Out[172]:

	Province/State	Country/Region	Lat	Long	1/22/20	1/23/20	1/24/20	1/25/20	1/26/20
0	NaN	Afghanistan	33.0000	65.0000	0	0	0	0	0
1	NaN	Albania	41.1533	20.1683	0	0	0	0	0
2	NaN	Algeria	28.0339	1.6596	0	0	0	0	0
3	NaN	Andorra	42.5063	1.5218	0	0	0	0	0
4	NaN	Angola	-11.2027	17.8739	0	0	0	0	0

5 rows × 129 columns

In [173]:

```
deaths.head(5)
```

Out[173]:

	Province/State	Country/Region	Lat	Long	1/22/20	1/23/20	1/24/20	1/25/20	1/26/20
0	NaN	Afghanistan	33.0000	65.0000	0	0	0	0	0
1	NaN	Albania	41.1533	20.1683	0	0	0	0	0
2	NaN	Algeria	28.0339	1.6596	0	0	0	0	0
3	NaN	Andorra	42.5063	1.5218	0	0	0	0	0
4	NaN	Angola	-11.2027	17.8739	0	0	0	0	0

5 rows × 129 columns

In [174]:

```
# The dataframes are series with cumulative data organized in the columns. Each row
 represents a different country
# The attribute Province/State is used for the overseas territorial collectivity tha
t belong to the Country.
# As I'm interested in the data for the main country, I filter out this Province/Sta
te

cases = cases[cases['Province/State'].isnull()]
deaths = deaths[deaths['Province/State'].isnull()]
```

In [175]:

```
# I remove the unenecessary columns

cases = cases.drop(['Province/State', 'Lat','Long'], axis=1)
deaths =  deaths.drop(['Province/State', 'Lat','Long'], axis=1)
```

In [176]:

```
# Before joining the three dataframe , I reshape the Cases and Death dataframe in or
der to trasform the date and the figures
# as rows details
# Reshaping for the dataframe cases. I remove the dates with 0 cases/deaths

cases_n = (cases.set_index(["Country/Region"])
         .stack()
         .reset_index(name='Cases')
         .rename(columns={'level_1':'date'}))

cases_n = cases_n[cases_n['Cases'] > 0]

cases_n.head(5)
```

Out[176]:

	Country/Region	date	Cases
33	Afghanistan	2/24/20	1
34	Afghanistan	2/25/20	1
35	Afghanistan	2/26/20	1
36	Afghanistan	2/27/20	1
37	Afghanistan	2/28/20	1

In [177]:

```
# Reshaping for the dataframe deaths

deaths_n = (deaths.set_index(["Country/Region"])
         .stack()
         .reset_index(name='Deaths')
         .rename(columns={'level_1':'date'}))

deaths_n = deaths_n[deaths_n['Deaths'] > 0]

deaths_n.head(5)
```

Out[177]:

	Country/Region	date	Deaths
60	Afghanistan	3/22/20	1
61	Afghanistan	3/23/20	1
62	Afghanistan	3/24/20	1
63	Afghanistan	3/25/20	2
64	Afghanistan	3/26/20	4

In [178]:

```
# The date attribute has a different format (m/d/yy) of the date attribute of measur
es_by_country (dd/mm/yyyy) dataframe
# I rename the column Country/Region before the join

cases_n['date'] = pd.to_datetime(cases_n['date']).dt.strftime('%d/%m/%Y')
cases_n = cases_n.rename(columns={"Country/Region": "country"})
```

In [179]:

```
deaths_n['date'] = pd.to_datetime(deaths_n['date']).dt.strftime('%d/%m/%Y')
deaths_n = deaths_n.rename(columns={"Country/Region": "country"})
```

In [180]:

```
# I join the three dataframe with a right inner join because the date field. The dea
ths and cases dataframe contains daily information
# The measures datframe is based on measure date implementation. If at least one mea
sure is not implemented for each day,
# some dates cannot be available for each country. In order to avoid loosing data fo
r deaths and cases dataframe the right join
# has been implemented

dfs = [measures_by_country, cases_n, deaths_n]

data = reduce(lambda left,right: pd.merge(left,right, how = 'right', on=['country',
'date']), dfs)
```

In [181]:

```
# Let's have a look at the new dataframe

data.head(5)
```

Out[181]:

	country	region	date	governance and socio-economic measures	humanitarian exemption	lockdown	movement restrictions	publi healt measure
0	Afghanistan	Asia	01/04/2020	0.0	0.0	0.0	1.0	0.
1	Afghanistan	Asia	02/04/2020	0.0	0.0	0.0	0.0	1.
2	Afghanistan	Asia	03/04/2020	0.0	0.0	0.0	0.0	1.
3	Afghanistan	Asia	07/04/2020	0.0	0.0	0.0	0.0	1.
4	Afghanistan	Asia	12/05/2020	0.0	0.0	0.0	0.0	1.

In [182]:

```
# I want to analyze data for the European countries and I remove the redundant colum
n Region

data = data[data['region'].isin(['Europe'])]

data =  data.drop(['region'], axis=1)
```

In [183]:

```
# I add a new column with the total of measures for each country and date
col_list= list(data)

col_list.remove('Cases')
col_list.remove('Deaths')


data['measures_tot'] = data[col_list].sum(axis=1)
```

In [184]:

```
# I add a column with the month extracted from date attribute (I will use the month
 in the plots)

data['date'] = pd.to_datetime(data['date'], format= '%d/%m/%Y')
data['month_date'] = pd.DatetimeIndex(data['date']).month

data['month_date'] = data['month_date'].apply(lambda x: calendar.month_abbr[x])
```

In [185]:

```
data.head(5)
```

Out[185]:

	country	date	governance and socio-economic measures	humanitarian exemption	lockdown	movement restrictions	public health measures	social distancing	
10	Albania	2020-04-02	1.0	0.0	1.0	0.0	0.0	0.0	
11	Albania	2020-03-11	1.0	0.0	0.0	0.0	1.0	0.0	
12	Albania	2020-03-12	1.0	0.0	0.0	0.0	0.0	0.0	
13	Albania	2020-03-13	0.0	0.0	0.0	1.0	0.0	0.0	
14	Albania	2020-04-13	0.0	0.0	1.0	3.0	0.0	0.0	

In [186]:

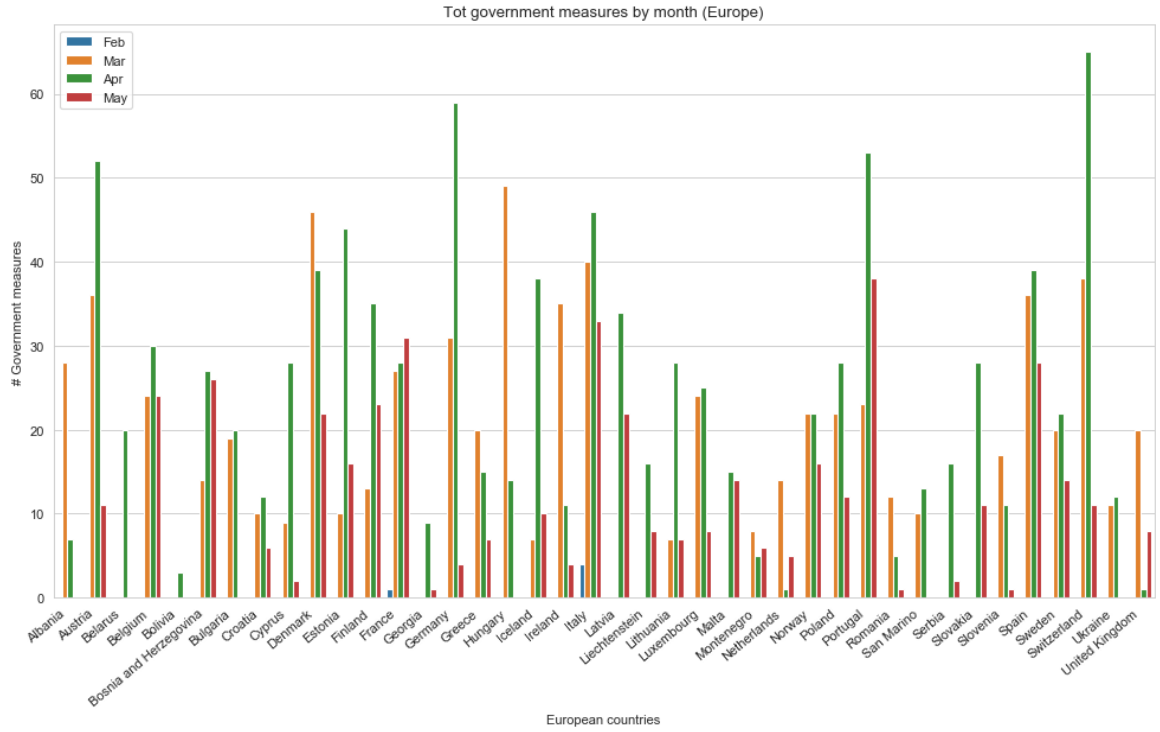
```
# I want to plot the # of measures implemented by each countries in the different months
# I make a new dataframe in which the deaths, cases and measures are aggregated by country and month
# As the deaths and cases are cumulated on month base, I decide to take the max value for each month

data_country_month = data.groupby(['country', 'month_date']).agg({'Deaths':'max','Cases' : 'max', 'measures_tot' : 'sum'})
data_country_month = data_country_month.reset_index()
data_country_month.head(5)
```

Out[186]:

	country	month_date	Deaths	Cases	measures_tot
0	Albania	Apr	31	773	7.0
1	Albania	Mar	11	223	28.0
2	Austria	Apr	584	15452	52.0
3	Austria	Mar	128	10180	36.0
4	Austria	May	628	16109	11.0

In [187]:

```
plt.figure(figsize=(15,8), dpi= 80)
bx = sns.barplot(x='country', y='measures_tot', hue = 'month_date', data=data_countr
y_month, hue_order = ['Feb','Mar','Apr','May'])
bx.set_xticklabels(bx.get_xticklabels(), rotation=40, ha="right")
plt.xlabel("European countries")
plt.ylabel("# Government measures")
plt.legend(loc='upper left')
plt.title("Tot government measures by month (Europe)")
plt.show(bx)
```



In [188]:

```
# There are some countries with peaks in April (switzerland, Portugal, Germany),
# some other instead with peak of measures on March (Denmark, Hungary, Italy)
# I want to analyze a subset of countries. I decided to isolate the top 10 countries
by measures (the top 10 countries for
# the total of measures implemented)

# the dataframe below contains the total measures for each country
measures_by_country = data.groupby(['country']).agg({'measures_tot' : 'sum'})
measures_by_country = measures_by_country.reset_index()

# I create a new dataframe with the top 10 countries
top10_countries = measures_by_country.sort_values('measures_tot', ascending = False)
.head(10)

# I cretae a new dataframe with the granularity of original 'data' dataframe contain
ing only the top 10 countries
data_top10country_month = data_country_month[data_country_month['country'].isin(top1
0_countries['country'])]
```

In [189]:

```
# I want to plot the #measures, deaths and cases for the top 10 countries
# To plot the deaths and cases as trend lines I create two new subset and reshape th
em ( bring the countries as columns)

top10_deaths = data_top10country_month.filter(['month_date','country', 'Deaths'])
top10_deaths = pd.pivot_table(top10_deaths, values = 'Deaths', index = 'month_date',
columns = 'country').reset_index()
top10_deaths.head(5)
```

Out[189]:

country	month_date	Austria	Belgium	Denmark	Finland	France	Germany	Italy	Portuga
0	Apr	584.0	7331.0	427.0	206.0	23629.0	6623.0	27967.0	854.
1	Feb	NaN	NaN	NaN	NaN	2.0	NaN	10.0	Nal
2	Mar	128.0	705.0	90.0	17.0	3523.0	645.0	12428.0	119.
3	May	628.0	9080.0	537.0	293.0	27485.0	7897.0	32007.0	1231.

In [190]:

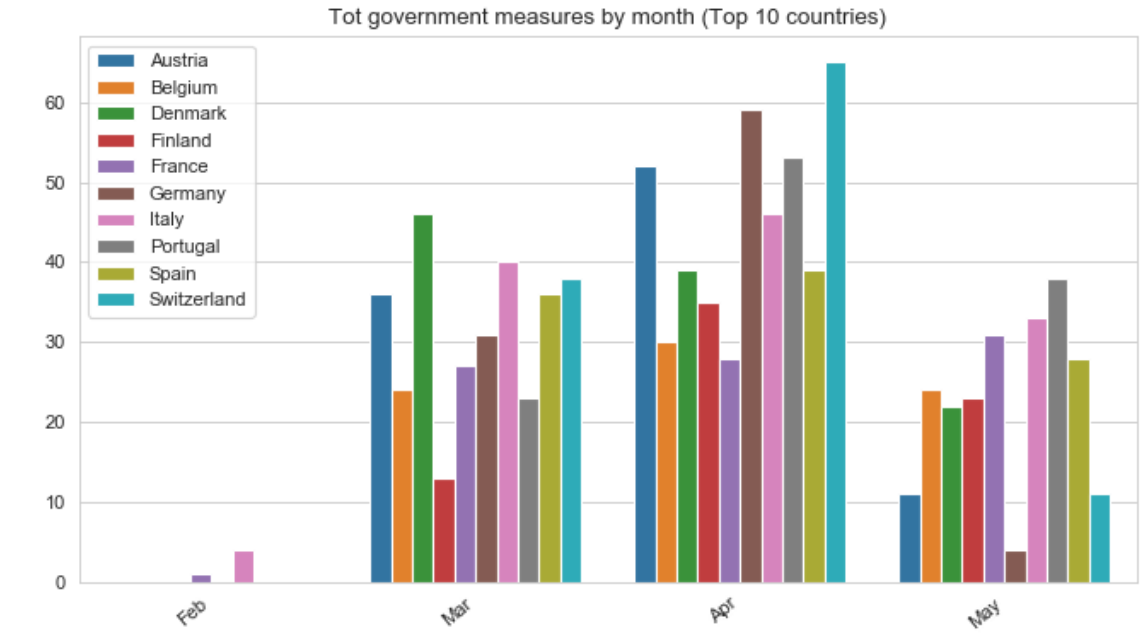
```
top10_cases = data_top10country_month.filter(['month_date','country','Cases'])
top10_cases = pd.pivot_table(top10_cases, values = 'Cases', index = 'month_date', co
lumns = 'country').reset_index()
top10_cases.head(5)
```

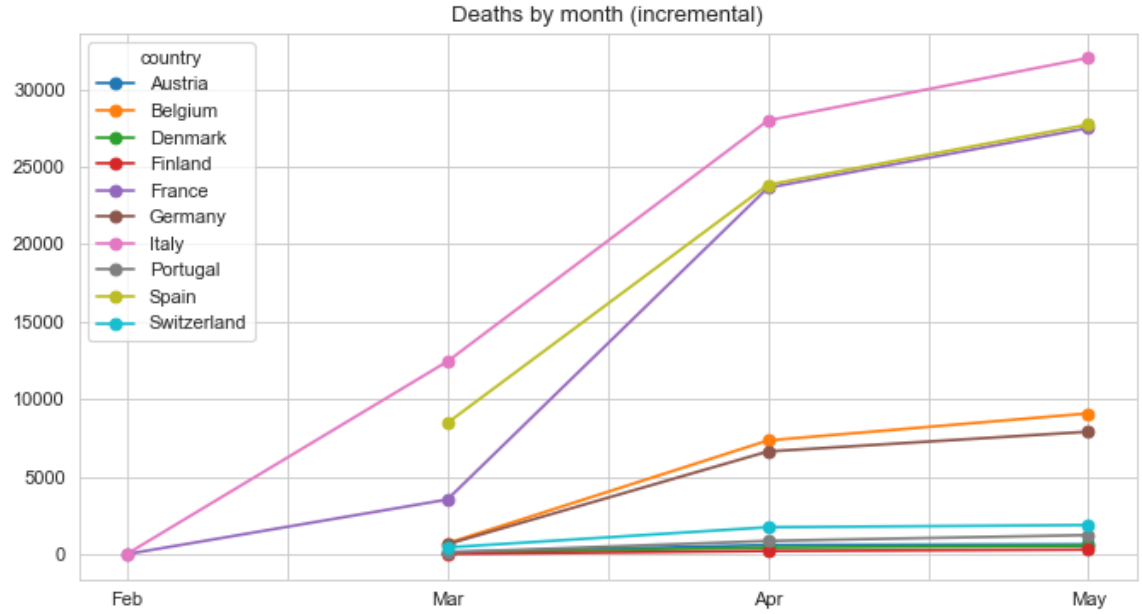
Out[190]:

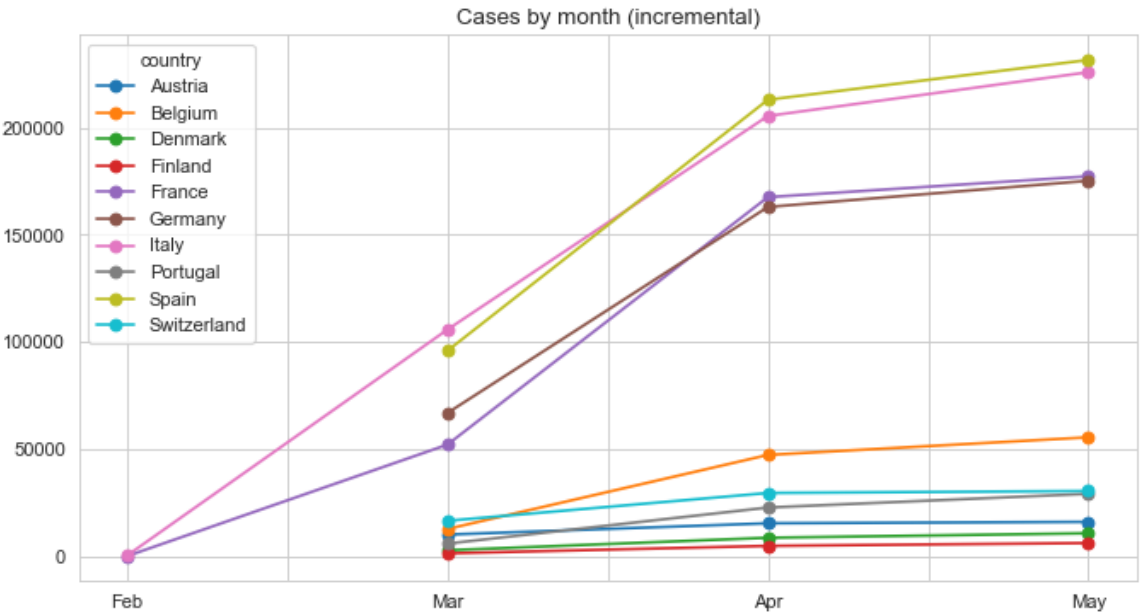
country	month_date	Austria	Belgium	Denmark	Finland	France	Germany	Italy	Port
0	Apr	15452.0	47334.0	8698.0	4906.0	167605.0	163009.0	205463.0	227
1	Feb	NaN	NaN	NaN	NaN	100.0	NaN	322.0	
2	Mar	10180.0	12775.0	2860.0	1418.0	52128.0	66885.0	105792.0	59
3	May	16109.0	55559.0	10791.0	6228.0	177319.0	175233.0	225886.0	292

In [191]:

```
fig, (ax1, ax2, ax3 ) = plt.subplots(3, 1,figsize=(10,18), dpi= 80)
bx = sns.barplot(x='month_date', y='measures_tot', hue = 'country', data=data_top10c
ountry_month, order = ['Feb','Mar','Apr','May'], ax = ax1)
bx.set_xticklabels(bx.get_xticklabels(), rotation=40, ha="right")
ax1.set_ylabel ('')
ax1.set_xlabel ('')
ax1.title.set_text('Tot government measures by month (Top 10 countries)')
bx.legend(loc='upper left')

field = 'month_date'
month_ordered = ['Feb','Mar','Apr','May']
dx = top10_deaths.set_index(field).loc[month_ordered].plot(marker = "o", ax = ax2)
ax2.set_xlabel ('')
ax2.title.set_text('Deaths by month (incremental)')

cx = top10_cases.set_index(field).loc[month_ordered].plot(marker = "o", ax = ax3)
ax3.set_xlabel ('')
ax3.title.set_text('Cases by month (incremental)')
```

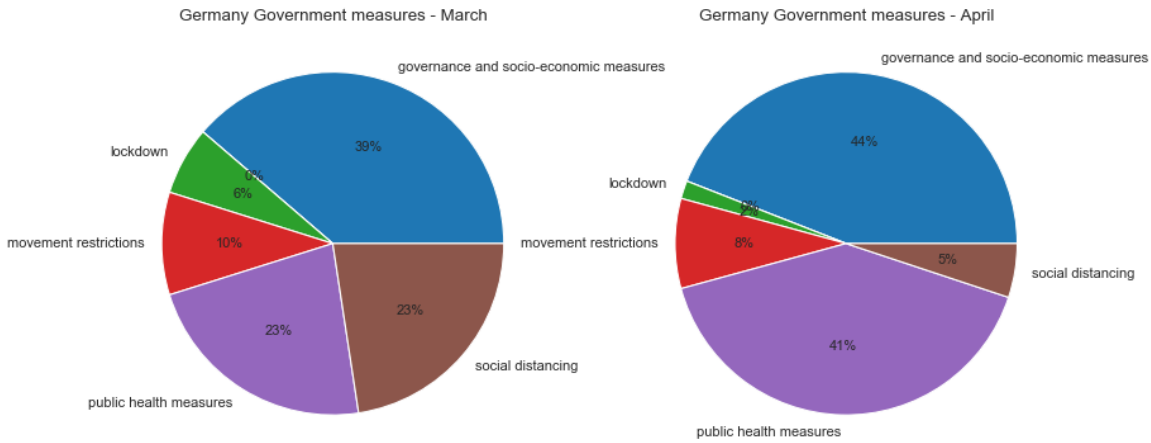

Tot government measures by month (Top 10 countries)
Austria
Belgium
Denmark
Finland
France
Germany
Italy
Portugal
Spain
Switzerland
0
10
20
30
40
50
60
Feb
Mar
Apr
May


Deaths by month (incremental)
country
Austria
Belgium
Denmark
Finland
France
Germany
Italy
Portugal
Spain
Switzerland
0
5000
10000
15000
20000
25000
30000
Feb
Mar
Apr
May


Cases by month (incremental)
country
Austria
Belgium
Denmark
Finland
France
Germany
Italy
Portugal
Spain
Switzerland
0
50000
100000
150000
200000
Feb
Mar
Apr
May

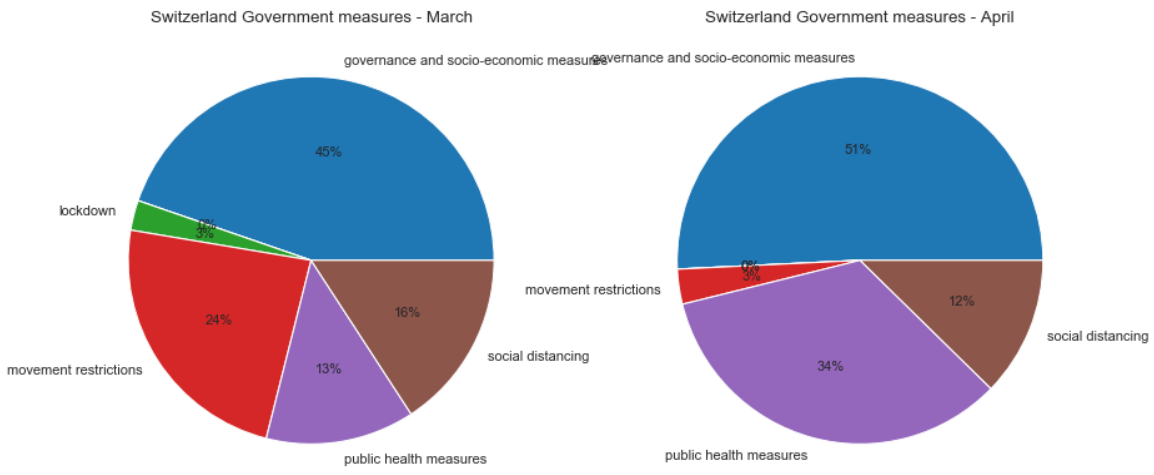
In [192]:

```
# I think that measures implemented during the month had delayed effects on deaths/cases confirmed
# I can see that countries as Portugal, Germany, Switzerland, Finland had a big jump of measures implemented between
# March and April.
# As measures implemented in April could have impact on deaths/cases during May, I can suppose that the increase
# of these measures have helped to flatten the death/cases curve for these countries.

# On the other side countries as Italy, Spain and France had not a big jump on measures implemented between March and April.
# For these countries the variance of deaths/cases between months has been huge.
# Germany is the country that could contradict my previous sentence because the huge increment of confirmed cases
# between March and April despite the big jump of measures.
# For this reason I want to investigate the distribution of measures categories for this country.

data_Germany = data[data['country'].isin(['Germany'])]
data_Germany = data_Germany.drop(['country','date', 'measures_tot','Cases','Deaths'], axis=1)
data_Germany = data_Germany.groupby(['month_date']).sum()
data_Germany = data_Germany.T

fig, (ax1, ax2 ) = plt.subplots(1, 2,figsize=(12,18), dpi= 80)
pie_1 = data_Germany['Mar'].plot(kind = 'pie', autopct='%1.0f%%', pctdistance=0.6, ax = ax1)
ax1.set_ylabel ('')
ax1.title.set_text("Germany Government measures - March")

pie_2 = data_Germany['Apr'].plot(kind = 'pie', autopct='%1.0f%%', pctdistance=0.6, ax = ax2)
ax2.set_ylabel ('')
ax2.title.set_text("Germany Government measures - April")
```



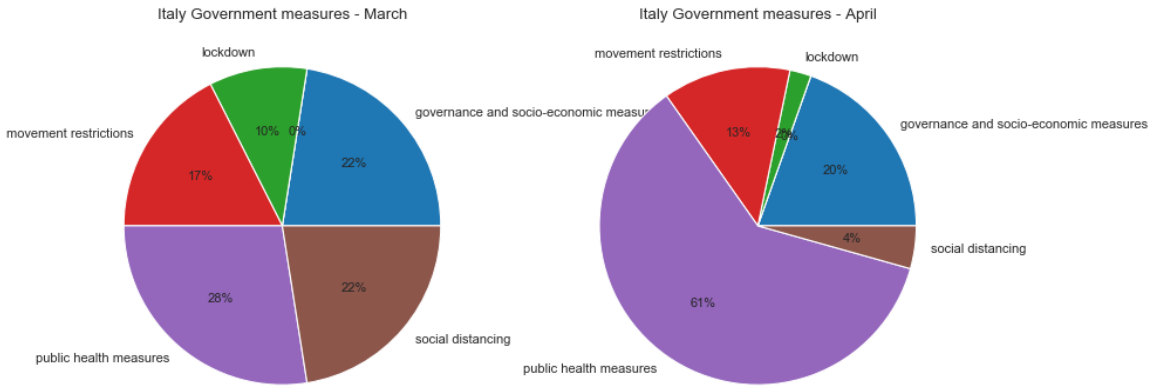
In [193]:

```
# The increase of German measures between March and April has to be attributed to tw
o main categories: governance and socio-economic,
# public health measures.
# In the 'Public health measures' category are included measures such as 'strenghten
ing the public health policy' and 'Testing policy'
# (attribute 'MEASURE' in the first dataset)
# This could be explain the huge increase of cases confirmed between March and April
and instead a less variance
# on deaths for the German country.
# I investigate if the distribution of the categories is similar in other countries
 with low cases/deaths figures.
# I analyze the Switzerland situation

data_Switz = data[data['country'].isin(['Switzerland'])]
data_Switz = data_Switz.drop(['country','date', 'measures_tot','Cases','Deaths'], ax
is=1)
data_Switz = data_Switz.groupby(['month_date']).sum()
data_Switz = data_Switz.T

fig, (ax1, ax2 ) = plt.subplots(1, 2,figsize=(13,20), dpi= 80)
pie_1 = data_Switz['Mar'].plot(kind = 'pie', autopct='%1.0f%%', pctdistance=0.6, ax
= ax1)
ax1.set_ylabel ('')
ax1.title.set_text("Switzerland Government measures - March")

pie_2 = data_Switz['Apr'].plot(kind = 'pie', autopct='%1.0f%%', pctdistance=0.6, ax
= ax2)
ax2.set_ylabel ('')
ax2.title.set_text("Switzerland Government measures - April")
```



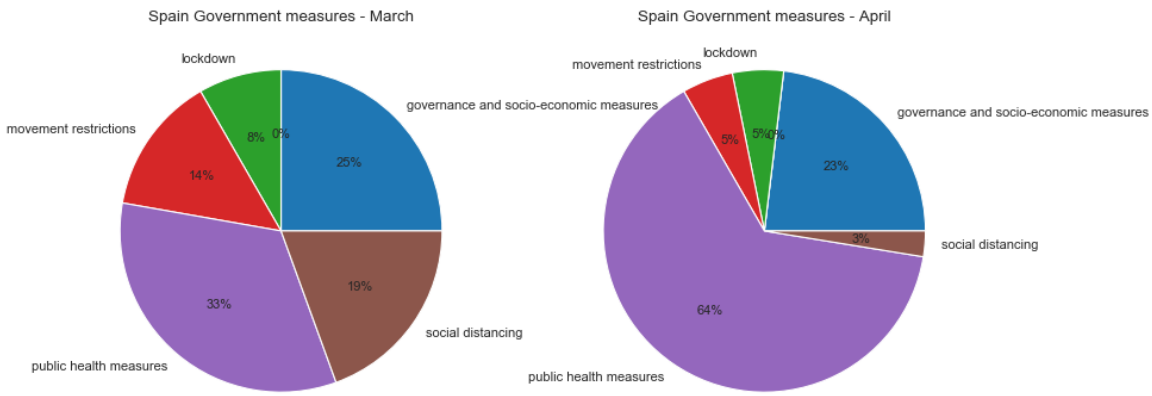
In [194]:

```
# For Switzerland the 'governance and socio-economic category' measures were the 50% of all the measures implemented
# As in Germany they seem , together the poublic health measures, the main important measures categories

# let's have a look at the countries with bigger case/deaths increase. I take the Italian example

data_Italy = data[data['country'].isin(['Italy'])]
data_Italy = data_Italy.drop(['country','date', 'measures_tot','Cases','Deaths'], axis=1)
data_Italy = data_Italy.groupby(['month_date']).sum()
data_Italy = data_Italy.T

fig, (ax1, ax2 ) = plt.subplots(1, 2,figsize=(12,20), dpi= 80)
pie_1 = data_Italy['Mar'].plot(kind = 'pie', autopct='%1.0f%%', pctdistance=0.6, ax = ax1)
ax1.set_ylabel ('')
ax1.title.set_text("Italy Government measures - March")

pie_2 = data_Italy['Apr'].plot(kind = 'pie', autopct='%1.0f%%', pctdistance=0.6, ax = ax2)
ax2.set_ylabel ('')
ax2.title.set_text("Italy Government measures - April")
```



In [196]:

```
# In Italy the governance and socio-economic measures seem to be a lower proportion
 in the total measures and compared
# with Germany and Switzerland.
# Let's have a look at the Spanish situation

data_Spain = data[data['country'].isin(['Spain'])]
data_Spain = data_Spain.drop(['country','date', 'measures_tot','Cases','Deaths'], ax
is=1)
data_Spain = data_Spain.groupby(['month_date']).sum()
data_Spain = data_Spain.T

fig, (ax1, ax2 ) = plt.subplots(1, 2,figsize=(12,20), dpi= 80)
pie_1 = data_Spain['Mar'].plot(kind = 'pie', autopct='%1.0f%%', pctdistance=0.6, ax
= ax1)
ax1.set_ylabel ('')
ax1.title.set_text("Spain Government measures - March")

pie_2 = data_Spain['Apr'].plot(kind = 'pie', autopct='%1.0f%%', pctdistance=0.6, ax
= ax2)
ax2.set_ylabel ('')
ax2.title.set_text("Spain Government measures - April")
```



In [160]:

```
# Again the governance and socio-economic measures are lower than the first two coun
tries analyzed.
# I note, moreover that the % of them has slightly decreased from March to April for
Italy and Spain.
# For Germany and Switzerland, instead, the proportion has increased from March to A
pril

# This suggests to me that a more deep analysis of measures implemented could sugges
t some winner measure that had
# a positive impact to slow-down the spread and the deaths cases.
```