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Personalized Training Profile

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Abstract. The personalization of health and personal care services has become popular in the development of smart cities. In this sense, it is important to develop physical activities to prevent diseases and physical conditions that affect health. In this paper we define the problem called Personalized Training Profile to identify the initial physical and health conditions of a person and, subsequently, track these conditions based on factors such as age, height, weight, height, body mass, and body fat, among others, to predict possible scenarios during physical training and prevent injuries or negative health conditions.

Keywords: Personalized Training Profile, Physical health, sports medicine; Project Scheduling Problem.

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1 Introduction

Nowadays, sedentary behavior practices such as a life without physical activity and a static job result in health problems such as obesity, and cardiovascular diseases (CVD), among others. In 2012, the World Health Organization (WHO) reported that 17.5 million people worldwide died from CVD (WHO, 2019). As an example, Castillo et al. (2006), identified that an average of six people per day in Costa Rica die from cardiovascular problems, with other diseases such as smoking, childhood obesity, diabetes, alcoholism, and hypertension, among others.

Physical inactivity is a second cause of health implications, not conducting this type of activity, contributes to the first cause, which is CVD; according to the WHO (2019), 60% of the world's population does not engage in physical activity to obtain health benefits. The implications of a sedentary lifestyle, have, in turn, had an impact on the rates of overweight and obesity, where, as of 2016, 39% of the adult population (18 years and older), 39% are overweight and 13% obese (WHO, 2019).

Based on the current health conditions of the world's population, in 2004, the WHO published the WHO Global Strategy on Diet, Physical Activity and Health, which addresses two main strategies WHO (2019):
a. Diet
b. Physical activity

In the present work, we focus on identifying a problem related to section b, in which it is necessary to monitor physical activity, and the parameters of each person's health conditions. For this purpose, diverse ways of recording have been proposed, from not recording physical activity to using smartphone applications. Based on their ease of use, portability, and the possibility of automation through sensors, smartphone applications have become popular, both with sports professionals and with people who want - or need - to do physical activity; however, these applications do not meet the needs required for optimal control, both of physical activities and the behavior of the human body in the face of changes in activity and the stress caused by changes in habit, unmeasured effort and lack of planning.

Table 1 presents a list of mobile phone applications that track users' physical fitness. The applications allow the capture of personal data, and establish exercise routines, among others; however, they are not considered for the development of an individualized profile. These applications allow the selection of exercise routines without considering the physical characteristics of the person or the extent to which they relate to their health condition. These characteristics can be harmful to people who do not know their limits and may therefore be at risk of physical harm.

Table 1. Comparative table of applications specifying whether they are customized individual limits, and therefore may have a risk of physical damage.

App	**Descrip*tion***	**Disciplin*e***	**¿*Health data*?**	**Pre-established routines?**	***Customized* routines?**
(Fitstar.com, 2019)	• Features fitness routines • Free and paid plans with beginner, intermediate, and advanced-level videos • Manually tracks progress and calorie tracking	Physical fitness	Yes	Yes	Yes
(Jefit Inc., 2019)	Personalized exercise plans and routines. Indoors and outdoors performance Time tracking and progress measurements.	Physical conditioning and weight training	Yes	Yes	Yes
(StrongLifts, 2019b)	Routines with video recording of the progress of the chosen self-training program for powerlifting at the basic level and with advanced functions in the paid version.	Weight training	Incomplete data	Yes	Yes
(StrongLifts, 2019a)	Fitness-type weight loss exercise routines and eating plans based on the initial profile.	Physical fitness	Yes	Yes	Yes
(Runtastic, 2019)	Calorie tracking and various running and fitness activities for weight reduction as well as GPS route, calorie, and distance tracking. Advanced functions in the paid version.	Running y fitness	Yes	Yes	Yes
(Puma, 2019)	Diverse types of training are available: fitness, strength and bodybuilding, speed and endurance, flexibility, and balance. Data is recorded and shared on a common web space to measure progress.	Physical fitness	Yes	Yes	Yes
(Perigee AB,	Diverse routines at various	Physical	Yes	Yes	Yes

2019)	levels for seven minutes to one hour. It offers twelve basic exercises; more exercises can be added and customized.	fitness			
(Beachbody, 2019)	Use is by invitation only. Various activities and meal plans are available.	Physical fitness	Yes	Yes	No
(MyFitnessPal, 2019)	It is based on the creation of a profile as a training target and the level of physical activity. It provides a food system, calculates the calorie level, and is associated with exercise routines.	Physical fitness	Yes	Yes	Yes
(Endomondo, 2019)	It features performance analysis and improvement, various routines and feeding functions, and advanced routines in the paid version.	Running & Cycling	Yes	Yes	No

In this research, the problem of Personal Training Profiling is defined as the personalized monitoring of physical and health conditions for the development of physical activities and to prevent negative health conditions or injuries, where different variables are identified that, if not monitored on time, can affect the physical performance of the person and even have negative health consequences. This proposal defines a mathematical model for its study and the initial simulation proposal based on the concept of the Project Scheduling Problem (Díaz-Parra, 2016) and the chess game. Finally, conclusions and future works are presented which, for this first definition of the problem, it is necessary to deepen in different fields of knowledge: health, sport, and computing, among other areas that allow better performance in the development and monitoring of health conditions and well-being of people.

2 Experimental procedures

Based on the proposed definition of the Personalized Training Profile (PTP), we have integrated different variables related to health and physical conditions that cover different aspects, which provide important information to determine the physical scope that the person can have, the physical complexion that can be developed, among other aspects that can be determined from this proposal. In this proposal, we start with three stages:
- Initial Physical Condition
- Mathematical model and algorithm
- Implementation

2.1 Starting physical condition

Corbin, Pangrazi, and Franks (2000) mention that physical qualities related to health include, among others, endurance, flexibility, strength, speed, and agility. Each body has its unique characteristics, so it is necessary to have the basic data before starting physical activity:
- Personal information
    - Age
    - Sex
    - Weight
    - Height
    - Body measurements (wrist, waist, shoulders, ...)

    - Body fat
- Health condition
    - Physical difficulty
    - Fluid retention
    - Respiratory condition
    - Cardiac condition
    - Disease
- Initial physical condition
    - Endurance
    - Speed
    - Strength
- Desired profile: in the case of the desired profile, this must correspond with the calculation of aspects based on the initial condition, so we must work on correspondence. For this, we start from the assumption presented in Table 2.

Table 2. Correspondence table of Biotype and Complexion Scale, and as a result, the physical scale.

	Endomorphic	Ectomorphic	Mesomorphic
Anorexia	*Thin*	*Fitness*	*Natural*
Underweight	*Thin* *Fitness*	*Natural*	*Curvy / Muscled*
Normal	*Natural* *Fitness* *Athletic*	*Natural* *Fitness* *Athletic*	*Curvy / Muscled*
Overweight	*Natural* *Athletic*	*Natural* *Curvy / Strong Muscled*	*Curvy / Strong Muscled*
Mild obesity	*Natural* *Athletic*	*Natural* *Curvy / Strong Muscled*	*Curvy / Strong Muscled*
Moderate obesity	*Natural*	*Natural* *Curvy / Strong Muscled*	*Natural* *Curvy / Strong Muscled*
Morbidly obese	*Natural*	*Curvy / Strong Muscled*	*Curvy / Strong Muscled*

2.1 Mathematical model

For the proposal of the PTP problem, we rely on the definition of Project Scheduling Problem (PSP) proposed by Ruiz-Vanoye et al. (2010) and the mathematical model of Huang et al. (2009), to present the equations that make up the mathematical model (equations 1 - 5):

$$T_j(\xi, x) = x_j v\, max\{T_j(\xi, x) + \xi_0\} \quad (1)$$

$$T_j(\xi, x) = \max_{(i,E)\in A}\{T_j(\xi, x) + \xi_{iE}\} \quad (2)$$

$$R = \sum_{(i,j)\in A} y_{ij} r_{ij} \quad (3)$$

$$\Sigma_{(i,j)\in A} k_{ij} - \Sigma_{(i,j)\in A} k_{ji} = \begin{cases} 1, & i = 1 \\ 0{,}2 \le i \le n-1 & \\ -1 & 1 = n \end{cases} \quad (4)$$

$$C(\xi, x) = \sum_{(i,j)\in A} c_{ij} + a * T(\xi, x) + (T(\xi, x) - T^0) * C \quad (5)$$

PTP can be considered as an acyclic graph G={N_1, N_f, Arcs, N_o} where N_1, is node 1 identified by the initial characteristics of the $person_x$, the final node is represented by N_f, this node being the desired physical state of the personx, The set of arcs (Arcs), is a sequence of intertwined activities $arc_{(i,j)}$, where each arc represents the improvement [or regression] of person x to his physical condition, time being a duration represented by a stochastic variable of the transition from activity i to activity j. The cost of the development of activity (i,j) is represented by C_{ij}, while the resource cost is denoted by r_{ij}. And finally, N_o, is the optimal node that is calculated concerning the individual conditions of the $person_x$ and an approximate function of N_f.

The development of a project is presented in Figure 1, where in the example a set of activities A = {a_1, a_2, a_3, a_4, a_5, a_6} is presented. The sequence of activities is represented by the arc (i,j) associated with an activity development cost and a resource cost.

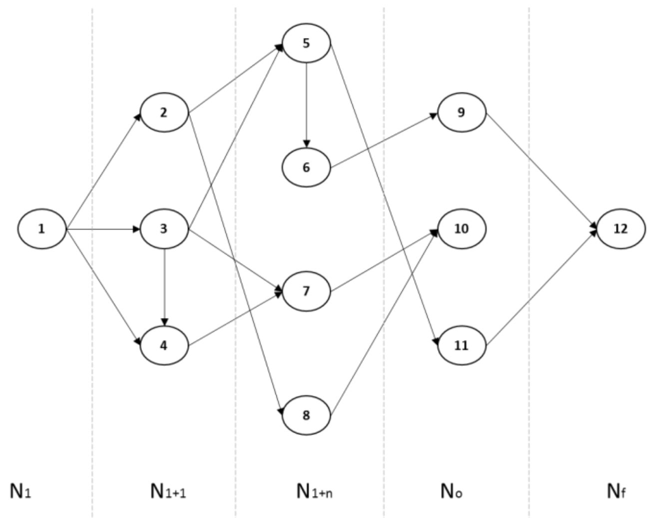

Fig. 1. IJCOPI logo.

2.2 Algorithm

In this initial proposal, PPE is based on the following algorithm (Figure 2), where the main stages are set out. At each stage, different techniques, and methods from artificial intelligence, mathematical or decision-making areas can be applied:

1. the $person_x$ data (N_1) and the desired profile (N_f) are recorded.
2. Calculate the body base data, health conditions, initial physical condition, and the range of exercise intensity that integrates the PFP (N_{x1}+ ~N_{x1}).

3. Calculation of the different scenarios until the optimal training profile (OTP) is reached.

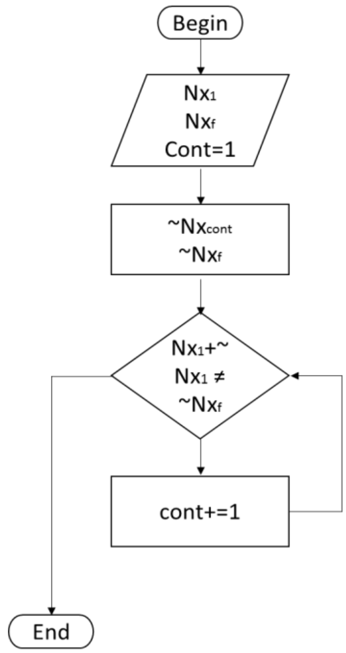

Fig. 2. PTP Algorithm

2.2 Implementation

Body Basis

- Body mass (BMI): The Kettle index (or Body Mass Index) is only applied to men and women in the age range of 20 to 64 years; however, these results may vary in case some conditions make this index vary such as pregnant women, breastfeeding women, among others. To calculate this index, the height in meters is taken and squared, then the body mass in kilograms must be divided by the figure obtained first (Osuna-Ramirez et al., 2006).

$$BMI = Body\ Mass\ (kg)/\ [Height\ (m)]2 \qquad (6)$$

- Complexion: Based on the BMI, the person's complexion type is selected Complexion (table 3).

Table 3. BMI-based complexion types.

Complexion scale	*Range*
Anorexia	*under 14.0*
Underweight	*14-18.5*
Normal	*18.5 - 24.9*
Overweight	*25.0 - 29.9*
Slightly obese	*30.0 - 34.9*
Medium obesity	*35.0 - 39.9*
Morbidly obese	*40.0 - more*

- Biotype: The definition of biotype depends primarily on each author; for this document, we base ourselves on the definition proposed by Zerón (2011) and the genial.guru site (2019) where they define the following biotypes based on wrist measurement (table 4):
    - Ectomorph: low muscle mass and low fat, long limbs and thin bone structure, difficulty gaining weight and muscle.
    - Mesomorph: normal muscle mass and little fat, athletic by nature, build muscle easily, predisposition to gain muscle mass and not to accumulate fat.
    - Endomorph: high muscle mass and high fat, generous size, broad and heavy bones, short legs.

Table 4. Biotype based on wrist measurement.

Biotype	***Men***	***Women***
Ectomorph	*18-20 cm*	*15-17 cm*
Mesomorph	*More than 20 cm*	*More than 17 cm*
Endomorph	*Less than 18 cm*	*Less than 15 cm*

- Physical scale: based on different authors such as Cardozo et al. (2016), among others, we have defined a classification for the physical scale based on the percentage of muscle fat a person possesses (table 5).

Table 5. Body fat percentages to establish the physique scale.

Physical scale	**% body fat**
slim	*5 - 9%*
natural	*12 - 16%*
fitness	*7 - 10 %*
athletic	*10 - 15%*
curvy	*15- 18%*
muscular	*3 - 7 %*
Strong	*16- 20%*

- Physical Condition: Guío-Gutiérrez. (2010) mentions that each author expresses uniquely and uniquely the concepts about physical capacities and qualities. For this research, we have directed physical conditioning towards the measurement of the following:
    - Flexibility
    - Endurance
    - Speed
    - Strength

- Exercise intensity: Another important aspect is exercise intensity, which can be determined based on the heart rate allowed for each person based on their age. According to Mayo Clinic (2018), the way to calculate the maximum heart rate is to subtract age from the value of 220, which is the maximum number of times the heart should beat per minute during exercise. According to the American Heart Association and the Centers for Disease Control and Prevention, an ideal heart rate is recommended in the following range:
    - Moderate exercise intensity - Minimum heart rate (50% - 70%).
    - Optimal exercise intensity - Optimal heart rate (70% - 85%)
    - Intense exercise intensity - High heart rate (100%)

3 Results

The characteristic of this type of problem called NP (Non-Probabilistic) is that there are an exponential number of combinations (Ruiz-Vanoye et al., 2018). For each decision taken, it is necessary to recalculate the possible scenarios, and the possible outcomes and establish a new optimal outcome until the choice of the final profile (Figure 3).

If we have the following data for a 40-year-old man, we can simulate four scenarios (negative, positive, optimal and extreme):

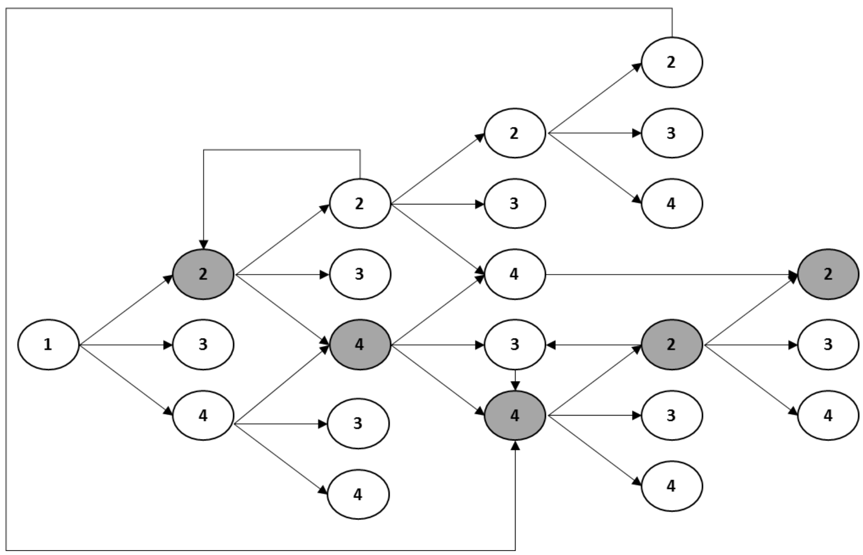

Fig. 3. Multiple Scenarios.

For the simulation process, we used Project Scheduling Problem (PSP) as an artificial intelligence technique and as decision variables, the methodology used in chess, where, when making a move, we have an exponential process of possible results and events that, when combined with the opponent's behavior (in this case some factors that cannot be controlled), generate multiple scenarios and multiple results until the expected outcome is reached. Firstly, we start from the initial physical condition determined by Tables 6, 7, and 8.

Guillén-García and Ramírez-Gómez (2011) mention that the following tests can be applied to measure the parameters related to physical condition:

- Speed: the 50 m test that measures time (seconds) can be applied.
- Endurance: the Cooper test, which measures the distance covered in 12 minutes, can be applied
- Flexibility: the vertical anterior trunk flexion test, which measures flexion-extension in centimeters.
- Leg strength: the longitudinal jump test, which measures distance, is applied.
- Arm strength: medicine ball throwing test that measures the length achieved.
- Agility: the agility circle can be applied, in which an obstacle course must be performed, and which is counted in seconds, among others.

On the other hand, Mojica, Poveda, and Pinilla (2008), present similar tests. In the case of the Torres-Anaya et al. (2018) research, the tests applied were focused on measuring the effects of an exercise program for university students, obtaining positive results.

For the case of the present research, the calculation of the parameters of strength, and flexibility, among others., will not be studied; however, it is necessary to consider them to estimate a range from 1 to 100 based on the results achieved in each test.

Table 6. Personal data

Indicator	***Data***
Age	*40 years old*
Sex	*Men*
Weight	*100*
Height	*1.75m*
Wrist measurement	*21 cm*
Waist	*112 cm*

Table 7. Initial Health Condition

Indicator	***Data***
Physical difficulty	*None*
Fluid retention	*No*
Respiratory distress	*No*
Cardiac difficulty	*No*
Disease condition	*None*

Table 8. Initial physical condition

Indicator	***Data***
Flexibility	*60*
Endurance	*40*
Speed	*40*
Strength	*70*

Secondly, the body base (table 9) and the recommended exercise intensity (table 10) are calculated.

Table 9. Base corporal

Indicator	***Data***
Body fat	*25%*
Body mass	*29.38*
Biotype	*Mesomorph*
Scale build	*Overweight*
Physical scale	*Strong*

Table 10. Recommended exercise intensity

Indicator	*Data*
Heart rate Intense	*180*
Optimal heart rate	*126-153*
Heart rate Moderate	*90-126*

The third is to identify scenarios from these data. This requires re-measuring the same parameters over a defined period (e.g., every month), to determine the progress or regression concerning the initial data and, in this way, to make a database with the behavior of each person concerning their physical and health performance. The data that vary for the development of exercise and/or diet (independent of this proposal), should be considered to predict concerning the chosen techniques, recommending artificial intelligence or statistical techniques (future work).

For this case, considering the three scenarios would be the following:

- Negative: increase in weight, body fat, and waist size; and deterioration of physical fitness.
- Positive: Maintain data with minor variation.
- Optimal: decrease in weight, body fat, and waist size; and improvement in physical fitness
- Extreme: decrease in weight, body fat, and waist circumference; deterioration of physical fitness; deterioration of muscle mass.

In the follow-up of this person, it was observed that in the development of moderate physical activity (walking, change of eating habits, and sporadic exercise), over 3 months, the following parameters changed:

Table 11. Parameter modification

Indicator	*Data*
Weight	***92***
Waist cm	***100***
Body fat	***20%***
Body mass	***27.03***
Flexibility	***60***
Technique	***45***
Endurance	***40***
Speed	***40***
Strength	***70***

Based on Table 2 and the data of the analyzed person (tables 6, 7, 8, 9, 10, and 11), the overweight-ectomorph ratio is obtained, which means that a natural, strong, or muscular physical scale can be obtained. For this analysis, an optimal scenario was obtained as a result, where a decrease in weight, body fat, and waist size was obtained, as well as an improvement in physical condition.

4 Conclusions

This proposal is a first approach towards the definition of the problem Personalized Profile for Training, where different parameters related to the health and physical condition of the person have been considered, from the first record (initial data or node 1) to the conclusion in an optimal state of health; however, this physical condition and health may or may not have an optimal state, since the data are modified day by day or situations arise where such data are altered by conditions external to the person. With this proposal, we seek to initiate a line of research in which different areas of study such as medicine, sports medicine, physical conditioning, computing, and gastronomy, among others, generate data tables according to each person and each specific situation.

Regarding future work, a simulation will be developed with the techniques and an application will be generated to record data and thus generate the best decision-making to have an optimal training and health profile.

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