

Article

# Classification Maps in Studies on the Retirement Threshold

Agnieszka Bielińska <sup>1</sup>, Dorota Bielińska-Wąż <sup>2,\*</sup> and Piotr Wąż <sup>3</sup><sup>1</sup> Department of Quality of Life Research, Medical University of Gdańsk, 80-210 Gdańsk, Poland<sup>2</sup> Department of Radiological Informatics and Statistics, Medical University of Gdańsk, 80-210 Gdańsk, Poland<sup>3</sup> Department of Nuclear Medicine, Medical University of Gdańsk, 80-210 Gdańsk, Poland

\* Correspondence: djwaz@gumed.edu.pl

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**Abstract:** The aim of this work is to present new classification maps in health informatics and to show that they are useful in data analysis. A statistical method, correspondence analysis, has been applied for obtaining these maps. This approach has been applied to studies on expectations and worries related to the retirement threshold. For this purpose two questionnaires formulated by ourselves have been constructed. Groups of individuals and their answers to particular questions are represented by points in the classification maps. The distribution of these points reflects psychological attitudes of the considered population. In particular, we compared structures of the maps searching for factors such as gender, marital status, kind of work, economic situation, and intellectual activity related to the attendance the University of the Third Age, which are essential at the retirement threshold. Generally, in Polish society, retirement is evaluated as a positive experience and the majority of retirees do not want to return to their professional work. This result is independent of the kind of work and of the gender.

**Keywords:** medical informatics; statistical computing; data analysis; retirement threshold

## 1. Introduction

Classification studies are a valuable source of information in various areas of science. The problem of classification is related to the problem of similarity of objects. Objects arranged in simple, one-dimensional sets may be classified in a unique way according to one, properly chosen, aspect of similarity. The problem becomes more complicated if we consider multidimensional sets, i.e., objects characterized by several different aspects. The degree of similarity depends on the selected aspects, on the number of aspects considered and on the mathematical measure establishing the relations between different properties.

One of class of objects considered by us is biological sequences. Both graphical and numerical classification of these objects is possible using methods based on *Graphical Representations* [1,2]. Within these methods, one can create a large number of different types of numerical characteristics (descriptors) of the plots representing the sequences. One kind of descriptors we propose are the distribution moments related to different statistical distributions describing the DNA sequences. We have shown that using these descriptors a pair of the sequences that differ by only one base can be distinguished. The coordinates of the descriptors representing these sequences are different in the classification maps [1]. The distribution moments we have also introduced as new descriptors of another class of objects—the molecular spectra [3,4]. The applications of the theory of molecular similarity are broad. Except for the studies of the properties of the systems explicitly considered in our works, the new descriptors may have broad range of interdisciplinary applications. For example, they may be applied in computational pharmacology and toxicology [5]. Our new descriptors have

also found their application in the classification of the solutions in the chaotic systems [6], or in the classification of the stellar spectra [7,8]. Another kind of descriptor we propose are values used in the classical dynamics such as coordinates of center of mass or the moments of inertia. Examples of the classification studies using these descriptors may be found in the theory of molecular similarity [9] or in bioinformatics [10].

A class of objects considered in this work are groups of individuals. The studies are focused on the *retirement threshold*. A graphical representation of the results known as the *Correspondence Analysis* (CA) proves to be very useful in this kind of study [11]. Recently, CA was applied for studies on a variety of problems, for example, on high school dropouts [12], and also in archeology [13], in food science [14], etc. In the CA the information about the whole system is stored on maps in which objects under consideration are represented by points located in a specific way. The classification of the objects is here performed by studying distances between the points and, in particular, by identifying clusters of the points. Objects corresponding to the points which form a cluster are similar in some way.

Progress of medicine and lower fertility rate caused significant changes in the structure of modern societies. The number of seniors in developed countries is growing dynamically. In Poland in 2010 the percentage of people aged 65 and over was 19%. According to Eurostat forecasts, in 2030 the ratio of elderly people to the population aged 15–64 will be 36%, and in 2050—56% [15].

Due to acceleration of aging process, it seems reasonable to study the quality of life of older people. An important role in shaping the quality of life of seniors plays the retirement threshold, which is described in literature as symbolic moment—starting a new chapter in life. It involves many negative changes such as loss of professional status, deterioration of the economic situation, as well as reduction in the number of social interactions. On the other hand, pensioners have much free time for family life and hobby. Therefore, despite losing one of the most important roles in life, one can set new goals and develop non-professional passions. The change of social role from employee to retiree is a natural process, but such a big change in life may lead to negative psychological effects [16–19]. Changes in different aspects of life due to the retirement threshold have been studied in many countries. For example, changes in the sleep duration were studied in the United States [20] and Finland [21]; changes in the physical activity were studied in Canada [22], Belgium [23], and Finland [24–26]; and changes in the body mass index were studied in the United States [27] and Finland [28]. A variety of changes in the quality of life in different domains have been observed, for example, in the subjective wellbeing [29], in the use of time, activity patterns, in health and wellbeing [30], in the health-related quality of life [31], in the enjoyment of everyday activities [32], and in mobility [33]. The observed changes at the retirement threshold are not unique. Different factors, e.g., sex, social background, and education level, may determine whether they are positive or negative. Education is one of the most important factors determining worry-free retirement [34]. Recently, the Universities of the Third Age (U3A) became popular in many countries, and their positive influence has been broadly discussed [35–39]. The International Association of Universities of the Third Age (AU3A) is a global international organization. The AU3A network includes institutions from Asia, both Americas, Europe, and Australia. The attendance of U3A grows exponentially in the global scale. In China alone the number of universities for senior citizens has grown from 19,000 in 2002 to 70,000 in 2017. The corresponding numbers of students of U3A in China is even more impressive: from 1.8 million to 8 million.

In the present work, we study the influence of factors, such as gender, kind of work, marital status, intellectual activity related to the attendance the University of the Third Age, economic situation, on the expectations and on the worries related to the retirement threshold from the Polish perspective. Some pilot studies on the changes of the quality of life related to the retirement threshold using the World Health Organization Quality of Life-BREF (WHOQOL-BREF) questionnaire, and this graphical representation of the results we have already published [40–45]. The WHOQOL-BREF questionnaire is a standard tool in the quality of life research and many versions of this questionnaire have been created in different countries, for example, the Polish version [46], the Bangla version [47], the Spanish

version [48], or the Finnish version [49]. This questionnaire is composed of 26 questions. Two questions are related to *Overall Quality of Life and General Health*. The remaining 24 questions concern four domains: *Physical Health*, *Psychological*, *Social Relationships*, and *Environment*. Using this questionnaire, we have shown that CA classification maps are a convenient tool for the studies on the role of different factors in changing the quality of life after the retirement threshold, such as gender [42] and marital status [43] in four domains, job position in *Physical Health* and *Psychological* domains [44], or in *Social Relationships* and *Environment* domains [45]. In most of cases, these factors play an important role. The considered factors are particularly important in the *Psychological* and in the *Social Relationships* domains. The influence of different factors, such as age, education, marital status, and job position on the *Overall Quality of Life and General Health* has also been studied by us using this graphical approach and WHOQOL-BREF questionnaire [40,41].

## 2. Materials and Methods

In the present work, the points forming clusters in CA maps correspond to subgroups of all individuals and to their answers to the questions. We used two our own questionnaires: *Questionnaire for an Employed or a Self-Employed Person* and *Questionnaire for a Retiree* (see Appendix A).

The studies have been performed in the period from February 2017 to May 2017 in Bydgoszcz, the eighth largest city in Poland (~350,000 inhabitants). We considered 449 individuals (older than 50): 160 employees (100 females and 60 males) and 289 retirees (186 females and 103 males).

We split the group of the retirees to two subgroups: students of U3A denoted in the figures as *retirees2* and non-students of U3A denoted as *retirees1* (Appendix A, question No. 9R). We also split all the subgroups (*employees*, *retirees1*, *retirees2*) according to the marital status. We consider two subgroups: *married* and *others* (Appendix A, question No. 7ER). In subgroup *others* are those individuals who are single, separated, divorced, or widowed.

Groups of individuals and their answers to particular questions (e.g., answer No. 1: A1) are represented by points in the classification maps. In this way, we can classify different subgroups, i.e., we can find subgroups of these individuals who answer in a similar way to some specific questions considered in the questionnaires.

The clusters of points are defined by the angles between vectors and the lengths of these vectors. The initial points of all vectors are located at the central point (CP) of the map, i.e., at the crossing point of the dotted lines marked in the maps. The terminal points of the vectors are denoted in the figures by empty squares (groups of individuals) and by full circles (answers). The squares and the circles belong to one cluster if the angles between the vectors (CP-square and CP-circle) are small. The longer are the vectors, the stronger is the positive association. Angles close to 90 degrees indicate no relationship. If the angles are close to 180 degrees, then they indicate a negative association. The longer are the vectors, the stronger is the negative association.

The final results have been generated using the R statistics language [50].

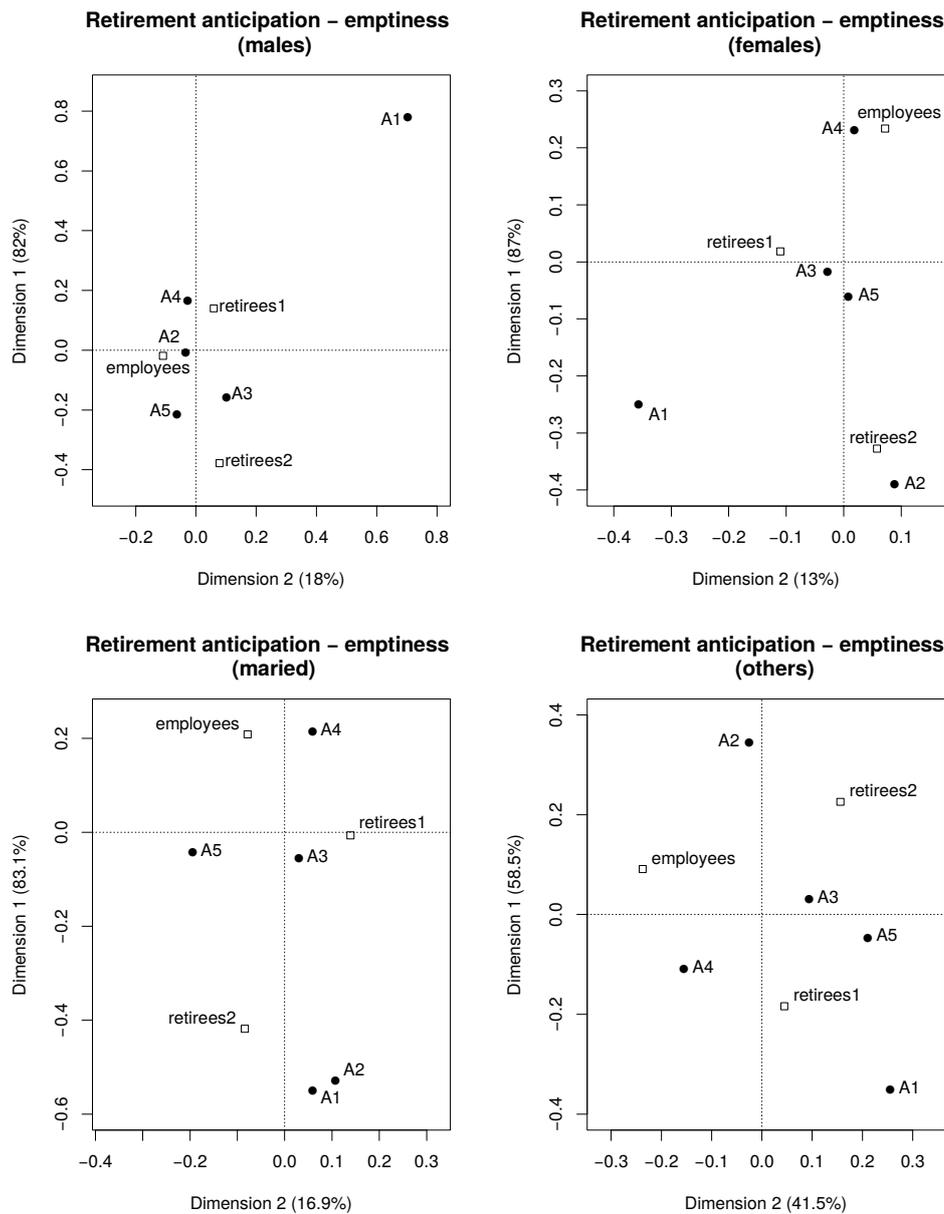
## 3. Results and Discussion

Figures 1–4 show the results (maps) obtained using CA.

Figure 1 shows maps related to the answers to questions about emptiness after the retirement (Appendix A, questions No. 21E and 18R). The structure of the maps for *males* and for *females* (top panels) are different. For *females* (top right panel), the angles between the vectors CP-*employees* and CP-A4, between CP-*retirees2* and CP-A2 are small. Consequently, we can extract two clusters:

- *employees*—A4,
- *retirees2*—A2.

The lengths of all of the vectors CP-*employees*, CP-A4, CP-*retirees2*, and CP-A2 are large. Then, the two associations are strong.

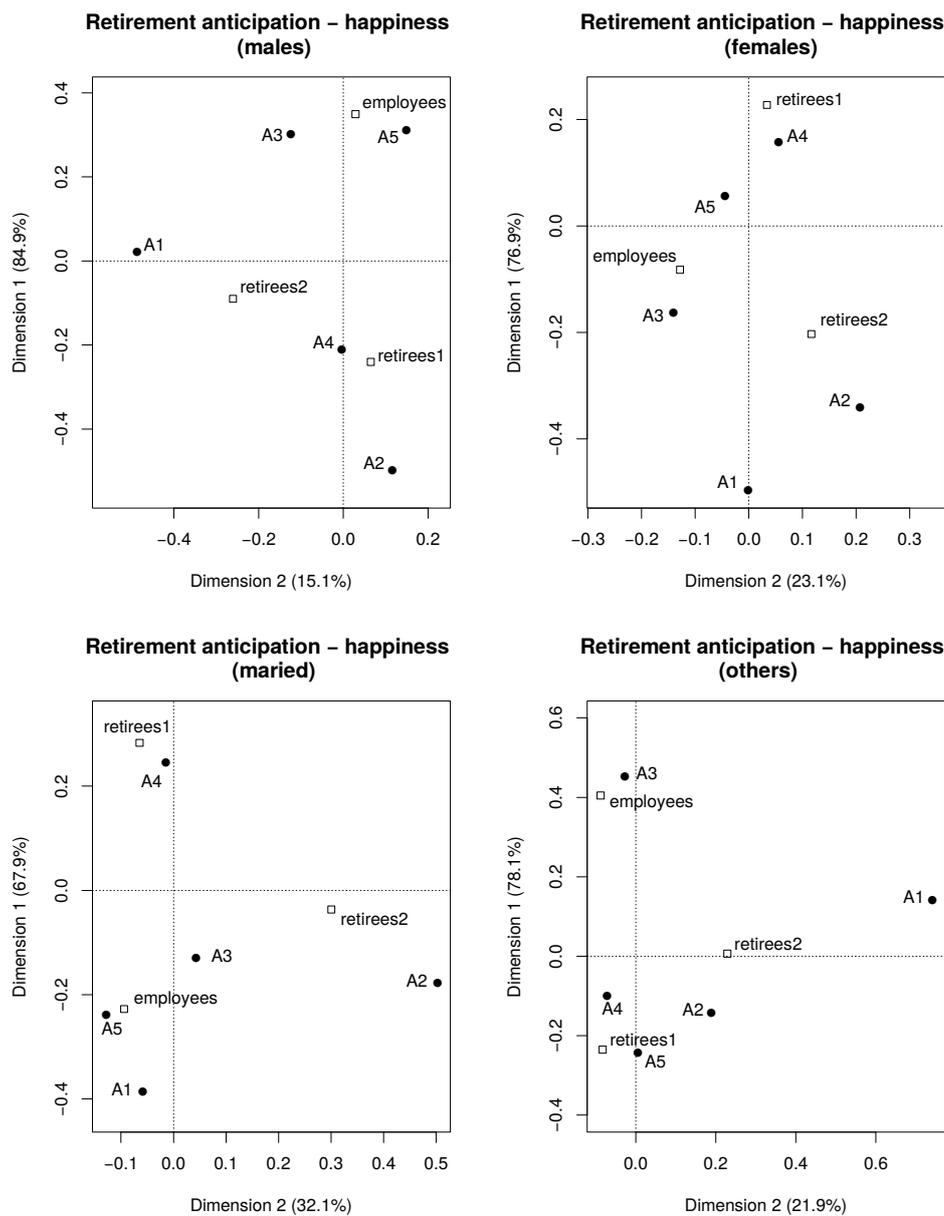


**Figure 1.** Classification maps (questions No. 21E and 18R).

For *males* (top left panel), the angles are nearly 180 degrees between vectors CP-*retirees2* and CP-*A4*, between CP-*retirees1* and CP-*A5*. Therefore, in this case, we have negative associations:

- *retirees2*—*A4*,
- *retirees1*—*A5*.

If the spread between the number of answers to different questions is large then the least common answers usually correspond to the negative associations. The least common answer about emptiness after retirement given by *retirees2* is *A4* “I was not afraid”. The least common answer about emptiness after retirement given by *retirees1* is *A5* “I was not afraid at all”. Depending on the lengths of the corresponding vectors, the strengths of the association may vary. In this case, the negative association for *males* is weak since the lengths of these vectors are smaller than for *females*. The point representing *employees (males)* is located close to the central point, so there are no strong associations of this group with any of the answers, while the most frequent answer for the *employees (females)* is *A4* “I am not afraid” (cluster *employees*—*A4*).



**Figure 2.** Classification maps (questions No. 15E and 15R).

Transition to retirement is a key moment when an individual must redefine his or her social roles, which is not always successful. Women more often define their social role as a family member: housewife and mother. After the end of their professional activity they find themselves in the role of grandmothers, participating in the family life of their children [51]. According to opinion polls in Polish society men are less involved in family life and performing household duties so after they terminate professional life they would stay without any activities and many of them may feel emptiness [52].

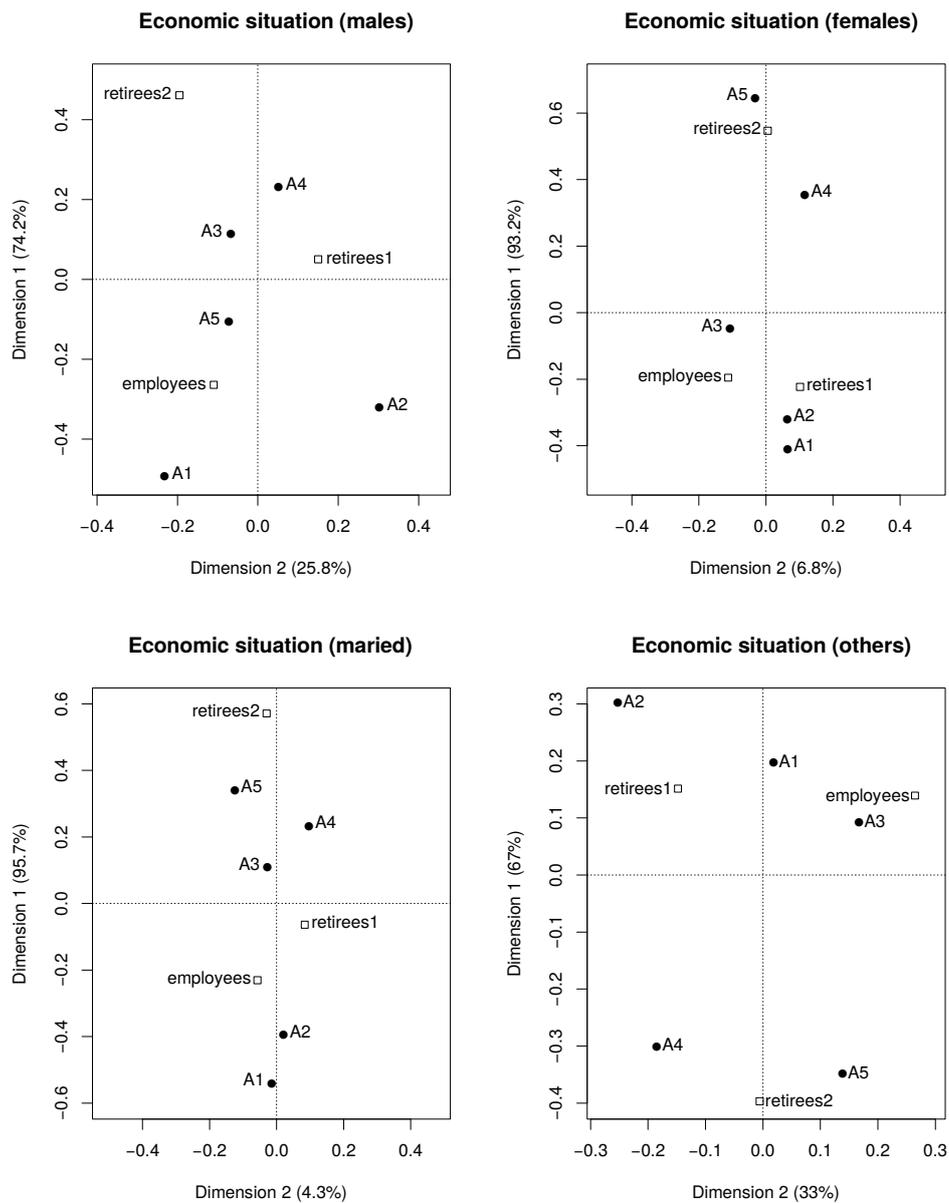


Figure 3. Classification maps (questions No. 19E and 20R).

If we consider the marital status, we observe negative associations for *married* (Figure 1, bottom left panel):

- *employees*—A1,
- *employees*—A2,
- *retirees2*—A4,
- *retirees1*—A5.

The angles between the vectors CP-*employees* and CP-A1, between CP-*employees* and CP-A2, between CP-*retirees2* and CP-A4, and between CP-*retirees1* and CP-A5 are close to 180 degrees. The least common answers for *employees (married)* about emptiness after the retirement are A1 “Yes, I am very much afraid” and A2 “Yes, I am slightly afraid”. The least common answer to this question of *retirees2 (married)* is A4 “I was not afraid”. The least common answer to this question of *retirees1 (married)* is A5 “I was not afraid at all”. As the lengths of CP-A5 and CP-*retirees1* are smaller comparing to other vectors, the association for *retirees1* is the weakest.

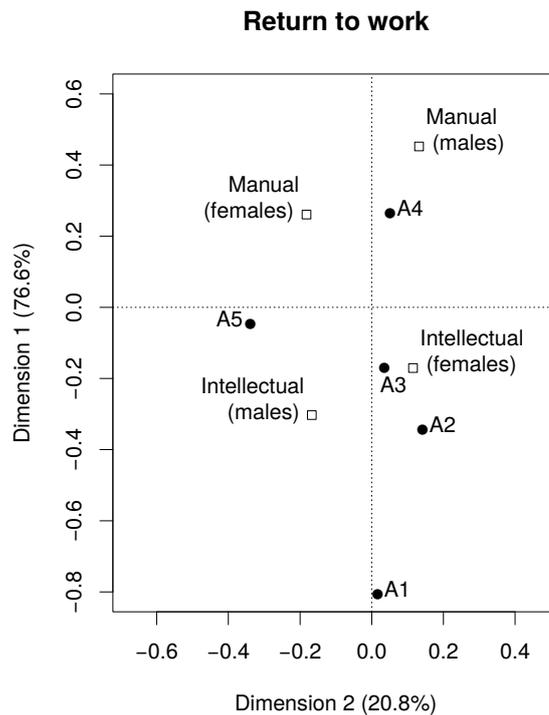


Figure 4. Classification map (question No. 25R).

For *others* (Figure 1, bottom right panel), the structure of the map is different than for *married*. We observe different negative associations:

- *employees*—A5,
- *retirees2*—A4,
- *retirees1*—A2.

Analogously, as for *married*, the least common answer to this question of *retirees2 (others)* is A4 “I was not afraid”. The marital status is not an important factor determining the kind of answer to this question for *retirees2*. For *retirees1 (others)* the least common answer is A2, whereas for *married* is A5. For *employees (others)* the least common answer is A5, whereas for *employees (married)* the least common answers are A1 and A2. For *employees* and *retirees1*, the marital status changes the results of the classification.

Similar studies can be performed for other aspects, for example, satisfaction with retirement (Appendix A, questions No. 15E and 15R). The results are shown in Figure 2: *males* (Figure 2, top left panel), *females* (Figure 2, top right panel), *married* (Figure 2, bottom left panel), and *others* (Figure 2, bottom right panel). The answer A1 corresponds to “Very unhappy”, whereas A5 corresponds to “Very happy”. We observe different clusters for *males* and *females*, so gender is an important factor influencing the kind of answer to this question. In particular, for *males* we observe the following clusters:

- *retirees1*—A2,
- *employees*—A5.

For *females* the clusters are:

- *retirees1*—A4,
- *retirees2*—A2.

The most frequent answer of *females* attending the U3A (*retirees2*) is the same as *retirees1 (males)*, i.e., A2. There are also several negative associations for *males*:

- *employees—A4*,
- *retirees1—A3*.

The least common answer for *retirees1 (males)* is A3. For *females* the negative associations are:

- *retirees2—A5*,
- *retirees1—A1*.

The least common answer for *retirees1 (females)* is A1. A5 is located close to the central point so the association for *retirees2 (females)* is weak.

If we consider the marital status, for this question, we also observe different clusters for *married* and for *others*. The marital status is an important factor influencing the results of the classification in this case. In particular, for *married* we observe the clusters (Figure 2, bottom left panel):

- *employees—A5*,
- *retirees1—A4*,

and for *others* (Figure 2, bottom right panel)

- *employees—A3*,
- *retirees1—A5*,
- *retirees2—A1*.

The associations *retirees1—A5* and *retirees2—A1* are weak for *others*. The most frequent answer for *employees (married)* is A5 “Very happy”, while for *employees (others)* the least common answer is A5 (negative association).

Figure 3 is concerned about the question on the adequate amount of money after retirement (Appendix A, questions No. 19E and 20R). Analogously to Figures 1 and 2, the top panels refer to *males* and to *females* and the bottom ones to *married* and to *others*. A1 corresponds to the answer “Not at all”, and A5 to “Quite enough”. For *males* (top left panel) the clusters are the following:

- *employees—A5*,
- *retirees2—A3*,

and for *females* (Figure 3, top right panel)

- *retirees1—A1*,
- *retirees1—A2*,
- *retirees2—A5*.

The negative associations for *males* are:

- *employees—A4*,
- *retirees2—A2*,

and for *females*

- *employees—A4*,
- *retirees2—A1*,
- *retirees1—A5*.

Employees and retirees estimate in a different way the economic situation during the retirement. Some differences are also between *males* and *females*. Considering the marital status, the clusters are also different. In particular, the group *employees (married)* clusters with A1, whereas *employees (others)* clusters with A3.

The summary is contained in the question about the return to the professional work (Appendix A, question No. 25R). The results are shown in Figure 4. The groups are split according to the kind

of work—*Manual labor* and *Intellectual labor* (Appendix A, question No. 4ER)—and according to the gender. Finally, four subgroups are considered and denoted in the figure as *Manual (females)*, *Manual (males)*, *Intellectual (females)*, and *Intellectual (males)*. The answer A1 is “Yes, full-time”, and the answer A5 is “Absolutely not”. We observe the cluster

- *Manual (males)*—A4.

The negative associations are as follows:

- *Manual (females)*—A2,
- *Manual (males)*—A1,
- *Intellectual (males)*—A4.

The most frequent answer of *Manual (males)* is A4 “No”. The associations of *Intellectual (females)* with A3 and A2 are weak. None of the groups clusters with A1 “Yes, full-time”. Our analysis shows that in Poland in 2017, reaching the retirement threshold is rather a positive experience.

In line with social expectations, the retirement age was reduced to 60 for females and 65 for males in October 2017.

#### 4. Conclusions

Summarizing, we described a non-standard approach to deriving information about objects met in the medical sciences based on an analysis of classification maps. We demonstrate that the graphical representation of the considered data (of the answers to some questions in the case of groups of individuals) is useful in health informatics, i.e., a lot of information is stored on one map. Searching for the so-called *clusters of points*, we can classify the objects. In this way, one can discover new properties of the considered objects. In the case of groups of individuals, we search for factors such as gender, marital status, kind of work, intellectual activity related to the attendance the University of the Third Age, economic situation, and determining the psychological attitudes of the considered population. For the creation of the classification maps, a statistical method, *Correspondence Analysis*, is used. New applications of the method are proposed: studies on expectations and worries related to the *retirement threshold*. Using standard methods, some considerable part of information may be lost. In particular, the commonly used Pearson’s coefficients measure the strength of the linear correlation between the variables. If the correlation is strong but nonlinear, for example, quadratic or exponential, then the standard methods, contrary to the CA, may show that there is no correlation or that the correlation is weak. Similar classification maps we are also going to apply in other medical informatics areas in forthcoming papers related to the studies on the quality of life and to bioinformatics.

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**Conflicts of Interest:** The authors declare no conflicts of interest.

#### Appendix A

##### Appendix A.1. Questionnaire for an Employed or a Self-Employed Person

###### I. Personal information

1ER. Gender:

A1. Male	A2. Female
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2ER. Age (years):

3ER. Education:

A1. Elementary school	A2. Vocational education	A3. High school	A4. University education	A5. Doctor's degree
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4ER. Kind of work:

A1. Manual labor	A2. Intellectual labor
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5ER. Business position:

A1. Staff	A2. Supervisor/manager	A3. Director/president	A4. Business owner
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6ER. In how many years do you plan to retire?

7ER. Marital status

A1. Single	A2. Married	A3. Separated	A4. Divorced	A5. Widowed
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8ER. Are you chronically ill?

A1. Yes	A2. No
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If yes, which disease you suffer from?

II. Questions about your current satisfaction level

9E. Are you satisfied with your job?

A1. Very dissatisfied	A2. Dissatisfied	A3. Neither satisfied nor dissatisfied	A4. Satisfied	A5. Very satisfied
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10E. Does your job make your life meaningful?

A1. Not at all	A2. Slightly	A3. Moderately	A4. Very much	A5. Essentially
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11E. How do you rate the interpersonal relations in your work?

A1. Very bad	A2. Bad	A3. Neither bad nor good	A4. Good	A5. Very good
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12E. Are you satisfied with your salary?

A1. Very dissatisfied	A2. Dissatisfied	A3. Neither satisfied nor dissatisfied	A4. Satisfied	A5. Very satisfied
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13E. Do you feel that you have enough energy to perform your work?

A1. Not at all	A2. Slightly enough	A3. Moderately enough	A4. Nearly enough	A5. Quite enough
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14E. Are you satisfied with your social life?

A1. Very dissatisfied	A2. Dissatisfied	A3. Neither satisfied nor dissatisfied	A4. Satisfied	A5. Very satisfied
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III. Retirement-related questions

15E. Are you happy that in several years/months you will retire?

A1. Very unhappy	A2. Unhappy	A3. Neither happy nor unhappy	A4. Happy	A5. Very happy
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16E. Do you think that after the retirement you will have enough energy to implement your aims?

A1. Not at all	A2. Slightly enough	A3. Moderately enough	A4. Nearly enough	A5. Quite enough
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17E. Are you afraid that after the retirement you may not be self-sufficient?

A1. Yes, I am very much afraid	A2. Yes, I am slightly afraid	A3. I do not think of it	A4. I am not afraid	A5. I am not afraid at all
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18E. Are you afraid that after the retirement you will feel lonely?

A1. Yes, I am very much afraid	A2. Yes, I am slightly afraid	A3. I do not know yet	A4. I am not afraid	A5. I am not afraid at all
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19E. Do you expect to have enough retirement income to support yourself?

A1. Not at all	A2. Slightly enough	A3. Moderately enough	A4. Nearly enough	A5. Quite enough
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20E. Do you think that you will be satisfied having a lot of free time during retirement?

A1. Very dissatisfied	A2. Dissatisfied	A3. Neither satisfied nor dissatisfied	A4. Satisfied	A5. Very satisfied
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21E. Are you afraid of emptiness after the retirement, because you will not be so active as before?

A1. Yes, I am very much afraid	A2. Yes, I am slightly afraid	A3. I do not think of it	A4. I am not afraid	A5. I am not afraid at all
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22E. Are you afraid that during the next several years your health is going to deteriorate?

A1. Yes, I am very much afraid	A2. Yes, I am slightly afraid	A3. I do not think of it	A4. I am not afraid	A5. I am not afraid at all
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*Appendix A.2. Questionnaire for a Retiree*

I. Personal information

1ER, 2ER, . . . 8ER (see Appendix A.1)

9R. Do you attend classes at the University of the Third Age?

A1. Yes	A2. No
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II. Professional work-related questions

10R. Were you satisfied with your job?

A1. Very dissatisfied	A2. Dissatisfied	A3. Neither satisfied nor dissatisfied	A4. Satisfied	A5. Very satisfied
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11R. Did your job make your life meaningful?

A1. Not at all	A2. Slightly	A3. Moderately	A4. Very much	A5. Essentially
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12R. How did you rate the interpersonal relations in your work?

A1. Very bad	A2. Bad	A3. Neither bad nor good	A4. Good	A5. Very good
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13R. Were you satisfied with your salary?

A1. Very dissatisfied	A2. Dissatisfied	A3. Neither satisfied nor dissatisfied	A4. Satisfied	A5. Very satisfied
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III. Just before retirement-questions

14R. Did you have enough energy to perform your work?

A1. Not at all	A2. Slightly enough	A3. Moderately enough	A4. Nearly enough	A5. Quite enough
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15R. Were you happy that in several years/months you would retire?

A1. Very unhappy	A2. Unhappy	A3. Neither happy nor unhappy	A4. Happy	A5. Very happy
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16R. Were you afraid that you would have not enough retirement income to support yourself?

A1. Yes, I was very much afraid	A2. Yes, I was slightly afraid	A3. I did not think of it	A4. I was not afraid	A5. I was not afraid at all
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17R. Were you satisfied that after the retirement you would have a lot of free time?

A1. Very dissatisfied	A2. Dissatisfied	A3. Neither satisfied nor dissatisfied	A4. Satisfied	A5. Very satisfied
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18R. Were you afraid of emptiness after the retirement, because you would not be so active as before?

A1. Yes, I was very much afraid	A2. Yes, I was slightly afraid	A3. I did not think of it	A4. I was not afraid	A5. I was not afraid at all
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IV. Questions about your current satisfaction level

19R. Do you think that after the retirement your health deteriorated?

A1. Yes, it did very much	A2. Yes, it did a little	A3. It is the same	A4. It is not worse	A5. On the contrary, I feel better
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20R. Do you have enough retirement income to support yourself?

A1. Not at all	A2. Slightly enough	A3. Moderately enough	A4. Nearly enough	A5. Quite enough
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21R. Are you afraid that due to your bad health you will not manage with your housework?

A1. Yes, I am very much afraid	A2. Yes, I am slightly afraid	A3. I do not think of it	A4. I am not afraid	A5. I am not afraid at all
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22R. Do you feel lonely?

A1. Yes, very much	A2. Yes, a little	A3. Neither yes nor no	A4. No	A5. Absolutely not
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23R. Are you satisfied with your social life?

A1. Very dissatisfied	A2. Dissatisfied	A3. Neither satisfied nor dissatisfied	A4. Satisfied	A5. Very satisfied
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24R. Are you satisfied with relations with your children and grandchildren (emotional relations, frequency of visits)?

A1. Very dissatisfied	A2. Dissatisfied	A3. Neither satisfied nor dissatisfied	A4. Satisfied	A5. Very satisfied
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25R. Would you like to return to your professional work?

A1. Yes, full-time	A2. Yes, part-time	A3. I do not think of it	A4. No	A5. Absolutely not
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