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Homage to the Memory of Academician Tiberiu Popoviciu

ELENA POPOVICIU
(CLUJ-NAPOCA)

October 29th, 2005 marks the 30th anniversary of the great academician's death. This volume of our *Annals* pays homage to his memory.

Tiberiu Popoviciu played an important role in the development of science, in general, and in the development of mathematics, in particular, as well as the creation of new fields of research in this domain of scientific thinking.

In 1957, Tiberiu Popoviciu founded the first Institute of Calculus, with a multi-disciplinary structure, in south-eastern Europe. The Institute of Calculus in Cluj-Napoca, of the Romanian Academy, succeeded to gather around it a group of gifted mathematicians, under the guidance of Tiberiu Popoviciu. The department of calculus machines of the Institute brought together a multi-disciplinary team (mathematicians, economist, physicist engineers) with the aim of building some very advanced computers. Thus, under the supervision of Tiberiu Popoviciu

Free knots for spline regression

PETRU P. BLAGA
(CLUJ-NAPOCA)

ABSTRACT. The simple spline regression with free knots is considered. An iterative procedure to obtain the values of the knots based on a multiple linear regression is established. Finally, some numerical experiments are considered.

1 Introduction

The relationship between a response (dependent) variable Y and a set of regressor (independent) variables X_1, \dots, X_p , can be explained by a functional relation

$$(1.1) \quad Y = f(X_1, \dots, X_p) + \varepsilon,$$

which is called *multiple regression model*. The *error term* (*random noise*) ε is a random variable with $E(\varepsilon) = 0$. The statistical technique for such investigating and modelling is named *multiple regression analysis*. We remark that the conditional expectation $E(Y|X_1, \dots, X_p) = f(X_1, \dots, X_p)$ is called *regression function* of Y on X_1, \dots, X_p .

If the form of the regression function f is known except for certain parameters, i.e.

$$(1.2) \quad Y = f(X_1, \dots, X_p; \beta_1, \dots, \beta_s) + \varepsilon,$$

From the Iwasawa decomposition to a Tits system

BRIGITTE E. BRECKNER CHRISTIAN SĂCĂREA
(CLUJ-NAPOCA) (CLUJ-NAPOCA)

ABSTRACT. Using properties of the parabolic subgroups in a semisimple Lie group G with finite center, we show how an Iwasawa decomposition of G gives rise in a natural way to a Tits system. Our approach differs from that taken in [5].

KEY WORDS: Tits system, parabolic subgroup, root system, Weyl group, semisimple Lie algebra, semisimple Lie group, Iwasawa decomposition

1 Root systems and parabolic sets

Throughout this section we are concerned with a fixed finite dimensional real vector space V endowed with the scalar product $\langle \cdot, \cdot \rangle$. Denote by $\text{Gl}(V)$ the group of automorphisms (bijective linear maps) $V \rightarrow V$. We recall that geometrically, a *reflection* is an automorphism of V leaving pointwise fixed some hyperplane (subspace of codimension one) and sending any vector orthogonal to that hyperplane into its negative. Evidently a reflection is orthogonal, i.e., preserves the scalar product on

On the Multidimensional Euler Contour of Abstract Varieties

MARIANA BUJAC
(CHIȘINĂU)

ABSTRACT. We define the notion of Euler contour for an abstract multidimensional variety analogically to the classic situation. We formulate and prove the needed and sufficient condition of Euler contour to exist on the oriented multidimensional variety of odd dimension. The existence of multidimensional Euler contour of even dimension is still pendent.

The notions of path, road, cycle and Euler contour for the graphs [1] are well known. Our goal is to generalize these notions for the complex of multy-ary relations [4] and to prove the existence of the above named notions.

Let $\mathcal{K}^n = \{\mathcal{S}^0, \mathcal{S}^1, \dots, \mathcal{S}^n\}$ be a complex of multy-ary relations where \mathcal{S}^m , $0 \leq m \leq n$ represents the multitude of m -dimensional simplexes.

Definition 1 A *m -dimensional path* of the complex \mathcal{K}^n is a succession of simplexes $S_1^m, S_2^m, \dots, S_i^m, S_{i+1}^m, \dots, S_k^m$ where $S_i^m \cap S_{i+1}^m \in \mathcal{S}^{m-1}$, $i = \overline{1, k-1}$. If S_i^m and S_{i+1}^m are also coherent [4] then this chain will be defined as *m -dimensional way* of \mathcal{K}^n .

A Metric Space with Independent Median

SERGIU CATARANCIUC
(CHIȘINĂU)

MARIANA SCRIPNIC
(CHIȘINĂU)

PETRU SOLTAN
(CHIȘINĂU)

ABSTRACT. It is indicated a new class of metric graphs with proportional nodes for which the identification of the median does not depend on the metrics and is exposed to an effective algorithm for its identification in the case of constant weights.

1. Let's assume that (X, d) is a metric space, where $X = \{x_1, x_2, \dots, x_m\}$, and $p : X \rightarrow R^+$ – is a positive real function. Find out point $x^* \in X$ that minimizes the function

$$(0.1) \quad f(x) = \sum_{i=1}^m p(x_i)d(x, x_i)$$

called the **median of space** (X, d) .

The papers [3], [4] and [5] refer to a class of metric graphs with proportional nodes, as indicated in (0.1), whose median *does not depend on the metrics*.

Our purpose consists in presenting a larger class of metric graphs with proportional nodes for which the identification of the median does not depend on the metrics. In a way this fact generalizes the results obtained in [3], [5]. Moreover, in the case when the function $p : X \rightarrow$

Streams in a Special Class of Graphs

SERGIU CATARANCIUC VITALIE TURCANU
(CHIȘINĂU) (CHIȘINĂU)

Abstract

In this article we study the problem of existence of circular streams in oriented graph, where graph satisfies next condition: each vertex of it satisfies the stockpiling and generating of stream properties. There is introduce notion of circular stream. We also give necessary and sufficiency conditions of existence of circular streams.

Let $G = (X, U)$ be a oriented graph with arbitrary number of vertex. We will denote $E^+(x)$ and $E^-(x)$ sets of edges of graph for which x is initial or final vertex respectively. We consider that vertex of this graph have behaviour of consumers or producers of some product \mathcal{P} . This product is transported on edges of G with condition that in each vertex the product or is consumed or is produced, so summar product in vertex x_i is changed. We will study the problem of existence of circular stream in G .

Let us define the next function on setx X and U :

On the Differentiation of the Extended Fourier'S Transformation by Exponential

GHEORGHE HALIC EDUARD HALIC
(ARAD) (ARAD)

ABSTRACT. The aim of this work is to show that, under certain conditions, the rule of differentiation of a classical Fourier's transform by exponential remains true also for the extended transforms, introduced in [4].

KEY WORDS: Fourier's transformation, neutrix calculus, neutralized integral.

MSC 2000: 42A38

In [4], the Fourier's transformation by exponential is extended over some usual continuous functions defined on \mathbb{R}^* , which are not integrable in the neighbourhood of the origin and in the neighbourhood of $\pm\infty$. For that, the concept of Cauchy's main value of integral and the neutralized integrals are simultaneously used.

One consider a function $g : \mathbb{R} - \{0\} \longrightarrow \mathbb{C}$, integrable in a classical sense on each closed interval included in $] -\infty, 0 [$ or in $] 0, \infty [$, a normal neutrix N_0 , constituted by functions of variable ξ , $\xi > 0$ and a normal neutrix N_∞ , constituted by functions of η , $\eta > 0$. The set of neutrices N_0 and N_∞ , was denoted by $\mathcal{N} = \{N_0, N_\infty\}$ and the function

$$(1) \quad \Phi(\xi, \eta) = \int_{-\eta}^{-\xi} g(t) dt + \int_{\xi}^{\eta} g(t) dt$$

Informational Aspects in the Game Theory

LUDMILA NOVAC BORIS HÂNCU
(CHIȘINĂU) (CHIȘINĂU)

1. The informational impact in the non-cooperative games

Last years the informational aspect represents a real imbold for the elaboration of the new study methods for not-cooperatist game theory. The informational aspect in the game theory is manifested by: the devise of possession information about strategie's choice, the payoff functions, the order of moves, and optimal principles of players; the using methods of possessed information in the strategie's choice by players. The inclusion of information as an important element of game have imposed a new structure to the game theory: the games in complete information (the games in extended form), the games in non-complete information and the games in imperfect information (the Bayes games). The player's posetion of supplimentary information about unfolding of the game can influence appreciably the player's gains. This can be observed as follows from:

Example 1. *(The role of knowledge of information by the first player about the strategy's choice by the second player).*

Let's consider an antagonist game in the normal form:

On the transportation problems with interval data

DOINA IONAC ȘTEFAN ȚIGAN
(ORADEA) (CLUJ-NAPOCA)

ABSTRACT. The purpose of this paper is to investigate the minimum cost and minimum time transportation problems where transportation costs and times are interval numbers. We characterize weak minimum cost transportation solutions and weak minimum lexicographic time transportation solutions. We suggest some procedures in order to find the absolute robust transportation solutions. We consider also interval transportation problems, where the objective parameters, sources and destination coefficients have been expressed as interval values. We show, for interval cost transportation problem, that by solving a two-objective linear cost transportation problem and an usual auxiliary linear cost transportation problem the optimal solutions of this interval transportation problem can be obtained. A similar approach is given for interval time transportation problem.

KEY WORDS: Uncertainty, absolute robust transportation solution, lexicographic time transportation problem, interval transportation problems

On Some Cauchy-Flett Mean-value Theorems

MIRCEA IVAN
(CLUJ-NAPOCA)

ABSTRACT. We obtain several Cauchy-Flett type mean value theorems in terms of divided differences.

KEY WORDS: Mean value theorems, divided differences.

MSC 2000: 26A24, 41A05

1 Introduction and Preliminary Results

T.M. Flett gave the following variation of the Lagrange Mean Value Theorem:

Theorem 1.1 (T.M. Flett [4]) *Let $f: [a, b] \rightarrow \mathbb{R}$ be differentiable on $[a, b]$ and $f'(a) = f'(b)$. Then there exists a point $c \in (a, b)$ such that*

$$f(c) - f(a) = f'(c)(c - a).$$

(See Figure 1 for a geometrical interpretation).

Some generalisations of measurable and integrable functions

OCTAVIAN LIPOVAN
(TIMISOARA)

ABSTRACT. We define the notion of pseudosubmeasure as a generalisation of the submeasure notion [1], and we study some properties of the topological ring of sets defined by that. Using families of pseudosubmeasures and the associated topological rings, the pseudosubmeasurable function concept is then defined. The convergence in measure, almost everywhere convergence and almost uniform convergence are generalized to the sequence of functions with values in pseudometric space.

Using the notion of control submeasure, there are introduced a criterion of functions pseudosubmeasurability. Finally, we develop an integration theory for these functions, with respect to a semigroup valued measure.

1 Preliminary concepts

The notions and the notations used here follow the papers [1] and [3]. Let \mathcal{S} be a ring (or algebra) of subsets of a fixed set S . A mapping $\eta : \mathcal{S} \rightarrow \overline{\mathbb{R}}_+$ is said to be a submeasure if:

$$(s_1) \quad \eta(\phi) = \phi$$

A new algorithm for solving multicriteria unimodal optimization problems

LIANA LUPȘA NICOLAE POPOVICI
(CLUJ-NAPOCA) (CLUJ-NAPOCA)

ABSTRACT. The aim of this paper is to present an implementable algorithm for generating all efficient solutions and weakly efficient solutions of any multicriteria optimization problem involving lower unimodal objective functions on a finite feasible set.

KEY WORDS: generalized unimodal functions, multiple criteria programming

MSC 2000: 90C29, 90C10

1 Introduction

Recall (see [6]) that a function $f : D \rightarrow \mathbb{R}$, defined on a nonempty set $D \subset \mathbb{R}$ is said to be *lower unimodal* on a subset S of D if there exist $u, v \in S$ satisfying the following conditions:

- i) $f(u) = f(v)$;
- ii) $f(x) > f(y)$ whenever $x, y \in S$, $x < y \leq u$;
- iii) $f(x) < f(y)$ whenever $x, y \in S$, $v \leq x < y$;

Some properties of functions defined on networks

DANIELA MARIAN
(CLUJ-NAPOCA)

ABSTRACT. We transpose for undirected networks some notions and results relating to metric space. Firstly we study the continuity of functions with real valued, defined on an undirected network N . Then we study sequences of functions with real values, defined on an undirected network. We prove that the linear real space $\mathcal{M}(N)$ of the functions with real values, defined on N and bounded on N , is a space of Banach with norm (2.2). We also prove that the linear real space $\mathcal{C}(N)$ of the functions with real values, defined on N and continuous on N is a space of Banach with norm (2.2). We adopt the definition of network as metric space in the sense of Dearing and Francis (1974).

KEY WORDS: directed networks, continuous functions, sequences of functions

1 Preliminary notions and results

Firstly, we recall the definition of undirected network as metric space introduced in [1] by P. M. Dearing and R. L. Francis. We consider an undirected, connected graph $G = (W, A)$, without loops or multiple edges. To each vertex $w_i \in W = \{w_1, w_2, \dots, w_m\}$ we associate a point

On Null Uniform Exponential Trichotomy of Evolution Operators in Hilbert Spaces

MIHAIL MEGAN CODRUȚA STOICA
(TIMIȘOARA) (ARAD)

ABSTRACT. The paper emphasizes the property of null uniform exponential trichotomy for evolution operators in Hilbert spaces as a particular case of the uniform exponential trichotomy. Some equivalent definitions, as well as several characterizations of the notion are presented. A Datko type theorem is also proved.

1 On Uniform Exponential Dichotomy

Let us consider X a Hilbert space and Δ the set of all pairs (t, t_0) of real numbers such that $t \geq t_0 \geq 0$. We denote by $L(X)$ the space of bounded linear operators from X to X and by $\|\cdot\|$ the norm of vectors and operators.

Definition 1.1 *A mapping $\Phi : \Delta \rightarrow L(X)$ is called evolution operator on X if following conditions are satisfied*

- (o₁) $\Phi(t, s)\Phi(s, t_0) = \Phi(t, t_0)$ for all $(t, s), (s, t_0) \in \Delta$
- (o₂) $\Phi(t, t) = I$ for all $t \geq 0$

Selection theorems for multivalued operators

ADRIAN PETRUȘEL GHIOCEL MOTȚ
(CLUJ-MAPOCA) (ARAD)

ABSTRACT. The aim of this paper is to report several selection theorems for multivalued operators,

KEY WORDS: multivalued operator, selection, continuous operator, Caristi condition.

MSC 2000: 52A01, 52A41

1 Introduction

Caristi's fixed point theorem states that each operator f from a complete metric space (X, d) into itself satisfying the condition:

there exists a lower semi-continuous function $\varphi : X \rightarrow \mathbb{R}_+$ such that:

$$(1.1) \quad d(x, f(x)) + \varphi(f(x)) \leq \varphi(x), \text{ for each } x \in X$$

has at least a fixed point $x^* \in X$, i. e. $x^* = f(x^*)$

Let (X, d) be a metric space and $\mathcal{P}(X)$ the space of all subsets of X . We denote by $P(X)$ the space of all nonempty subsets of X and by $P_p(X)$ the set of all nonempty subsets of X having the property “ p ”, where “ p ” could be: $cl = closed$, $b = bounded$, $cp = compact$, $cv = convex$ (for normed spaces X), etc.

Compression-expansion fixed point theorems in two norms

RADU PRECUP
(CLUJ-NAPOCA)

ABSTRACT. In this paper we present compression-expansion fixed point theorems in cones where the compression and the expansion conditions are expressed in two norms.

KEY WORDS: Positive solution, fixed point, cone, boundary value problem.

MSC 2000: 47H10, 34B15.

1 Introduction

Let $(E, |\cdot|)$ be a normed linear space and $\|\cdot\|$ will be another norm on E . Also $C \subset E$ will be a cone, i.e., a nonempty convex (not necessarily closed) set with $0 \notin C$ and $\lambda C \subset C$ for all $\lambda > 0$. We shall assume that there exist constants $c_1, c_2 > 0$ such that

$$(1.1) \quad c_1 |x| \leq \|x\| \leq c_2 |x| \quad \text{for all } x \in C.$$

Hence the norms $|\cdot|$ and $\|\cdot\|$ are topologically equivalent on C (but not necessarily on E).

In [5] the following two theorems are proved:

Semigruppı e approssimazione

IOAN RASA
(CLUJ-NAPOCA)

ABSTRACT. Si presentano metodi per approssimare il semigruppı fortemente continuo associato ad un proiettore di Altomare.

MSC 2000: 47D06, 41A36

1 Introduzione

Sia X un sottoinsieme compatto e convesso di \mathbf{R}^p . Si consideri un proiettore di Altomare $T : C(X) \rightarrow C(X)$. (Per la definizione e ulteriori dettagli si rimanda, ad esempio, a [7],[8],[9]).

Fissato $x \in X$, sia $\mu_x(f) := Tf(x)$, $f \in C(X)$.

Gli operatori di Bernstein-Schnabl associati a T si definiscono ponendo (vedasi [1], [2], [3], [7], [8], [9])

$$(1.1) \quad B_n f(x) = \int_{X^n} f\left(\frac{t_1 + \dots + t_n}{n}\right) d\mu_x(t_1) \dots d\mu_x(t_n)$$

per ogni $n \geq 1$, $f \in C(X)$, $x \in X$. Il semigruppı fortemente continuo $(T(t))_{t \geq 0}$ associato a T può essere approssimato tramite le iterate degli operatori B_n :

$$(1.2) \quad T(t)f = \lim_{n \rightarrow \infty} B_n^{[nt]} f, \quad f \in C(X), t \geq 0.$$

Cyclic representations and fixed points

IOAN A. RUS
(CLUJ-NAPOCA)

ABSTRACT. The present paper discusses an aspect of the open Problem 17 in [8] (p.148): Let (X, d) be a complete metric space and $Y \subset X \times X$. An operator $f : X \rightarrow X$ is an (Y, a) -contraction if $a \in [0, 1[$ and

$$d(f(x), f(y)) \leq ad(x, y), \text{ for all } (x, y) \in Y.$$

The problem is to construct a fixed point theory for (Y, a) -contractions, or more general for (Y, a) -generalized contractions.

KEY WORDS: fixed point structure, cyclic representation, generalized contraction

MSC 2000: 47H10, 54H25

1 Introduction

The following problem is well known (Problem 17 in [8] p.198):

Let (X, d) be a complete metric space and $Y \subset X \times X$. An operator $f : X \rightarrow X$ is an (Y, a) -contraction if $a \in [0, 1[$ and

$$d(f(x), f(y)) \leq ad(x, y), \text{ for all } (x, y) \in Y.$$

For which subsets Y the operator f has a fixed point?

A Method of Description for d -convex Simple and Non-oriented Graphs

NADEJDA SUR
(CHISHINAU)

ABSTRACT. In this article we study non-oriented graphs that are d -convex simple. There are defined recursively a special class of graphs for which we show any graph included in it is d -convex simple. It is also true that any d -convex simple graph is contained in this class.

Let $G = (X_G, U_G)$ is a connected, simple and non-oriented graph. By *distance* between two vertex x, y we mean the length of the shortest path between them and denote $d(x, y)$. We have to say that the distance introduced below define a metric on graphs. A *d -segment* between two vertex x, y is the set $\langle x, y \rangle = \{z \in X \mid d(x, z) + d(z, y) = d(x, y)\}$.

Definition 0.1 *Subset $A \subset X$ is called **d -convex set** in graph $G = (X, U)$ if for any $x, y \in A$ we have that d -segment $\langle x, y \rangle \subset A$.*

Definition 0.2 *A **d -convex closure** of a subset $B \subset X$ is the smallest by inclusion d -convex set $A \subset X$ such that $B \subset A$, denoted by **d -conv(B)**= A .*

Definition 0.3 *The graph $G = (X, U)$ is called **d -convex simple** if it does not have d -convex set A , such that $2 < |A| < |X_G|$.*

Monotonic Balanced Optimization Problem

ȘTEFAN ȚIGAN EUGENIA MARIA IACOB
(CLUJ-NAPOCA) (ENSCHEDÉ)

I.M. STANCU-MINASIAN
(BUCUREȘTI)

ABSTRACT. The purpose of this paper is to investigate several monotonic lexicographic balanced discrete optimization problems. We show that these problems can be solved efficiently if some associated lexicographic bottleneck problems can be solved efficiently. We consider two particular cases of the balanced optimization problem (with difference and ratio objectives) having interval data, which can be formulated as monotonic lexicographic balanced problems. For special cases of the assignment problems, optimal path and optimal spanning tree in a connected graph with interval data, algorithms for finding in polynomial time the most uniform optimal solutions are suggested.

KEY WORDS: Monotonic balanced optimization, lexicographic optimization, bottleneck problems, optimal path problem, optimal tree problem, assignment problem.

1 Introduction

The balanced optimization problem is a combinatorial problem that was introduced by Martello et al. [14]. Several of its variants and

A short survey of the collaborative systems as interdisciplinary support in the global economy

RODICA AVRAM-NIȚCHI ȘTEFAN NIȚCHI
(CLUJ-NAPOCA) (CLUJ-NAPOCA)

1. In 2005 our team awarded a Consortium Grant of The National Scientific Research Council from Higher Education (CNCSIS), in cooperation with other four teams from Economic Sciences Academy of Bucharest, "Al. I. Cuza" University Iași, West University Timișoara and Technical University of Cluj-Napoca. In the present note we will present a short survey concerning this subject considering it as an interdisciplinary issue in the economic and business activities and more specific in Economic and Business Information Systems.

2. As it was mentioned above, the collaborative systems represents a new interdisciplinary research field, being at the confluence of economic sciences, computer science, cybernetic, cognition sciences, psychology, linguistic, decision and executive support services, management (more exactly work scheduling), etc. [Giboin2000].

There are many definitions of these systems. About the shorter and more relevant of these, we consider: "a collaborative system is a dynamic objects collection, that communicate and cooperate to achieve a common or shared objective" [Butenko03].

De l'activite culturelle du mathematicien

Gh. Țițeica

ELVIRA BOTEZ
(CLUJ-NAPOCA)

“Le tableau de la spiritualité roumaine serait incomplet si l'on n'y ajoute pas la figure du mathématicien”, écrit N. Ciorănescu dans son ouvrage intitulé *Gh. Țițeica. La vie et l'oeuvre*. La biographie-même du savant serait incomplète si l'on n'y présente que son oeuvre scientifique, originelle d'ailleurs et de grande importance; car, vraiment, les biographes du grand mathématicien ne parlent que très rarement de ce côté culturel de son activité. Voilà, en ce qui suit, quelques informations sur sa prodigieuse activité culturelle.

Gheorghe Țițeica est le successeur, à l'Académie Roumaine, de Spiru Haret, qui est à la fois son maître; on remarque des similitudes d'intérêt et d'esprit avec son maître, déjà dans son discours de réception: *La vie et l'activité de Spiru Haret* (16/29 mai 1914), *Discours au nom de l'Académie Roumaine au monument de Haret* (1935), ainsi que dans le mémoire *Au souvenir de Spiru Haret* (1938). Sur le modèle des intentions de Haret dans la création de la revue **Albina** (1897) - servir la vérité, créer un instrument de changement social, d'émancipation du peuple, G. Țițeica et G. G. Longinescu fondèrent, en octobre 1905, **NATURA**. Revue scientifique de vulgarization. Elle se proposait de

From Newton's second law to Schrödinger equation in molecular dynamics.

I. Hydrogen atom and harmonic oscillator

MIHAELA IRIMIEA ADNAN BOGDAN ȘTEFAN HOBAI
(BACĂU) (HAIFA) (TG. MUREȘ)

ABSTRACT. The paper presents some applications of the Schrödinger equation: the wave function for the energy level of hydrogen atom and for the harmonic oscillator.

KEY WORDS: Schrödinger equation, energy level, hydrogen atom, harmonic oscillator.

Introduction

An important aim of many (bio)chemists is to perform molecular dynamics simulation. This is one of the many techniques that belongs to the realm of computational chemistry and molecular modeling. In this way it tries to understand and predict microscopic properties based on detailed knowledge on an atomic scale[1].

Results

Ideally, the (relativistic) time-dependent Schrödinger equation describes the properties of molecular system with high accuracy.

An application of Shepard's interpolation

ZITA FAZAKAS MIHAELA IRIMIEA ȘTEFAN HOBAI
(TG. MURES) (BACĂU) (TG. MUREȘ)

ABSTRACT. The paper presents the Shepard's interpolation used for the modeling of non-uniform distributed data - biochemical parameters of human saliva influenced by sodium fluoride(NaF). The effect of NaF solution on the activity of human salivary enzyme (alfa - amylase) was examined in vivo.

KEY WORDS: Shepard interpolation, weight function, sodium fluoride, salivary amylase

INTRODUCTION

The aim of the modeling is to obtain a set of uniform distributed data, suitable for the most important algorithms of visualization. In present paper the experimental data are biochemical parameters.

α - amylase is an enzyme able to bind on the bacterial surface and to hydrolyze starch, giving rise to products that are transformed into organic acids. Therefore the salivary amylase has a carrier effect [1]

Fluoride has a high chemical reactivity and a small ionic radius, able to reduce the caries by three principal mechanisms: (a) inhibiting bacterial metabolism after diffusing into the bacteria as the HF molecule, when the plaque is acidified; (b) inhibiting demineralization at the crystal surface; (c) enhancement of demineralization and thereby forming a low solubility veneer, fluoroapatite, on the remineralized crystal [2].

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