The year that changed everything (?)

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1. Motivation, data, research questions

When did the Middle Ages end? Opinions widely diverge, as it is very difficult to define when a new history chapter begins. As terrorism is concerned, no one could ignore the worldwide impact sept 2001 had. Indeed, were people asked about a date in history to mark a new era of terrorism, 2001 would be certainly selected. Apart from the inquestionable emotional, political and socio-cultural significance 9/11 had, can we safely assume that this date was a turning point for the impact and the conception itself of terrorism? And if it so, in which way and for what reasons? This are the general issues I hope to address in my visual analytics enquiry:

- I will first compare the pre-2001 and post-2001 periods in terms of terrorism impact. I will consider the spatial distribution of terror attakcs through coroplath mapping, their worldwide longitudinal progress, and the tipology of attacks.

- Secondly, I will compare the impact terrorism had on different regions, zooming in from continents to nations.

- Thirdly, I will analyze the groups behind terrorism, focusing on the major actors and their evolution over time.

- Finally, I would like to understand better how much the threat of terrorism the western world feels is justified by data. I will compare for this reason the likelihood of dying by terrorist attack with that of death by car crash, focusing on USA data.

My personal hypothesis is that, due to a climate of fear, we tend to cognitively overestimate the impact that terrorism has on the western world. On the other hand, even because of weak media coverage, we do not consider enough the impact that terrorism has in other parts of the world.

To answer these questions and test my hypothesis I will make use of the Global Terrrorism Database (GTD). The GTD can boast 170,000 observations and over 50 features, giving information about location, targets and perpetrators of terrorist acts. The major strenght of the dataset, in addition to its richness, is its longitudinal nature, spanning from 1970 to 2016, which will allow me to follow the evolution of terrorist acts over the years. The major limitation of data is in my personal view a too broad definition of terrorism, described as *"threatened or actual use of illegal force and violence by a non-state actor to attain a political, economic, religious, or social goal through fear, coercion, or intimidation"*. I think that, as the current surge of jihad terrorism may show, terrorism is so heterogeneous a phenomenon that it is confusing for me to compare a bombing attack by religious extremists which kills 100 people with a kidnapping by politically-oriented groups. The issue is not only linguistic, because different phenomena require different strategical countermeasures. More information about the database can be found at (www.start.umd.edu/gtd/), and on kaggle (www.kaggle.com/START-UMD/gtd).

2. Tasks and approach.

I chose to use R as analytic tool to take advantage of its packages. Following the work of Hadley Wickham (2016), I mainly used packages of the tidyverse, with a particular emphasis on **dplyr** and **ggplot2**, respectively for data preparation and visual analysis. The dialogue between these two packages was the technical constant of my anaysis. In fact, for each visualization produced, I first had to manipulate data so that to have it in the form needed for the graph I had in mind. This process was iterative, because often the visualization offered a new insight about data, so that a new data manipulation was needed to approach the research question under a different angle. To illustrate this process, which was perhaps my main personal conquest, I chose two of the analyses whose results I will later describe with a focus on the research process and its questions. With regard to the first research question, I wanted to analyze the worldwide cost over the years of terror attacks. Thus, I decided to draw a line chart, comparing the trends of three different measures: total numeber of attacks, deaths and injured. I first grouped the observations by year (*group by*), then I created the three needed summary variables (*summarise*). Finally, with the **reshape** package I changed the structure of dataset using the melt *command*, gathering all the new computed variables in a single column. This way I was able to draw three distinct lines in the same line chart. Interestingly, I noticed that the lines widely diverged on the year 2001, where 9/11 caused a spike in casualties not registered in the number of attacks. In this case, the graph showed an obvious truth: it is one thing to count the number of attacks, and a completely different one to consider the number of casualties. I tested this dicotomy even further with two distintct wordclouds, visualizing the most prolific (number of attacks) and the most deadly (number of deaths) terrorist groups. Again the two visualization were very different, providing by the way interesting insights on the groups of terror. These simple and yet crucial visual information made me reconsider the way I was originally evaluating the impact of terror attacks, as I started to focus almost exclusively on terrorism deaths as a more significative and interesting measure. As for the visual analytics techniques employed to answer my main research questions, I used:

- simple and grouped bar charts to compare different groups of data (nations, cities, terrorist groups), sometimes with a reference to time (pre-2001 vs post-2001, yearly variation in terrorist attacks);

- choropleth mapping to get a better spatial understanding of the distribution of terror in the world. In this regard the GTD was a precious resource, as it provides latitudes and longitudes of each attack;

- line charts, mainly to get a grasp on the longitudinal variations of data, and for comparing trends of different measures (death vs count of terrorist attacks).

- scatterplot with categorical data (continents), to visualise the overall variations in terrorist attacks;

- wordclouds, which I find a very interesting visualization technique.

3. Analytical steps

3.1 Pre-2001 vs post-2001

The Year that changed everything?
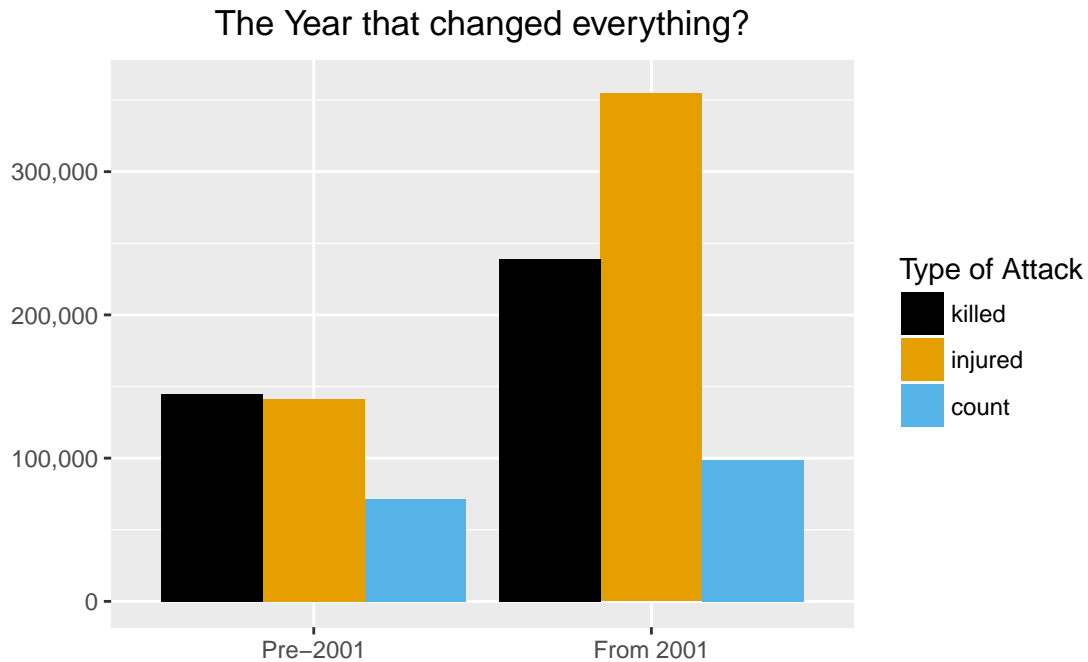
The first graph is a simple grouped bar-chart, where we can see the difference in casualties (both injured and killed victims of terrorism), and the total count of attacks. The analysis is very asymmetric, considering that we are comparing 40 years of terrorism against only 15. However, I chose 2001 as cut-off because of its ideological impact on the way we perceive terrorism. Having said that, the results show that the period after 2001 registered an increase of almost 100,000 dead and 200,000 injured people in 30,000 additional attacks. These numbers alone tell us that something changed in the nature and frequency of the attacks.

## Terrorism Deaths by Country – Pre 2001
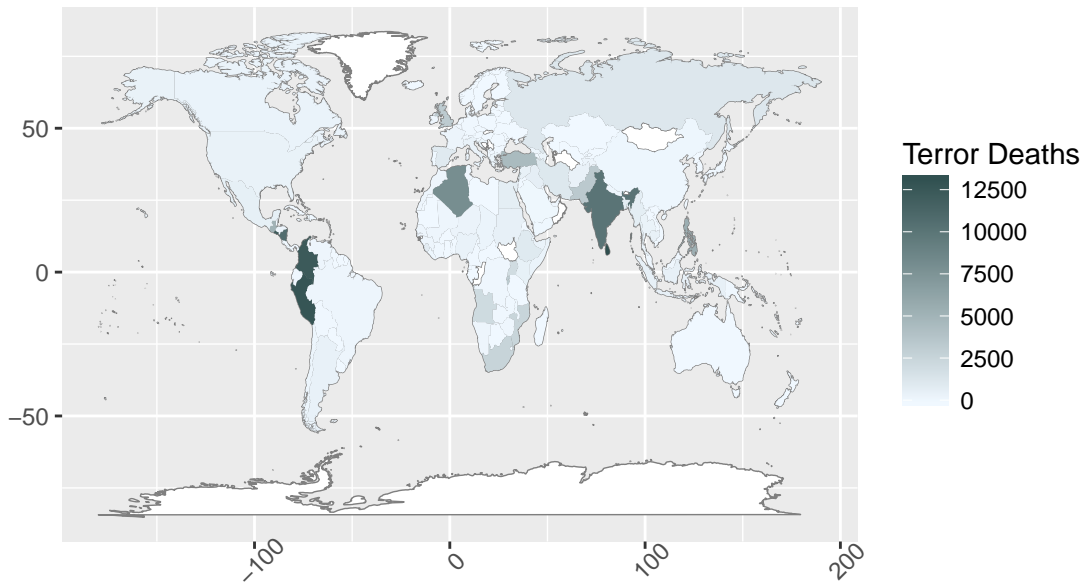
I then drew two choropleth maps to understand better the spatial distribution of terror in the two different periods. Before 2001 terrorism was more widespread, and had a lower incidence, as can be seen comparing the two scales in the legend. The hotspots include Central (Nicaragua, El Salvador) and Southern America (Colombia and Peru), India and Sri Lanka, and Algeria.

Terrorism Deaths by Country – Post 2001
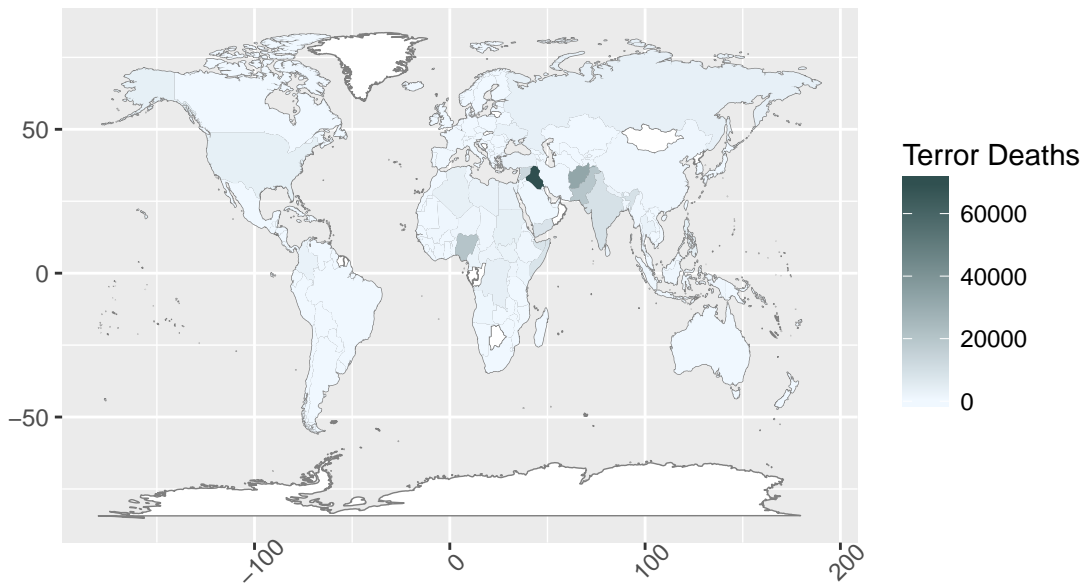
The world post-2001 is completely changed: not only the number of incidents has increased, but also it now concentrates in two major areas: Middle East (Iraq mainly) and South Asia, with a peak in the Afghanistan/Pakistan area.

Type of attack by period
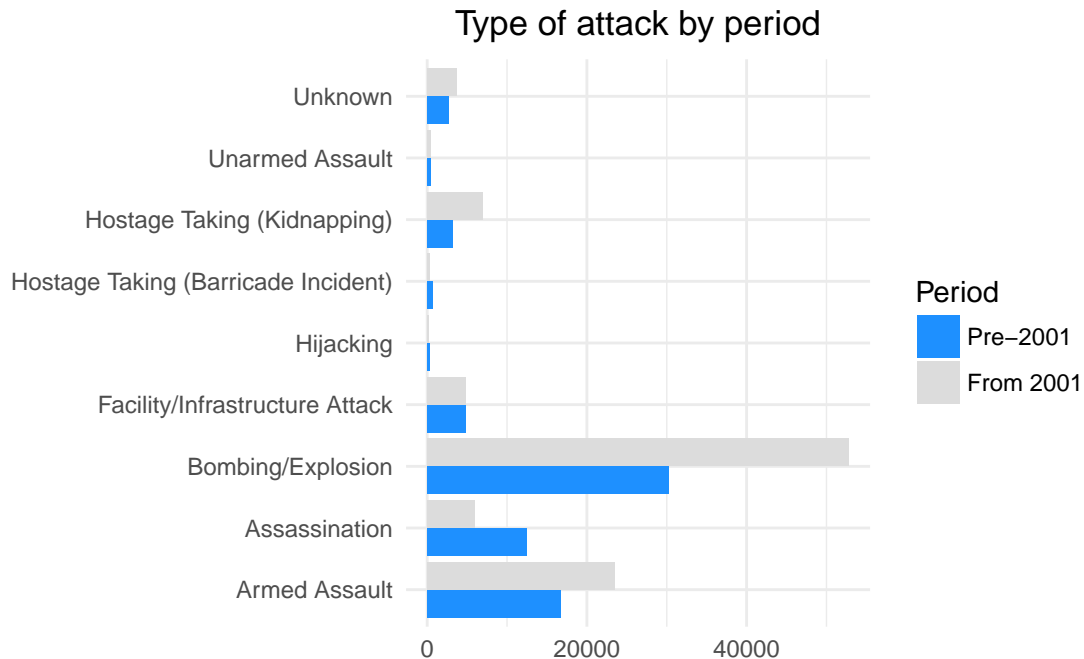
I also checked if the methods of the attacks changed after 2001. I created a bar-chart comparing attack types prior and post 2001. The major insight is the increasing relevance of bombing post-2001.

## Terrorism by attack type, 1970–2016
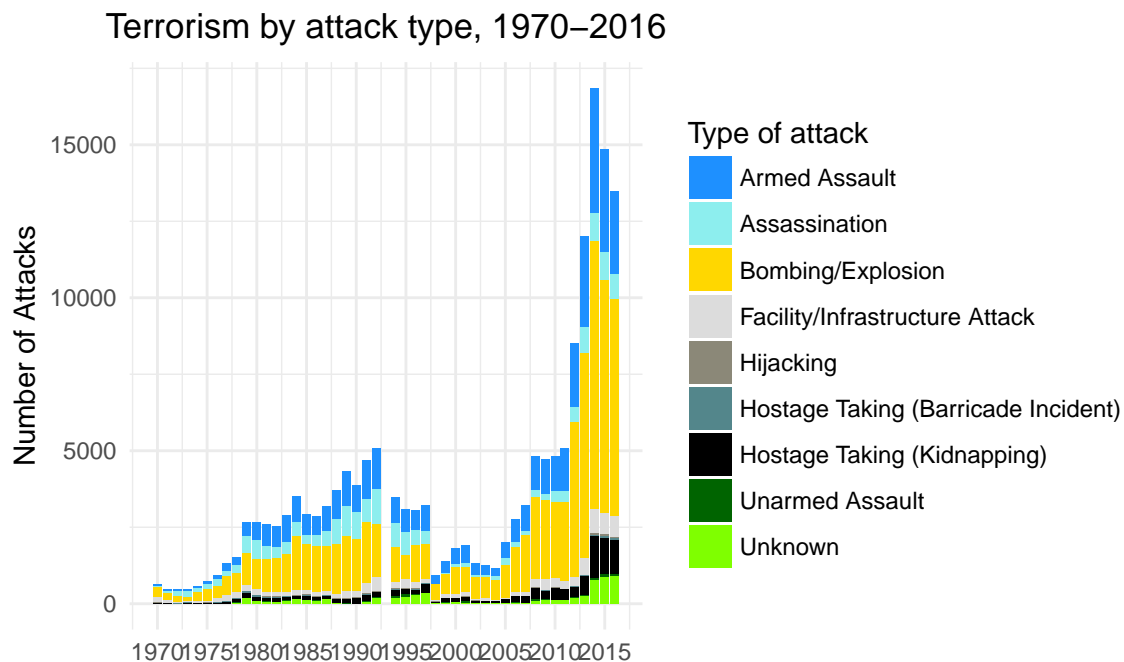
This result was further analysed in a stacked barplot, which showed that the attacks tripled from 2010 to 2014, and this sudden peak is mostly explained by the increase in bombing attacks. This graph starts to show a curious trend in data. Though it is true that after 2001 terrorism - so to say - exploded, the world did not exceed the terrorism levels registered in the nineties until after 2010. Thus, for almost ten years after 9/11 the level of worldwide terrorism was not unheard of, at least in terms of total attacks.

Worldwide Terror Attacks Impact Over Years
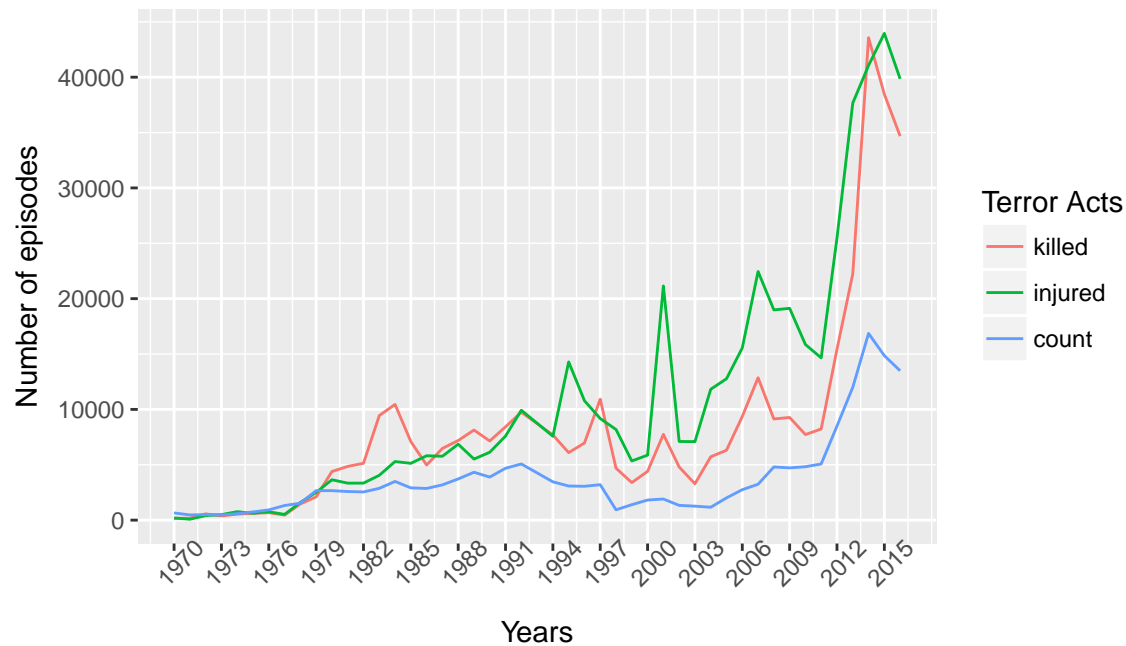
To understand better this trend I drew a line chart comparing three distinct trends from 1970 to 2016: injured, dead and number of terrorist attacks. First, the 9/11 is clearly the most evident event in the whole sequence, with a very distinct peak in casualties after a somewhat decreasing trend. Moreover, terrorist acts start to become deadlier, perhaps for the new typology of attacks.

Lastly, between 2012 and 2014 terrorism had an incredible surge. But which areas of the world were most interested by this phenomenon?

3.2 Zooming in from the world to nations
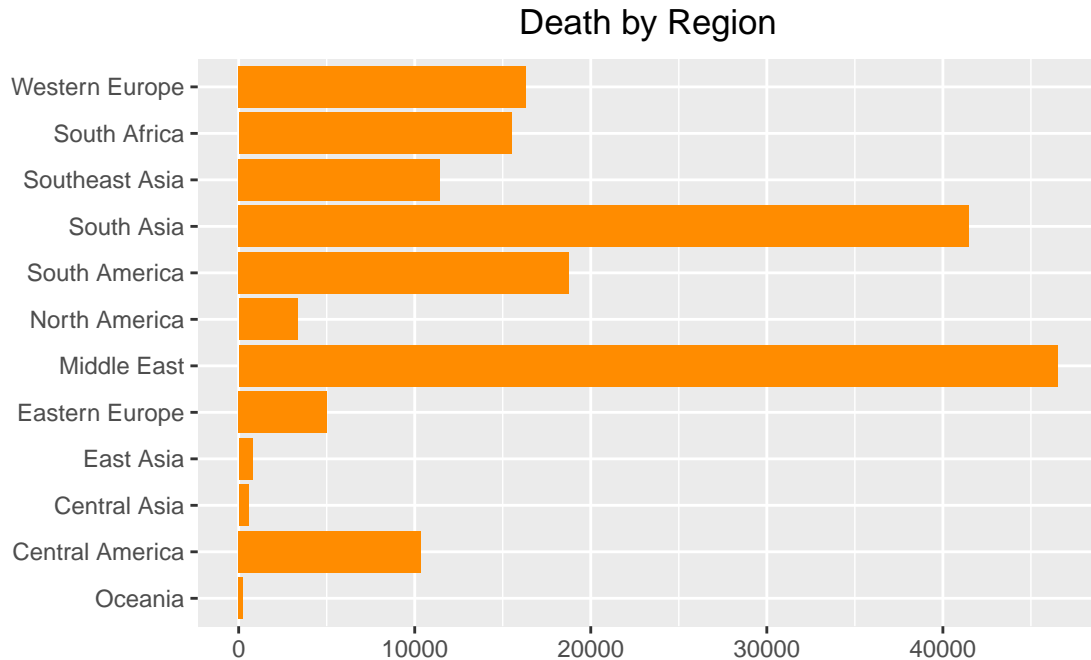
First, I visualized terrorist deaths by region with a simple bar-chart. Unsurprisingly, South Asia and Middle East show the higher rates. Europe, Northern America, and Oceania are among the most unaffected areas.
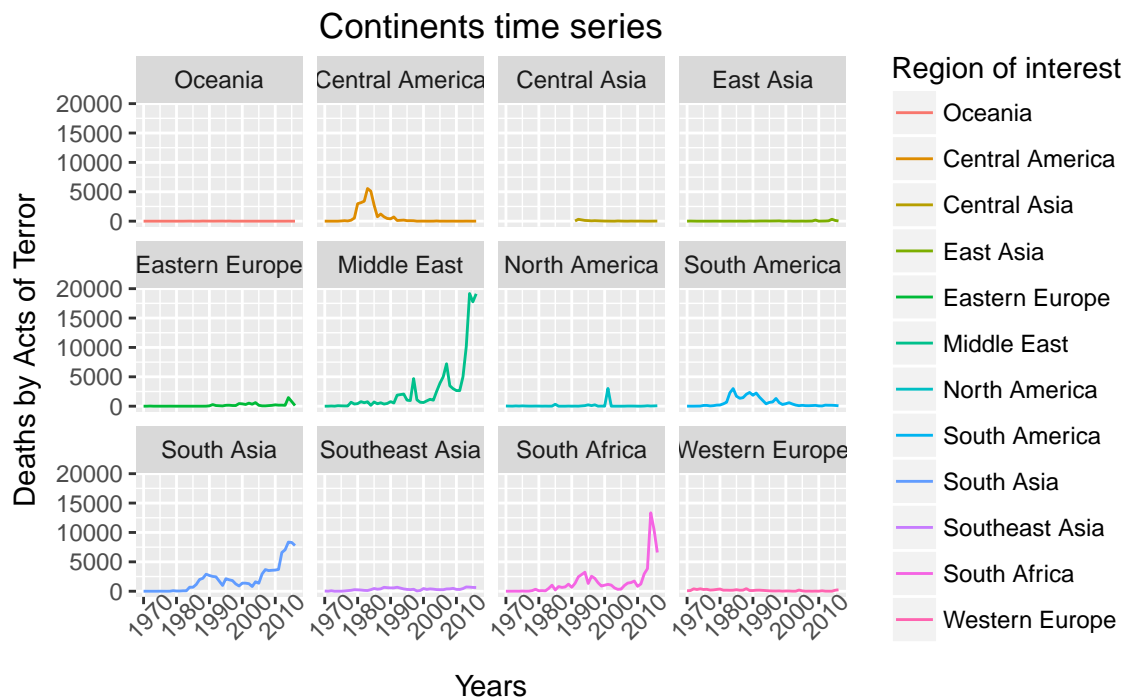
The evolution of terrorism by continent showed that:

- Central and Southern America had a bloody terrorist period between 1980 to 1995;

- the only evident sign of terrorism in North America is 9/11;

- in Middle East, we have three major peaks: one during the nineties, which is dwarfed by a second increase between by and large 2005 and 2010, and a second scary surge after 2010. Terrorism become stronger in South Asia after 2005 and in South Africa after 2010.

Terrorist Death by Country
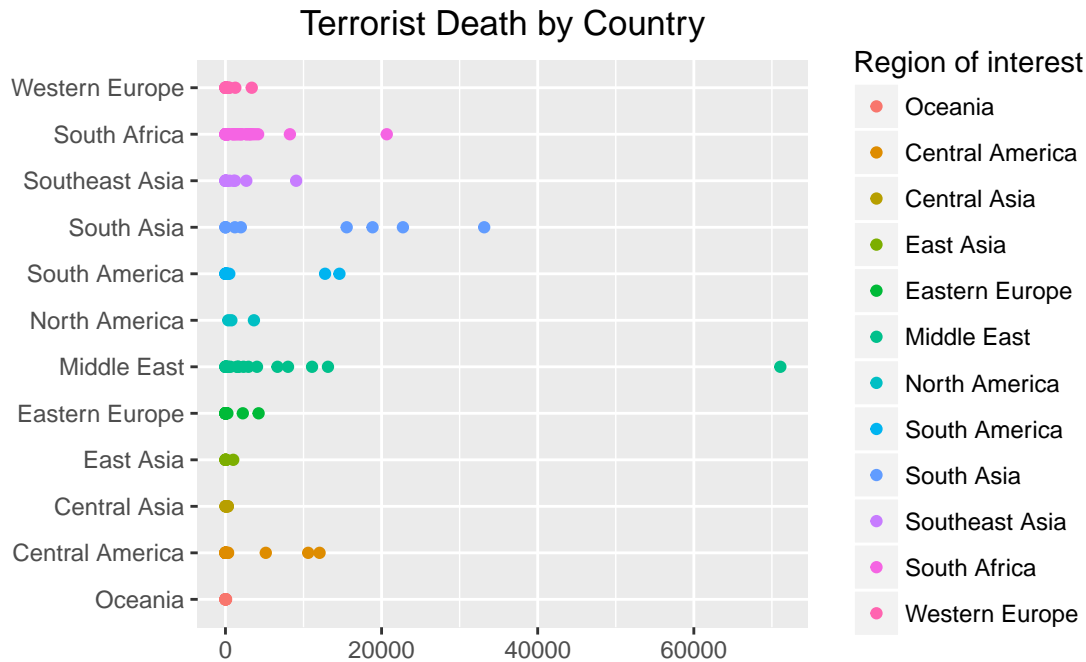
However, it is very difficult to explain the evolution of terrorism at a continental level. In fact, the most interesting information is often derived by the most extreme outliers. Which countries are these points? To answer this question, we need to concentrate at country level. Next barchart shows that Iraq is the first 'point' in the Middle East group, followed by Syria. In South Asia, Afghanistan is followed by Pakistan and India. In Africa, Nigeria is the most affected by terrorism.

Terrorist Deaths by nation
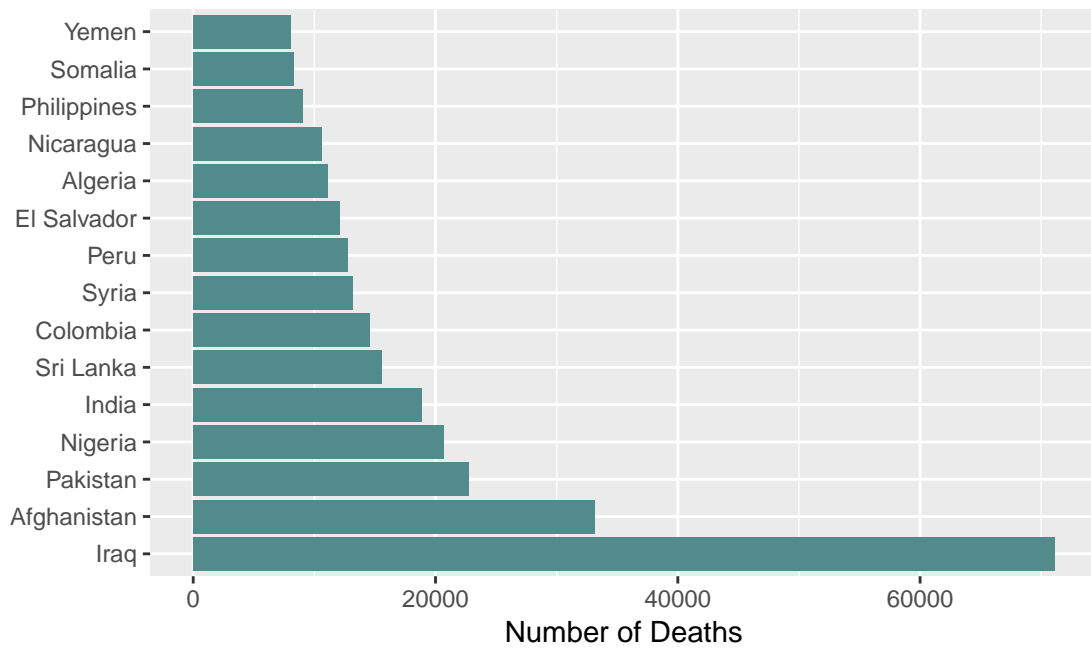
The new barchart orders the countries in relation to death rate by 100.000 people. Interestingly, Iraq and Afghanistan remain in the top five, and El Salvador and Nicaragua jump to the first three positions. Who are the groups behind these massacres?

## Terrorism death weighted by population
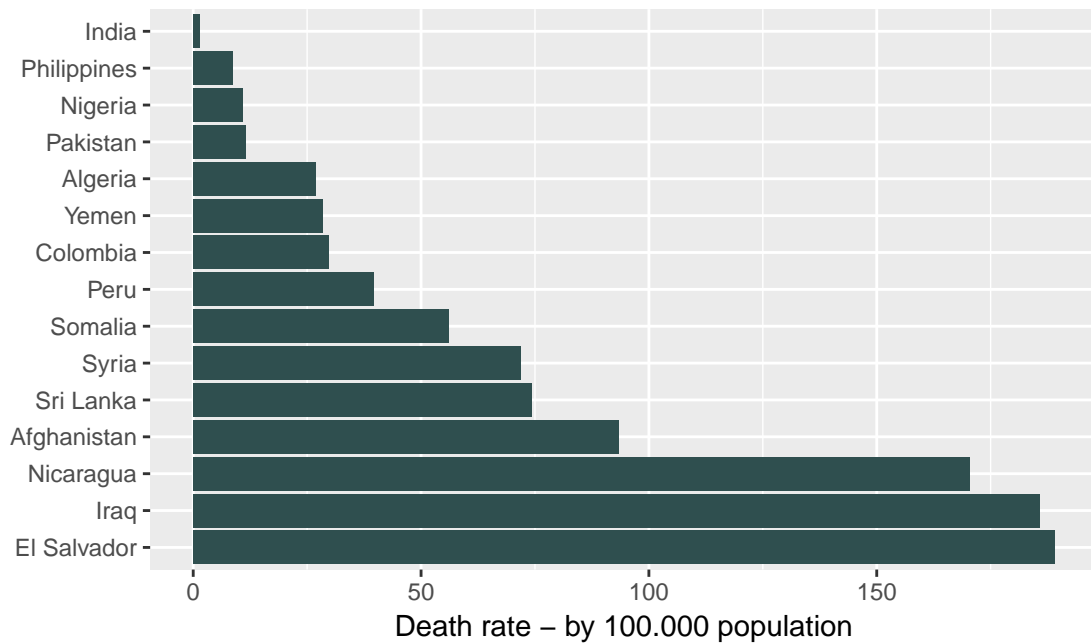
3.3 Terrorist groups

After a preprocessing phase, I drawed two wordclouds, showing first the most active groups (Nnumber of attacks) and secondly the deadlier (number of deads). Interestingly, European terrorist groups like ETA and IRA are present in the first one, but almost disappear in the second, while ISIL took the first spot in the second one.
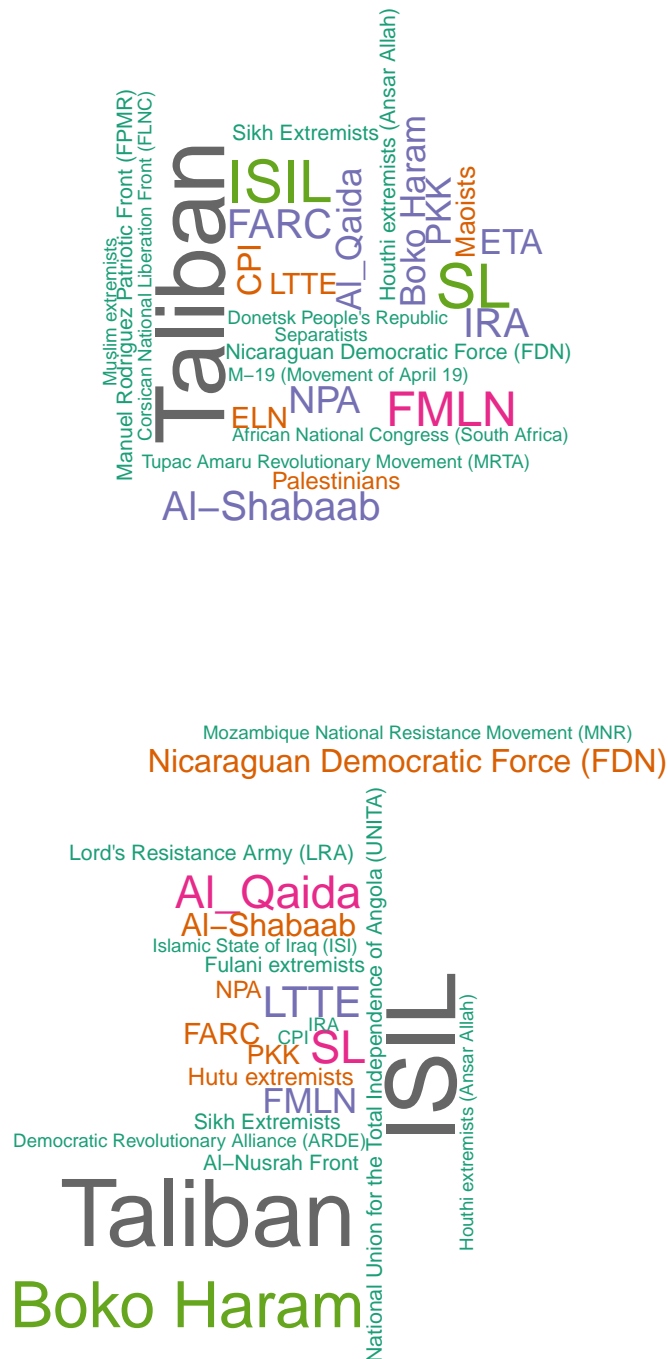
The presence of Boko Haram explains the position of Nigeria in the ranking, Farabundo Marti National Liberation Front (FMLN) explains El Salvador and Nicaraguan Democratic Force (FDN) Nicaragua. FARC and Shining Path (SL) account for most terrorism rates in South America. Liberation Tigers of Tamil Eelam (LTTE) explains the deaths in Sri Lanka, and New People Army the ones in Philippines. However, most of the deadliest terrorist groups are jihadist: Al-Shabaab (Yemen), Boko Haram (Nigeria), Al-Qaida (Iraq and Arabian Peninsula), Taliban (Afghanistan and Pakistan), ISIL (Iraq and Syria).

Top five terrorist groups
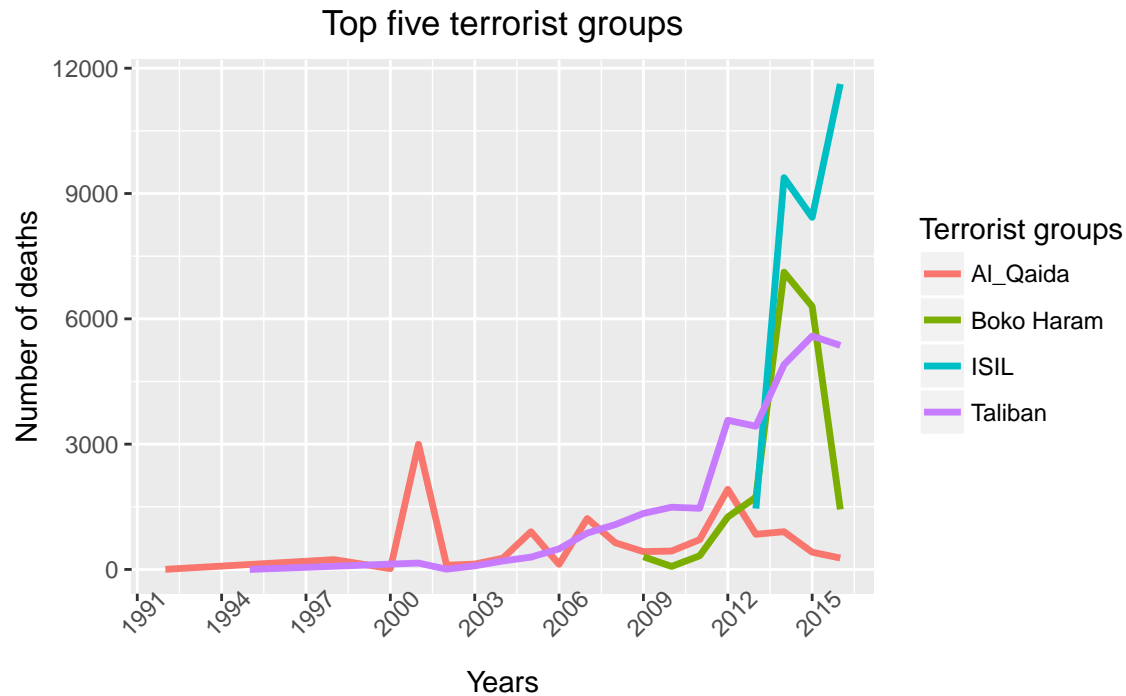
I visualise now the evolution of the top four terrorist groups for number of deaths: ISIL (1), Taliban (2), Boko Haram (3) and Al-Qaida (4). Interestingly, after 9/11 peak Al-Qaida did not grow much in terms of impact, and instead began a decline after 2012. In those same years another menace was born in Middle East, that of ISIL. Taliban actions steadily increased after the invasion of Afghanistan, with a boost from 2011.

3.4 How much is terrorism impacting the Western World?

I already showed that Europe and Northern America are among the regions less interested by the phenomenon of terrorism in the time frame considered. To discuss this in more detail I compared Iraq and USA, which is the western country most affected by terrorism. The results speak for themselves: the contrast is so stark that the USA series is almost indistinguishable from 0, apart for the spike of 9/11.

Comparison USA vs Iraq

Car crash vs terrorist deaths
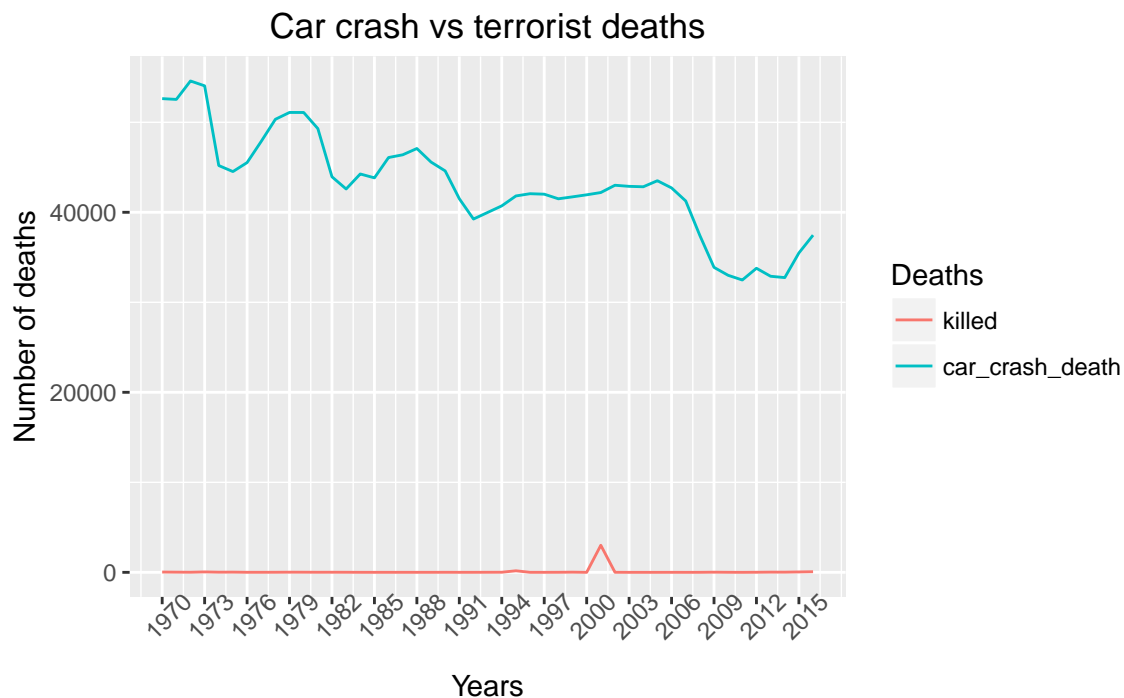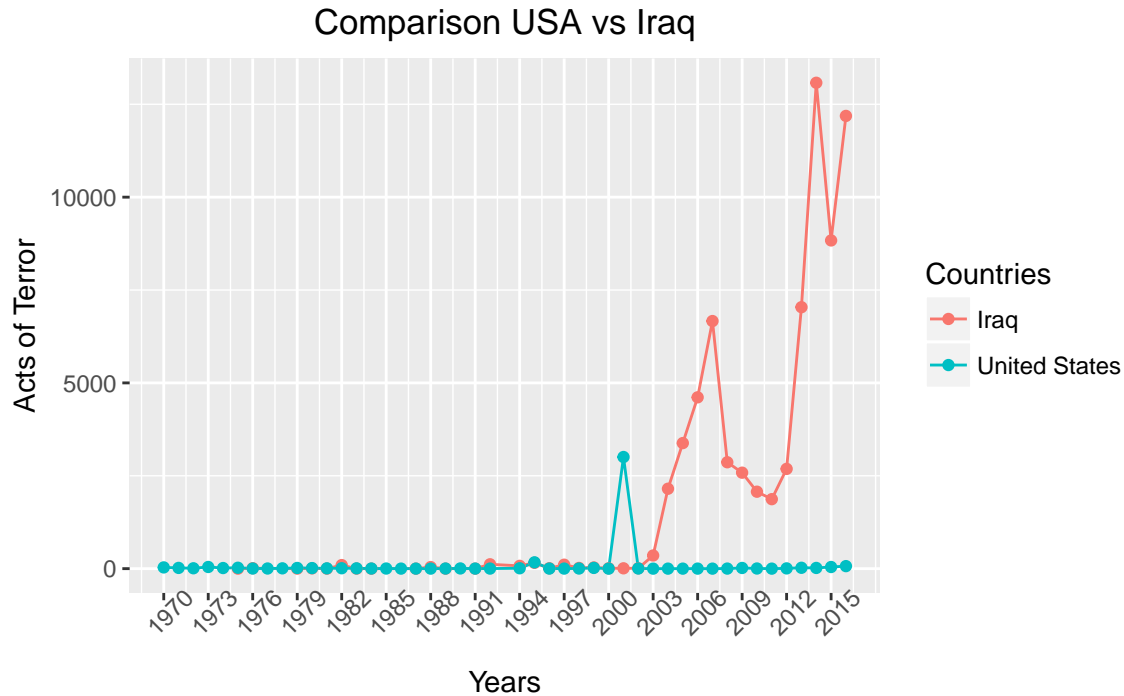
Finally, I compared the number of deaths by terrorism with deaths by car accident in the USA from 1970

to 2016. The results are astonishing, though predictable: even in 2001 car accidents killed 25 times more americans than 9/11.

4.Findings

The first finding concerns the temporal evolution of terrorism. Though 2001 is certainly a major turning point in the contemporary history of terrorism, the progress of terror acts in the last 15 years is more complex. In fact, we can identify three major periods worldwide:

- terrorism grew significantly between 2003 and 2007;

- between 2007 and 2010 a quieter phase followed;

- From 2011 and 2016 terrorism reached levels never seen since 1970.

The second finding regards the spatial distribution of terrorism. The most affected areas in the last 15 years are Middle East (Iraq and Syria) and South Asia (Afghanistan and Pakistan). These regions lead and explain the worldwide trends. Indeed, they are plagued by the most active terrorist groups of the last decades: ISIL and Al-Qaida, and Taliban. These jihadist terrorist groups are the most aggressive and deadliest in recorded history, even due to their reliance on bombing attacks.
The temporal evolution of terrorism in these areas matches almost perfectly the political and military consequences of 9/11. In this regard I would highlight the following events:

- Between 2001 and 2003 Afghanistan and Iraq were invaded;

- in 2007 20,000 American troops were added to the Iraqi front, stabilising the area;

- in 2011 we had the formal withdrawal of USA troops from Iraq, followed in 2013 by the handover of security from NATO to Afghan national forces. Afterwards, the ISIL menace took form, peaking in 2014 with the capture of Tikrit and Mosul, and Taliban activities resumed with more strength.

In conclusion, with the invasions terrorism showed an increase, stopped by a momentary surge in military operations; however, after the withdrawal of western troops terrorism skyrocketed as the political instability grew. This possible interpretation leads us to the second main result: though much of the attention when terrorism is concerned is dedicated to western countries, Europe and America are among the areas less touched by terrorism. For instance, if we consider USA data about car accident, it can be easily seen that car accidents kill way more people than terrorist attacks: in 2001, 42196 americans died because of car crashes, against the 2996 victims of 9/11. Nonetheless, terrorists scare us more than cars and we seem to believe that the main target of jihadist attacks are european and american citizens. Data show us that it is not so. But fear is seldom rational or data-grounded.

5.Critical reflections

Limitations The major limitation of this work regards data collection about american car crash, which was downloaded from
Wikipedia (www.en.wikipedia.org/wiki/List_of_motor_vehicle_deaths_in_U.S._by_year). I am aware it is not the most reliable of sources, but it was the ony one I found with exactly the data I was searching, organised in a very simple and complete table. In any case, I checked the reliability of data comparing it with official studies of the USA government (www.catalog.data.gov/dataset?tags=crash), and the results matched. As for the research process, I am aware of two main problems. First, my initial assumptions were basically based on my amateurish knowledge of the phenomenon. A more thorough literature review should have guided my research efforts, helping me in shaping better questions and interpreting with more ease the results. Second, I offered a very strong interpretation of the spatio-temporal pattern of terrorism growth in Middle East, basically hinting that the military interventions created a political vacuum which resulted in a

net increase in terrorist activities. This interpretation should be tempered by the awareness that causality cannot be inferred by this context. I am more than open to a further discussion about it.

Implications Apart from these limitations, I think the findings do have some interesting implications:

- cognitive bias. We believe that terrorism is a greater risk than the actual numbers imply. This is an interesting phenomenon for the field of risk assessment and decision-making. Negative emotions and unpredictability may be some of the factors behind it.

- information & media. It troubles me to think that this kind of information is available to everyone and yet almost no one discusses it in the more depth. Indeed, I have seen in the last few years tons of maps and statistics about the escalation of terror acts in Europe, and not a single one comparing Europe to other parts of the world. In my view, fear has been nourished instead of being put into perspective. And yet, data may help in this regard. The first step to fight terror in my mind is to be aware of its true effects and to consider it a worldwide problem. Spreading even some simple statistics about it would be an important step in this direction.

- international politics. The hypothesis that political chaos is a fertile ground for terrorism seems supported by the pattern seen in both Southern and Central America in the '80 -'90 and Middle East in the last 15 years, and yet it should be further investigated. The potential impact of such a finding would be very important in my view. Interventions meant to tackle terrorism may backfire if they contribute to trigger an unstable political climate. Recent events in Lybia seem to warn us that we do not have learned the lesson.

Effectiveness & Generalizability I think that my research questions were thoroughly addressed by the visual analytics approaches I chose. Admittedly, I used very simple techniques, but I do think they were effective. Bar-charts were perfect for comparing different categorical variables, and line charts were the right choice for the analysis of temporal patterns. The scatterplot was important to jump from continent analysis to a nation level, because it showed the high degree of heterogeneity inside each continent. I used wordclouds because I find them very engaging and they do help in highlighting the most frequent words. Considering they are not very precise and that humans are not very good at detecting slight size differences I used them only to introduce the topic, before digging deeper. The two maps I drew were useful for visualizing better the spatial distribution of terrorism. On the other hand, I would very much like for the future to draw an interactive map where it is possible to see the evolution of terrorism through the years just sliding an icon.
Finally, I think that my research approach is particularly well-suited to spatial and longitudinal data analysis. Thus, my research approach could well be applied to other domains, provided they offer the same kind of data. For example, I would be very interested in a similar analysis about gun violence, to understand the trends of the last decades and its cost in human lives. I think even an analysis on military expenditures would be adequate for this kind of approach.