Functional Software Prototypes for Defining and Monitoring Individual Exercise Program

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INTRODUCTION

According to a report issued by the World Health Organization (2011), about 63% of the estimated worldwide deaths in 2008 were due to chronic diseases. In Brazil, the percentage of deaths is even higher, reaching 72% according to the Ministério da Saúde (2011) (Brazillian Ministry of Health). Such diseases are characterized by a long continuous treatment along with, in general, a slow progression as shown by the World Health Organization (2011). Among the chronic diseases are: heart disease, kidney disease, cancer, diabetes, hypertension, chronic respiratory diseases and obesity.

The prevalence of obesity is considered a major public health problem in both developed and developing countries, according to the Agência Nacional de Saúde Suplementar (2007) (Brazilian National Health Agency). As shown by Gomes & Lerario (2009), Brandão et al. (2009), obesity is also directly related to the development of other chronic diseases such as heart disease, diabetes, and hypertension. In developed countries as well as in some emerging countries, including Brazil, the costs of treatment of these diseases that are a result of obesity are significant. In Brazil, approximately 10% of the money invested in the National Health System is a result of the overweight or obese, as shown by Bahia et al. (2012). The gravity of the situation is such that in the United States, the costs of obese patients exceeded the costs of smokers (Cawley & Meyerhoefer, 2012) (Moriarty et al., 2012).

Some risk factors are associated with chronic diseases. The main risk factors are smoking, physical inactivity, unhealthy food consumption and abuse in alcohol consumption. Among these, there is physical inactivity. Daily physical activity enables numerous health benefits to the individual. Some of these benefits are weight control and reduction of cardiovascular disease, type 2 diabetes mellitus, and the risk of cancer (Bianchini, Kaaks, & Vainio, 2002). Thus, it can be stated that daily physical activity helps reduce the risk of death from chronic noncommunicable diseases. Even the World Health Organization (2013) itself, in its Global Action Plan, promotes physical activities and exercises for this purpose.

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However, people seek physical activity not only when they are sick or obese. The quest for physical exercise occurs for various reasons, such as: aesthetic reasons, for a better physical condition, for leisure and health issues, which can have a preventive or treatment character. So many different reasons make it not possible to elect a default environment, or establish similar environments, where the practice of exercise should be done exactly the same way. A person can work in different ways, a bodybuilding gym in your own home or even in public parks.

According to Melzer et al. (2004), despite the benefits, some care must be taken during regular physical exercise, seeking to avoid problems such as musculoskeletal disorders, dehydration, heat stroke, sudden cardiac death, and oxidative stress. Such problems often occur due to unsupervised practice and / or irresponsible exercise. Furthermore, Melzer et al. (2004) states that these types of practices can be extremely detrimental and even lethal to both healthy and unhealthy people due to the possibility of physiological disorders.

In order to prevent such disturbances, it is expected that the individual performs the physical exercises according to recommendations set by health professionals (doctors, physiotherapists, fitness trainers, etc). One problem is that, from a physiological point of view, each individual is unique. Obviously, for certain purposes, two individuals may belong to the same equivalence class and thus can be treated similarly. However, any two individuals can not generally follow the same recommendations for the practice of their exercise. This is due to their specificities. Fletcher and Trejo (2005) state that recommendations are customized according to age, weight, history, and predisposition to certain diseases, fitness, health, etc.

One overwhelming problem in having a professional overseeing the physical activity is the financial cost to keep this professional dedicated to only one person for the time and place that is convenient for an individual. This paper presents two prototypes of software tools used to set exercise programs. Such tools provide customized recommendations given the physiological characteristics of each individual and the nature of the exercise to be practiced.

BACKGROUND

An automaton is a device able to represent a language according to well-defined rules. A deterministic finite automaton is formally defined as follows: a deterministic finite automaton, denoted by G, is a tuple $G = (Q, \Sigma, \delta, q_0, Q_m)$, where: Q is the finite set of states; Σ is a finite alphabet, also called the finite set of events; $\delta: Q \times \Sigma \rightarrow Q$ is a function, usually partial, transition; q_0 is the initial state; and $Q_m \subseteq Q$ is the set of states marked, also called accepting states or final states.

An automaton G operates as follows. It starts at its initial q_0 and the occurrence of some event $e \in \Sigma$, it performs a transition by changing from the state q_0 to $\delta(q_0,e) \in Q$. It is desirable to extend the transition function δ of the domain $Q \times \Sigma$ to the domain $Q \times \Sigma^*$ recursively as follows: $\delta(q, \varepsilon) = q$, $\delta(q, we) = \delta(\delta(q, w),e)$ and for $w \in \Sigma^*$ and $e \in \Sigma$. Thus, one can use δ directly with words (sequence of events) function, even if the word represents a single event, or even no event (the empty word).

Related Works

In the context of software developed to monitoring exercise technology, two works that have been developed for clinical and home environments stand out. They are presented by Fasola and Mataric (2010) and by Harden et al. (2012). The follow-up works presented by Ho and Chen (2009) and Andersen et