**Brexit in the Europe. Relocation of financial professionals.**

**Where to go from London?**

1. Introduction. Brexit and exodus prerequisites.

"Brexit" is the withdrawal of the United Kingdom (UK) from the European Union (EU). Following a referendum held on 23 June 2016 in which 51.9 per cent of those voting supported leaving the EU, the invocation of Article 50 of the Treaty on European Union started a two-year process which was due to conclude with the UK's exit on 29 March 2019, a deadline which was later extended to 31 October 2019. Withdrawal has been advocated by Eurosceptics, both left-wing and right-wing, while pro-Europeanists, who also span the political spectrum, have advocated continued membership. There is no solid consensus on whether it's definitely good for economics to withdraw, or vice-versa. The broad consensus among economists is that Brexit will likely reduce the UK's real per capita income in the medium term and long term, and that the Brexit referendum itself had damaged the economy. Studies on effects since the referendum show a reduction in GDP, trade and investment, as well as household losses from increased inflation. Brexit is likely also to reduce immigration from European Economic Area (EEA) countries to the UK, and poses challenges for UK higher education and academic research.

Former Prime Minister David Cameron, who called the referendum and campaigned for Britain to remain in the EU, announced his resignation the following day. Home Secretary Theresa May replaced him as leader of the Conservative party and as Prime Minister. Following a snap election on June 8, 2017, she remains Prime Minister. The Conservatives lost their outright majority in Parliament, though, and with it – May's critics argue – a mandate for a "hard Brexit," in which Britain leaves the EU's single market and customs union. (The alternative is known as "soft Brexit.")

The new Brexit deadline for Britain to ratify the withdrawal agreement is October 31. The deal May negotiated with the EU has been rejected by the House of Commons three times. May has given up on winning the support of hardline Brexit supporters in her own party and is now hoping to reach a compromise with the main opposition party.

1. London City and the financial sector.

London's finance industry is based in the City of London and Canary Wharf, the two major business districts in London. London is one of the pre-eminent financial centers of the world as the most important location for international finance. London took over as a major financial center shortly after 1795 when the Dutch Republic collapsed before the Napoleonic armies. For many bankers established in Amsterdam (e.g. Hope, Baring), this was only time to move to London. The London financial elite was strengthened by a strong Jewish community from all over Europe capable of mastering the most sophisticated financial tools of the time. This unique concentration of talents accelerated the transition from the Commercial Revolution to the Industrial Revolution. By the end of the 19th century, Britain was the wealthiest of all nations, and London a leading financial centre. Still, as of 2016 London tops the world rankings on the Global Financial Centres Index (GFCI),[280] and it ranked second in A.T. Kearney's 2018 Global Cities Index.

Economists have warned that London’s future as an international financial center depends on whether the UK will obtain passporting rights for British banks from the European Union. If banks located in the UK cannot obtain passporting rights, they have strong incentives to relocate to financial centers within the EU. It's worth to say, that during the Brexit referendum in 2016, the UK as a whole decided to leave the European Union, but a majority of London constituencies voted to remain in the EU.

The consequences of Brexit are tremendous for London city and financial sector overall. New York has overtaken London as the world’s most attractive financial center, a survey said on Wednesday, as Britain’s decision to leave the EU prompts banks to shift jobs out of the city to keep access to Europe’s single market.

1. Relocation of financial companies and finance professionals.

On 4 October 2016, the Financial Times assessed the potential effect of Brexit on banking. The City of London is world leading in financial services, especially in foreign exchange currency transactions, including euros. This position is enabled by the EU-wide "passporting" agreement for financial products. Should the passporting agreement expire in the event of a Brexit, the British financial service industry might lose up to 35,000 of its 1 million jobs, and the Treasury might lose 5 billion pounds annually in tax revenue. Indirect effects could increase these numbers to 71,000 job losses and 10 billion pounds of tax annually. The latter would correspond to about 2% of annual British tax revenue. According to Anthony Browne of the British Banking Association, many major and minor banks may relocate outside the UK.

Financial services firms, which account for about 12 percent of Britain’s economic output and pay more tax than any other industry, potentially have a lot to lose from the end of unfettered access to the EU. Around 5,000 roles are expected to be shifted from London or created in the EU due to Brexit by March, a Reuters study published earlier this year found.

More than 2 million people work in financial services across Britain, with 396,000 in London. The head of the City of London predicted in July that 3,500 to 82,000 financial jobs would go because of Brexit in the short-term and more might disappear later.

1. Cities-competitors – enticing invitations for London financiers.

Many world countries and their capitals hope to catch the payrolls taxes and economic impact of financial institutions relocation from London. Other reasons to compete for the City men include almost guaranteed property prices surge and cultural level increase if financiers will relocate to the city, to mention also educational level soar in the winning city.

So, which other cities (do NOT mismatch "cities" with the "City of London"!) are trying to lure financial institutions and financiers?

From the global perspective, the list of leading finance capitals looks as follows: New York took the first place, London the second place followed by Hong Kong and Singapore in the Z/Yen global financial centers index, which ranks 100 centers on factors such as infrastructure and access to quality staff. European alternative financial centers are Frankfurt, Paris, Dublin, Amsterdam and others.

So, Asian competitors are most close, with Hong Kong only three points behind London in global rank. Many London executives have warned that the biggest threats to London are not from other European centers but from global competitors such as New York and Hong Kong. Moreover, the largest increase has come from Asians in London who are concerned about how Brexit could affect London as a finance center and a place to build their careers. They think job-market sentiment is better back home. Recruiters in Hong Kong and Singapore have spotted a surge in enquires from London-based banking professionals wanting to relocate to Asia.

But none of the competitors in Europe play for time: as an example, by July 2016 the Senate of Berlin had sent invitation letters encouraging UK-based start-ups to re-locate to Berlin. And more influential business capital of Germany, Frankfurt, takes situation seriously - advantages, including the presence of important financial institutions such as the European Central Bank and almost other 200 banks, as well as numerous law firms, make Frankfurt an attractive market for international investors in the light of the changes caused by Brexit. In France Paris is set to become Europe’s post-Brexit trading hub as the world’s biggest banks and asset managers prepare for life after the UK leaves the European Union. And Amsterdam is scrambling to present himself as the best place to relocate London’s largest financial services business - Amsterdam city leaders admit to having had conversations with more than 100 companies thus far [as on 11.27.2017], and are already arranging re-location for 18 of them. Other European alternatives may include Dublin, Luxembourg, Madrid and many others.

**The final list of cities, which we compare with London, includes New York City, Paris, France, Frankfurt, Germany, Berlin, Germany, Amsterdam, Netherlands, Dublin, Ireland, Singapore, Singapore and Hong Kong, China. We will call these cities "alternatives".**

1. Relocation problem of the financier from the point of view of a data scientist.

Let us stop for a minute and try to imagine – where will I go if I leave London because of Brexit? Of course, financiers buy or rent a home in the city where he lives, he or she would eat, drink and go in for sports. They have families and their children go to schools (or kindergartens). They like movies, theater and and recreation facilities. So, where to go from the London, to minimize adventure aftermath?

To answer all of these questions, we need to compare the above-mentioned cities – how all and everyone is similar or dissimilar with London. This can be done very differently – we can compare GDP, price level of the "financier's consumption basket", or count friends and co-workers in every alternative city, or just construct an indicator how long and tidy is to go from the city of work to the sweet small village where financier's mother-in-law lives. One of approaches is to compare alternatives geographically – which option of relocation is MOST similar with London in the spatial arrangement of city venues, so that the venues in London and in the alternative relocation city are distributed identically throughout the city. And this is a kind of data science task – to represent each city as a dataset and compare the proximity of such a datasets. For example, a person buying or renting a home in Paris (alternative) might want to be able to compare the neighborhoods of Paris to other neighborhoods in London (reference point).

The core question of how to account for spatial effects. Most of modern cities are similar: as anything the financier can get in London, sure he can get in every other megapolis. The only difference is in the spatial distribution of their venues. In practice, spatial effects can be accounted for by partitioning the data into discrete spatial units of aggregation (neighborhood), and then ignoring any spatial dependencies in the data within these discrete units. By tallying the amount of parks, bars, or universities the city has relative to all other types of venues, one can get a sense for what a city is like.

1. Data sources for Data Science problem of analyzing cities as a collection of venues:

For the venues, the collected data are from the widely used location-based Social Network (LBSN) Foursquare. Users of Foursquare "check-in" to their current location on their mobile device by selecting it from a list of nearby named venues. Their check-in is then broadcast to their social connections. The venue information is easily accessible through a public API, and all venues are annotated with categories of different granularities which represent a natural semantic grouping for venues.

The best source for neighborhood data for USA cities is Zillow at <http://www.zillow.com/howto/api/neighborhood-boundaries.htm> Unfortunately, it does not match our purpose since does not embrace non-US cities. So, to get neighborhood allocation data (but Hong Kong), we parse files from "Airbnb Data Collection" of Tom Slee on the web site: <http://tomslee.net/airbnb-data-collection-get-the-data>. These data are collected in August 7, 2017. To obtain neighborhood-related coordinate information on Dublin, Singapore and Hong-Kong, we refer to google search of coordinates for every interesting neighborhood.

To select residential ("sleeping") neighborhoods for the second part of the work< we manually output the search results for the phrase "best neighborhoods in [Dublin, Singapore, Hong Kong] for expats" and then make a choice.

Discretization of venues into categories is performed naturally by using either the principal or secondary categories of the venues, depending on which analysis we perform. There are 9 principal venue categories and 231 secondary venue categories.

In total, once this processes was complete, the final data set for comparing the central city parts consisted of near 400 000 venues from 9 cities, with the best represented city, New York, having near 70 000 venues

1. Methodology:

There is a number of approaches how we can compare cities as a collection of venues. In every approach it is natural to characterize a city by the ensemble of amenities it offers. The main difference is how to partition (an if partition at all) the city – by equally sized grid regions, by municipal neighborhoods boundaries or do no spatial aggregation within the city at all.

Our work is greatly inspired by an article:

***Daniel Preoţiuc-Pietro, Justin Cranshaw, Tae Yano. Proceedings of the 2nd ACM SIGKDD International Workshop on Urban Computing, "Еxрlоring vеnuе-bаsеd сity-tо-сity similаritу mеаsurеs".***

This article states 3 possible approaches to partition the city - city-centric, Grid-centric representation and neighborhood-centric representation. The fundamental concept is the bag of venues, which is a representation of a spatial region r. Suppose there are n venues located within r, and each is chosen from a global set of m venue categories, then we define the m-dimensional bag of venues vector:

), where ci is the number of venues of category i within r, and n is the total number of all the venues :



If we partition by the grid, we first divide the area of city x into a set of k of equally sized grid regions r1,r2,...,rk (in our experiments we use grids with step of 600 meters latitude and longitude. The choice of exact figure is explained downwards). Then we aggregate across these grids. First computing

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the sum of all grid points, we then normalize the result, to represent the city x as y/|y|1. This representation is thus better at measuring how certain categories concentrate within the regions ri.

On a city-centric approach we do no spatial aggregation within the city. Viewing its venues as spatially exchangeable, we representing a city x as its bag of City Abbreveations. On a neighborhood approach this representation is equivalent to the grid-centric approach, but here, rather than aggregating over arbitrarily chosen grids, we aggregate over municipal neighborhood boundaries, hypothesizing that neighborhoods most effectively communicate the city’s character.

To obtain a list of venues around the chosen point, we use the same approach as Mr. Alex Aklson in his course "Applied Data Science Capstone". That means, we formulate "explore" query for Foursquare API and get all venues in the chosen radius around the specified point. Users of Foursquare “check-in” to their current location on their mobile device by selecting it from a list of nearby named venues. Their check-in is then broadcast to their social connections. Foursquare users can also specify a hierarchical categorical description to a venue, such as “Restaurant” and “Mexican Restaurant”.

All of the approaches have their pro and contra. In our case the city-centric approach is inappropriate because of severe restrictions on the maximum number of venues, levied by the Foursquare API.

In this work we choose the grid-centric approach because of the following reasons:

1. the FourSquare API allows anyone to get no more, then 100 different venues for every query only. If we follow the neighborhood or city-centric approach, this restriction will severe affect the bags of venues we get (for neighborhoods or the whole city), thus the inference will be unprecise. For the grid-centric approach we manually adjust the step between grid nodes to get less than 100 venues in feedback for every call. As it seems, the radius of 300 meters (and equivalent node distance of 2\*R = 600 m or "step") fits our purpose.
2. the borders of neighborhoods are not an ideal square or a circle. So, we never get exact information about venues in the neighborhood (this get us in a sorrow), and often loose the crucial part of venues, under the assumption we do not have the exact coordinates of every neighborhood (and such a geometric approach is beyond the scope of this coursework). Moreover, following the different geometry of neighborhoods, we never can exactly estimate the mistake (and that make us bemoan). But, on the opposite, in a grid-centric approach we get a consistent result, and the mistake is exactly (1-(Pi/4)), where Pi = 3.1415926... Since for our purpose the exact mistake size is not as important, as it to be steady and predictable, we choose the grid-centric approach.
3. the grid-centric approach allows to explore any area by summarizing bag of venue values for grid nodes without overlapping. In the neighborhoods representation we get overlapping or (as explained in b) upstairs) lose large part of venues feedback.

We make two different analysis for the set of cities we selected. During the first run, we compare London City and city centers of the chosen alternative cities. On the second run, we compare residence areas (sleeping zones). Overall, we get a clear picture of the differences or similarities for the cities.

**The algorithm runs sequentially in the next order:**

1) import libraries and install the packages geopy, folium and geocoder

2) import data from city dataset from Tom Slee web site. This data will allow us to obtain centers of "sleeping" neighborhoods, in the second part of the work.

3) we make an acquaintance with London boroughs and London neighborhoods and output the maps for them, with the lists of their names

4) we make a grid for London City and central parts of alternatives. We choose 10 steps, each for 600 meters, to cover the central part of each city. I.e. "central" in our work means 6 km x 6km area around cities centers.

5) we obtain venues for the every grid node.

6) we accumulate the nodes for every city

7) we make the overall list of venues categories, add the list of venue's categories from other cities to every city, and sort them alphabetically, then count the number of venues of each category for every city. Thus we know, that every bag of venues has equal length and is consistent.

8) we normalize our bags.

9) we compare the bags of venues by means of the hierarchical clustering.

10) we choose 4 (four) recreational zones neighborhoods for every city and make grid for them. We choose the step of 400 meters and make 2 steps in longitude and latitude directions (9 points overall) for every neighborhood, thus covering of area of 0.64 square kilometers.

11) we obtain venues for all grid nodes and accumulate the bags of venues for all four neighborhoods in every city

12) we make the overall set of unique venues categories, add the list of venue's categories from other cities to every city, and sort them alphabetically, then count the number of venues of each category for every city. Thus we know, that every bag of venues has equal length and is consistent.

13) we normalize our bags.

14) we compare the bags of venues by means of the hierarchical clustering.

**And voilla, now we know, where to relocate away from the intimidating Brexit.**

1. Exploratory data analysis

Overall, the list of "sleeping" neighborhoods is obtained from the next links:

* New York: (<https://www.niche.com/places-to-live/search/best-neighborhoods-for-families/m/new-york-city-metro-area/>)
* Paris: is very nice to live almost everywhere in the centre or Monmartr. The choice of best neighborhoods for Paris is quite arbitrary: <https://www.book-a-flat.com/magazine/en/where-to-live-in-paris>
* Frankfurt: <https://www.movingto-germany.com/frankfurt-neighborhoods/>
* Berlin: <https://www.movingto-berlin.com/neighbourhoods/>
* Amsterdam: <https://dutchreview.com/expat/moving/where-to-live-in-amsterdam-neighbourhoods-in-amsterdam/>
* Dublin: <https://www.crownrelo.com/intl/en-ru/moving-to-ireland/dublin-accommodation>
* Singapore: <http://www.livinginsingapore.org/seven-best-places-to-live-in-singapore/>
* Hong Kong: <http://www.livinginhongkong.org/7-best-places-to-live-for-expats/>

Following web data (https://sheerluxe.com/2018/03/16/officially-best-place-live-london), the best places to live in London are:

BERMONDSEY, SOUTHWARK Average house price: £560,256

CLAPTON, HACKNEY Average house price: £606,510

FULHAM, HAMMERSMITH & FULHAM Average house price: £1,176,793

FURZEDOWN, WANDSWORTH Average house price: £553,333

HERNE HILL, LAMBETH/SOUTHWARK Average house price: £783,844

KINGS CROSS, CAMDEN/ISLINGTON Average house price: £797,157

NOTTING HILL, KENSINGTON & CHELSEA Average house price: £1,837,896

RICHMOND, RICHMOND Average house price: £850,552

TUFNELL PARK, CAMDEN/ISLINGTON Average house price: £734,463

WANSTEAD, REDBRIDGE Average house price: £515,595

As finance professionals are quite healthy, we can take this list as a starting point, with the following precautions:

We exclude 3 most expensive areas of NOTTING HILL, KENSINGTON & CHELSEA, FULHAM, HAMMERSMITH & FULHAM and RICHMOND. These are probably for the lucky investors, but we consider healthy wage-earners. Also, we do not find such boroughs as TUFNELL PARK, KINGS CROSS and CLAPTON in Tom's Slee data.

So, for our purpose we choose etalon London neighborhoods of BERMONDSEY, FURZEDOWN, HERNE HILL and WANSTEAD.

We follow the same approach for every other city.

The Airbnb data on Tom's Slee web-site are absent for Hong Kong, and are incomplete for Dublin and contradictory for Singapore. So, we manually search for the coordinates of the chose neighborhoods via Google search.

1. Machine learnings were used.

To compare cities we use hierarchical clustering, and we use it to compare the bags of venues. Although other options exist, we prefer hierarchical clustering for its ease in interpretation of the results as a dendrogram, and since its not intuitive to select the number of clusters a priori. One intuitive presumption would be that geographic distance between cities would play a large role in the clustering. This is true for recreational zones, but not for city centers.

1. Results

So, we ran two different clusterings. The first was for area 6km x 6 km cities centeres. Finance professionals in London work in the City, which is the central point. In alternatives, the financial institutions are also in the centers of each city.

The second run was for recreational areas, where financiers and their families live, we call such neighborhoods "sleeping" (though it is not exactly, since people not only sleep, but buy foods, bring their children to schools or kindergarten, walk and speak with their neighbors. We took 4 such "sleeping" neighborhoods, each was 0.8km x 0.8 km, i.e. the overall "sleeping" area was 2.56 square kilometers in every city.

Let us interpret the second run first (figure 1).

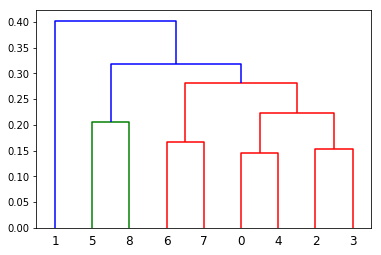


figure 1. Normalized vectors of bag-of-venues for "sleeping" areas.

As we see from the picture, London and Dublin are most similar. At the same time we see, that the data are consistent and logically clear, because we get 3 pairs of the similar and "close proximity" cities:

first pair – saxonic cities of London (8) and Dublin(5);

* second pair – German cities Frankfurt (2) and Berlin (3)
* third pair – South-east Asia cities of Singapore(6) Hong Kong(7)

A little confusing is the proximity of New York (0) and Amsterdam (4), since these are very different cities, with different culture and social and economic background.

As for Paris, which seems "far from any other city", such a result may be explained both be its uniqueness, and also by the selection of "unsatisfactory" neighborhoods sample. As we noticed above, there are a lot of places, where it is nice to live in Paris, and its difficult to make an unambiguous choice.

So, we finally conclude from "sleeping" neighborhoods comparison, that:

1. our methodology is consistent
2. Dublin is the most similar to London, without another option.

Now let us turn to the comparison of city centers (figure 2).

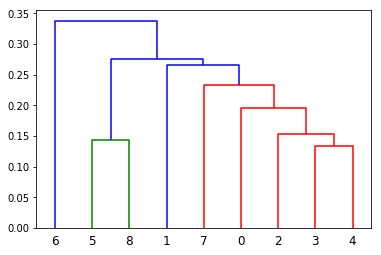


figure 2. Normalized vectors of bag-of-venues for city centers.

Again, we see that London and Dublin are most similar. But we also see Paris and Singapore as next similar to London alternatives.

Taking into account both runs, we conclude that Dublin is the most likelihood alternative for finance professionals to relocate to, with Paris taking the second place.

We also note that Asian "tiger" Hong Kong is much closer to London, then Amsterdam, Frankfurt or New York.

1. Discussion section

On our study, we normalized bag-of-venues vectors. It is interesting to see, if normalization is worth to do, or it adds nothing to the final result.

If we try to avoid normalization on a first run (comparing city centers), we get the following result:

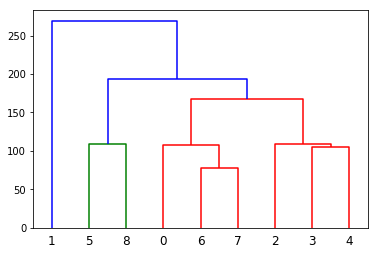


figure 3. Non-normalized vectors of bag-of-venues for city centers.

From the figure 3 we see, that London and Dublin still are the closest cities. But the second place now is indefinite. That means high level of noise in the result. I.e. though normalization does not crucially change the picture, it removes noise and is essential for the correct study.

1. Conclusion.

In this short coursework we have presented comparing cities as vectors of venue categories. We have identified and emphasized the choice of aggregation level as grid-centric, and showed that this methodology is consistent. To find the most closest alternative to London, we used hierarchical clustering and identified Dublin as a relocation alternative.

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15. Selecting recreational neighborhoods – follow the links:

* New York: (<https://www.niche.com/places-to-live/search/best-neighborhoods-for-families/m/new-york-city-metro-area/>)
* Paris: is very nice to live almost everywhere in the centre or Monmartr. The choice of best neighborhoods for Paris is quite arbitrary: <https://www.book-a-flat.com/magazine/en/where-to-live-in-paris>
* Frankfurt: <https://www.movingto-germany.com/frankfurt-neighborhoods/>
* Berlin: <https://www.movingto-berlin.com/neighbourhoods/>
* Amsterdam: <https://dutchreview.com/expat/moving/where-to-live-in-amsterdam-neighbourhoods-in-amsterdam/>
* Dublin: <https://www.crownrelo.com/intl/en-ru/moving-to-ireland/dublin-accommodation>
* Singapore: <http://www.livinginsingapore.org/seven-best-places-to-live-in-singapore/>
* Hong Kong: <http://www.livinginhongkong.org/7-best-places-to-live-for-expats/>