Development of a Mobile app for Modeling and Visualization of Factors Affecting Life Expectancy

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***Abstract*—This paper describes approach to development of a mobile app "Microlife", which would enable its user to track, measure and visualize the effect of positive and negative factors affecting his/her life expectancy. The underlying approximate mathematical model is presented and main ideas behind it. Directions of further development are outlined.**

I. INTRODUCTION

The "microlives" concept proposed in [1] encourages the metaphor that people go through their lives at different speeds according to their lifestyle. Loosely interpreted, someone who smokes 20 a day is rushing towards their death at around 29 hours a day instead of 24. On the contrary, healthcare improvements and healthier life-styles may be moving someone's death away by up to 6 hours per day. This idea of premature ageing has been found to be an effective metaphor in encouraging behavior change.

The authors further develop this idea into a mobile app called "Microlife", which would enable its user to track, measure and visualize the effect of positive and negative factors affecting his/her life expectancy.

Section II contains the overview of the underlying approximate mathematical model. Section III is dedicated to general description of the “Microlife” mobile app. In conclusion we summarize the overall results of the work and directions of further development.

II. THE UNDERLYING APPROXIMATE MATHEMATICAL MODEL

There exist a number of studies regarding statistical relations between life expectancy and various factors, including, but not limited to alcohol consumption, smoking, overweight, sedentary lifestyle, and physical exercise – e.g. [1,2,3,4,5,6,7] as well as numerous other.

Following [1], a microlife is 30 minutes of person's life expectancy, which is approximately one-millionth of life expectancy for 22 year-old man or 26 year-old woman in UK (equal to 57 years). Here are some examples of what would, on crude average, cost a person 1 microlife: smoking 2 cigarettes, drinking 7 units of alcohol (e.g., 2 pints of strong beer), each day of being 5 Kg overweight. Derivations of these quantities are given in [1] and do not have to be repeated in this paper.

It should be noted that behaviors may interact (consumption of large amounts of beer may lead to overweight), and in every case the numbers are very approximate and in no case can be extrapolated to extreme behaviors.

Also the relation is not always linear, but rather U-shaped, when e.g. non-drinkers and heavy drinkers have higher all cause mortality rates, than light drinkers. Furthermore, the precise shape and location of the U likely depend on age, gender, and location, as well as genes, and needs to be quantified [4].

Nevertheless, the idea of premature ageing has been found to be an effective metaphor in encouraging behavior change [1]. The structural model allows to visualize the positive and negative contribution of various factors to the life expectancy of a person measured in microlives (Fig. 1).

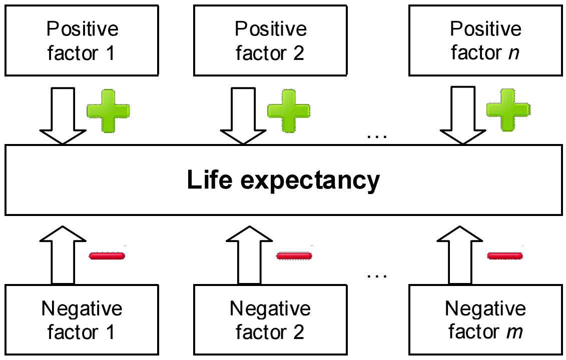

Fig. 1. Structural model

According to [8], change in life expectancy may be a more appealing measure of risk than the standardized mortality ratio (SMR). However, the Gompertz relationship, with some reservations, can provide a quick method of judging the change in life expectancy associated with a given SMR value.

According to the Gompertz approximation, the annual risk of dying at age t is approximated by a function $h_t=Be^{kt}$, where k and B are computed using statistical tables. This formula allows calculating the change in life expectancy proportional to the logarithm of SMR.

Using Gompertz model and SMR tables it is possible to calculate duration of 1 microlife for each of the factors: alcohol consumption, smoking, overweight, sedentary lifestyle, physical exercise, etc. For example, each day of having BMI by 5 kg/m^2 over the 25 kg/m^2 limit would costs approximately 19 minutes of reduced life expectancy. Similarly, for a 25 year-old each hour of low physical activity may cost approximately 25 minutes of reduced life expectancy.

The basic life expectancy also depends on age, gender and region of the user. The B and k coefficients for the Gompertz model for particular age, gender and region can be computed using statistical SMR tables using least-squares method.

III. "MICROLIFE" APP DESCRIPTION

The app performs the following functions:

- Input of initial user information (age, height, weight, gender) as well as occurrence of various factors affecting life expectancy and their parameters.
- Calculation of numerical values in microlives for the occurred events and SMR on daily basis and their total effect on life expectancy.
- Visualization of the total effect of the factors on life expectancy for the current day, as well as historical data in figures and charts.
- Various settings and help on app usage.

The app includes support module in Python for parsing the online Practical Science Database "Russia in figures" [9], which contains 28 databases with 4321 data series for 88 regions of Russia.

The mathematical module uses 3rd party libraries:

- Apache commons math [10] library of lightweight, self-contained mathematics and statistics components addressing the most common problems not available in the Java programming language.
- Joda-Time [11] – a quality replacement for the Java date and time classes.
- NumPy [12] – the fundamental package for scientific computing with Python.

The app is implemented for Android platform with user interface following Material Design guidelines [13]. Specifications for the app were developed based on IEEE Recommended Practice [14].

IV. CONCLUSION

The app had been tested on a group of users and has proven to be operational. The ongoing steps are publication in Google Play [15], and porting the app to iOS platform.

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