Migration simulation in EU

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Technologies

- python 3.7
- mesa (Apache2 licensed agent-based modeling framework in python)
- pandas
- numpy
- seaborn + matplotlib

Purpose

- Visualise how people relocate between countries
- Show how factors (e.g. „How comfortable people feel with immigrants in their country?”) can affect on decisions about migration

Data

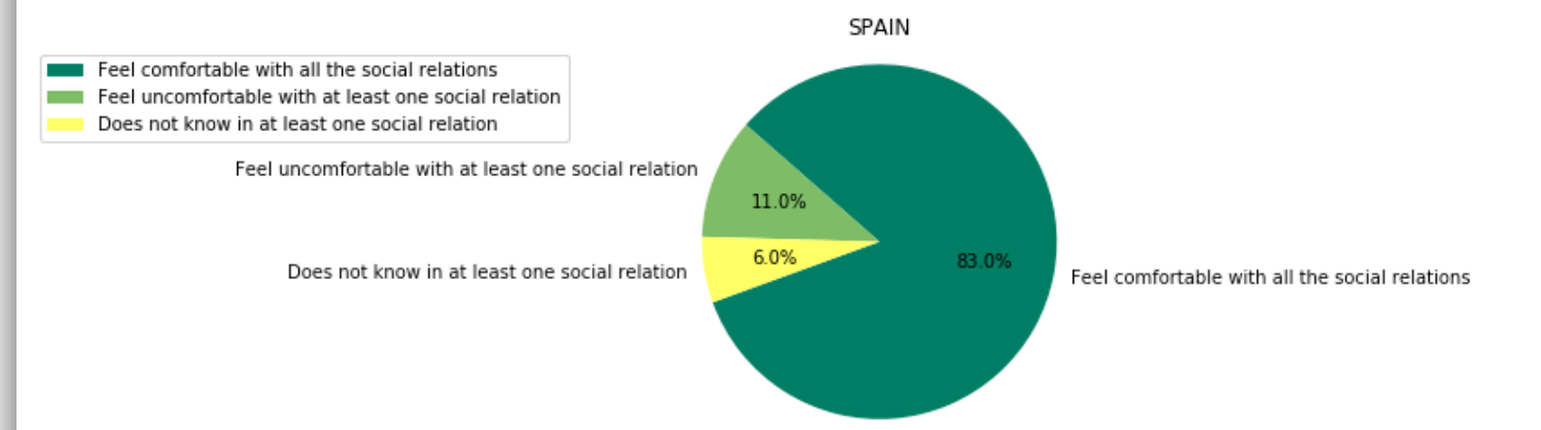
Data was gathered especially from EU reports.

Choosing the most important features for simulation and agents attributes can be observed in data_analysis notebook. One can found visualization of them

Example of data analysis and visualisation

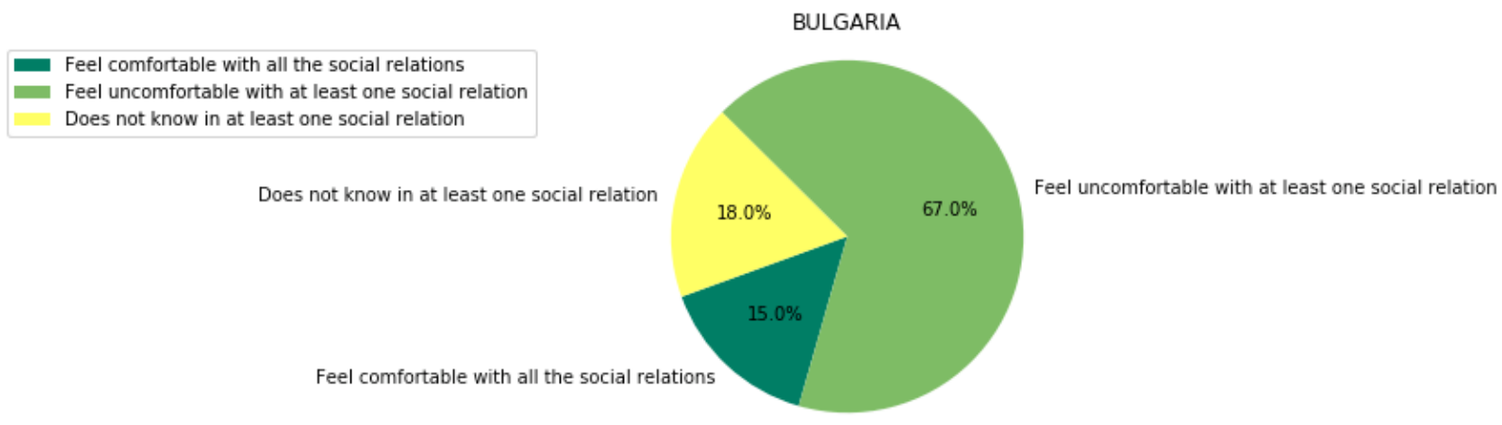
People in Spain feel the most comfortable with social relations with immigrants.
Below is the visualization for this country.

```
1 visualize_data_on_pie_chart('Spain', df_immigrant_as_your_X)
```



People in Bulgaria feel the most uncomfortable with social relations with immigrants.
Below is the visualization for this country.

```
1 visualize_data_on_pie_chart('Bulgaria', df_immigrant_as_your_X)
```



How it works?

- Agent's attributes: origin country, immigrant or not (if yes, current country is not same as origin country), race, religious denomination and how likely to travel is.
  E.g. „likely to travel" is sampled from random uniform from 0 to „likely to travel" value for agent's origin country.

- All features has corresponding multiplier to avoid outliers in happiness values.

- Agent can move only to neighbouring countries.

How it works?

- Agent can move only to neighbouring countries.
- Agent choose next country based on below formula:
    - Calculate happiness for all neighbouring countries
    - Probability of choosing the next country:

$$\frac{happiness}{sum - of - happiness - for - all - neighbouring - countries}$$

- To give agent possibility of staying in current country, happiness for current country is calculated as follow:

```
if self.current_country == self.origin_country:
    happiness_index[self.current_country] = self.likely_to_travel * self.happiness
else:
    happiness_index[self.current_country] = (1 - self.likely_to_travel) * self.happiness
```

- All values are a subject of sigmoid function to have values from 0-1

What is gathered?

- During the simulation, visited countries are collected in order to provide analysis of results (can be found in result_analysis notebook).

Results

- Animation showing number of people in each country in each step.

- Analysis of results (including e.g. correlation between religious denomination and choosing next country) can be found in result_analysis notebook.