

EE434
Biomedical Signal Processing
Spring 2011
Final

Due date: June 10th, 2011, midnight

Instructions: This is a take-home test. Complete the questions, and return your work as a single PDF document by e-mail before the due date and time. Clearly explain your methodology and justify your answers. Sharing of ideas is encouraged, but sharing of results and/or text is not. Your name on your test is a testimony that you have neither received nor given any unauthorized assistance. Correct answers to wrong questions are not creditable.

Question 1: (15 pts) Consider the Hodgkin-Huxley action potential model, and explain how the following changes would affect the action potentials generated by an external current.

- a) (5 pts) Half of the Na⁺ channels on the axonal membrane are inhibited.
- b) (5 pts) Half of the K⁺ channels on the axonal membrane are inhibited.
- d) (5 pts) The axon has been placed in a lower Na⁺ environment.

Question 2: (25 pts) Stochastic models of molecular evolution on nucleotide sequences characterize the probability of replacing a base X at a site with another base Y in t units of time by a matrix $P(t)$ of probabilities $P_{X \rightarrow Y}(t)$ determined by

$$P(t) = \begin{bmatrix} P_{A \rightarrow A}(t) & P_{A \rightarrow G}(t) & P_{A \rightarrow T}(t) & P_{A \rightarrow C}(t) \\ P_{G \rightarrow A}(t) & P_{G \rightarrow G}(t) & P_{G \rightarrow T}(t) & P_{G \rightarrow C}(t) \\ P_{T \rightarrow A}(t) & P_{T \rightarrow G}(t) & P_{T \rightarrow T}(t) & P_{T \rightarrow C}(t) \\ P_{C \rightarrow A}(t) & P_{C \rightarrow G}(t) & P_{C \rightarrow T}(t) & P_{C \rightarrow C}(t) \end{bmatrix} = \exp(Qt)$$

where Q is the associated rate matrix. The rate matrix presumed by the Kimura's two-parameter model is given by

$$Q = \begin{bmatrix} -\alpha - 2\beta & \alpha & \beta & \beta \\ \alpha & -\alpha - 2\beta & \beta & \beta \\ \beta & \beta & -\alpha - 2\beta & \alpha \\ \beta & \beta & \alpha & -\alpha - 2\beta \end{bmatrix}$$

where α and β are the transition and the transversion rates respectively.

- a) (10 pts) Compute and plot the curves of $P_{A \rightarrow G}(t)$, $P_{C \rightarrow A}(t)$, and $P_{T \rightarrow T}(t)$ using $\alpha = 1.0$ and $\beta = 0.5$ for $t \in [0, 1]$.
- b) (10 pts) Repeat above using $\alpha = 2.0$ and $\beta = 1.0$.
- c) (5 pts) What can you say about the limit values and the speed of convergence of $P(t)$ as t goes to infinity between the two cases above?

Question 3: (30 pts) Carry out a SAM analysis on the dataset GDS3542 available for download at the GEO data server, and identify the differentially expressed genes between

- a) (10 pts) the baseline and at 12 hours.

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XLVI Mexican Conference on Biomedical Engineering José de Jesús Agustín Flores Cuautle, Balam Benítez-Mata, Ricardo Antonio Salido-Ruiz, Gustavo Adolfo Alonso-Silverio, Guadalupe Dorantes-Méndez, Esmeralda Zúñiga-Aguilar, Hugo A. Vélez-Pérez, Edgar Del Hierro-Gutiérrez, Aldo Rodrigo Mejía-Rodríguez, 2023-10-25 This book reports on cutting edge research and best practices in the broad field of biomedical engineering Based on the XLVI Mexican Congress on Biomedical Engineering CNIB 2023 held on November 2-4 2023 in Villahermosa Tabasco Mexico this first volume of the proceedings covers research topics in biomedical signals and image processing artificial intelligence biosensors and wearable systems with applications ranging from disease classification and diagnosis to health monitoring and medical therapy All in all this book provides a timely snapshot on state of the art achievements in biomedical engineering and current challenges in the field It addresses both researchers and professionals and it is expected to foster future collaborations between the two groups as well as international collaborations

Biomedical Signal and Image Processing with Artificial Intelligence Chirag Paunwala, Mita Paunwala, Rahul Kher, Falgun Thakkar, Heena Kher, Mohammed Atiquzzaman, Norliza Mohd. Noor, 2023-01-09 This book focuses on advanced techniques used for feature extraction analysis recognition and classification in the area of biomedical signal and image processing Contributions cover all aspects of artificial intelligence machine learning and deep learning in the field of biomedical signal and image processing using novel and unexplored techniques and methodologies The book covers recent developments in both medical images and signals analyzed by artificial intelligence techniques The authors also cover topics related to development based artificial intelligence which includes machine learning neural networks and deep learning This book will provide a platform for researchers who are working in the area of artificial intelligence for biomedical applications Provides insights into medical signal and image analysis using artificial intelligence Includes novel and recent trends of decision support system for medical research Outlines employment of evolutionary algorithms for biomedical data big data analysis for medical databases and reliability opportunities and challenges in clinical data

Currents in Biomedical Signals Processing - Methods and Applications Aleksandra Dagmara Kawala-Sterniuk, Mariusz Pelc, Radek Martinek, Grzegorz Marcin Wójcik, 2022-09-05

Advanced Methods of Biomedical Signal Processing Sergio Cerutti, Carlo Marchesi, 2011-06-09 This book grew out of the IEEE EMBS Summer Schools on Biomedical Signal Processing which have been held annually since 2002 to provide the participants state of the art knowledge on emerging areas in biomedical engineering Prominent experts in the areas of biomedical signal processing biomedical data treatment medicine signal processing system biology and applied physiology introduce novel techniques and algorithms as well as their clinical or physiological applications The book provides an overview of a compelling group of advanced biomedical signal processing techniques such as multisource and multiscale integration of information for physiology and clinical decision the impact of advanced methods of signal processing in cardiology and neurology the

integration of signal processing methods with a modelling approach complexity measurement from biomedical signals higher order analysis in biomedical signals advanced methods of signal and data processing in genomics and proteomics and classification and parameter enhancement **Recent Advances in Biomedical Signal Processing** Juan Manuel

Górriz, Elmar W. Lang, Javier Ramírez, 2011 Biomedical signal processing is a rapidly expanding field with a wide range of applications from the construction of artificial limbs and aids for disabilities to the development of sophisticated medical imaging systems Acquisition and processing of bio Speech, Audio, Image and Biomedical Signal Processing using Neural Networks Bhanu Prasad, S.R.M. Prasanna, 2008-01-03 Humans are remarkable in processing speech audio image and some biomedical signals Artificial neural networks are proved to be successful in performing several cognitive industrial and scientific tasks This peer reviewed book presents some recent advances and surveys on the applications of artificial neural networks in the areas of speech audio image and biomedical signal processing It chapters are prepared by some reputed researchers and practitioners around the globe *Innovations in Biomedical Engineering* Marek Gzik, Zbigniew

Paszenda, Ewa Piętka, Ewaryst Tkacz, Krzysztof Milewski, Jacek Jurkojć, 2022-05-31 This book presents the latest developments in the field of biomedical engineering and includes practical solutions and strictly scientific considerations The development of new methods of treatment advanced diagnostics or personalized rehabilitation requires close cooperation of experts from many fields including among others medicine biotechnology and finally biomedical engineering The latter combining many fields of science such as computer science materials science biomechanics electronics not only enables the development and production of modern medical equipment but also participates in the development of new directions and methods of treatment The presented monograph is a collection of scientific papers on the use of engineering methods in medicine The topics of the work include both practical solutions and strictly scientific considerations expanding knowledge about the functioning of the human body We believe that the presented works will have an impact on the development of the field of science which is biomedical engineering constituting a contribution to the discussion on the directions of development of cooperation between doctors physiotherapists and engineers We would also like to thank all the people who contributed to the creation of this monograph both the authors of all the works and those involved in technical works *VTAC eGuide 2016* VTAC, 2015-07-15 The VTAC eGuide is the Victorian Tertiary Admissions Centre's annual guide to application for tertiary study scholarships and special consideration in Victoria Australia The eGuide contains course listings and selection criteria for over 1 700 courses at 62 institutions including universities TAFE institutes and independent tertiary colleges

Biomedical Signal Processing for Healthcare Applications Varun Bajaj, G. R. Sinha, Chinmay Chakraborty, 2021-07-20 This book examines the use of biomedical signal processing EEG EMG and ECG in analyzing and diagnosing various medical conditions particularly diseases related to the heart and brain In combination with machine learning tools and other optimization methods the analysis of biomedical signals greatly benefits the healthcare sector by

improving patient outcomes through early reliable detection The discussion of these modalities promotes better understanding analysis and application of biomedical signal processing for specific diseases The major highlights of Biomedical Signal Processing for Healthcare Applications include biomedical signals acquisition of signals pre processing and analysis post processing and classification of the signals and application of analysis and classification for the diagnosis of brain and heart related diseases Emphasis is given to brain and heart signals because incomplete interpretations are made by physicians of these aspects in several situations and these partial interpretations lead to major complications FEATURES Examines modeling and acquisition of biomedical signals of different disorders Discusses CAD based analysis of diagnosis useful for healthcare Includes all important modalities of biomedical signals such as EEG EMG MEG ECG and PCG Includes case studies and research directions including novel approaches used in advanced healthcare systems This book can be used by a wide range of users including students research scholars faculty and practitioners in the field of biomedical engineering and medical image analysis and diagnosis

Signal Processing and Machine Learning for Biomedical Big Data Ervin Sejdic,Tiago H. Falk,2018-07-04 Within the healthcare domain big data is defined as any high volume high diversity biological clinical environmental and lifestyle information collected from single individuals to large cohorts in relation to their health and wellness status at one or several time points Such data is crucial because within it lies vast amounts of invaluable information that could potentially change a patient s life opening doors to alternate therapies drugs and diagnostic tools Signal Processing and Machine Learning for Biomedical Big Data thus discusses modalities the numerous ways in which this data is captured via sensors and various sample rates and dimensionalities Capturing analyzing storing and visualizing such massive data has required new shifts in signal processing paradigms and new ways of combining signal processing with machine learning tools This book covers several of these aspects in two ways firstly through theoretical signal processing chapters where tools aimed at big data be it biomedical or otherwise are described and secondly through application driven chapters focusing on existing applications of signal processing and machine learning for big biomedical data This text aimed at the curious researcher working in the field as well as undergraduate and graduate students eager to learn how signal processing can help with big data analysis It is the hope of Drs Sejdic and Falk that this book will bring together signal processing and machine learning researchers to unlock existing bottlenecks within the healthcare field thereby improving patient quality of life Provides an overview of recent state of the art signal processing and machine learning algorithms for biomedical big data including applications in the neuroimaging cardiac retinal genomic sleep patient outcome prediction critical care and rehabilitation domains Provides contributed chapters from world leaders in the fields of big data and signal processing covering topics such as data quality data compression statistical and graph signal processing techniques and deep learning and their applications within the biomedical sphere This book s material covers how expert domain knowledge can be used to advance signal processing and machine learning for biomedical big data applications

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