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 $P_{X \to T}(t)$ 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 $P_{A\rightarrow B}(t)$, $P_{C\rightarrow A}(t)$, and $P_{F\rightarrow F}(t)$ 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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José de Jesús Agustín Flores
Cuautle, Balam Benítez-Mata, Ricardo
Antonio Salido-Ruiz, Gustavo Adolfo
Alonso-Silverio, Guadalupe DorantesMéndez, Esmeralda ZúñigaAguilar, Hugo A. Vélez-Pérez, Edgar Del
Hierro-Gutiérrez, Aldo Rodrigo MejíaRodríguez

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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 fiel 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 expect to foster future collaborations between the two groups as well as international collaborations Biomedical Signal Analysis Mr. Rohit Manglik, 2024-01-12 EduGorilla Publication is a trusted name in the education sector committed to empowering learners with high quality study materials and resources Specializing in competitive exams and academic support EduGorilla provides comprehensive and well structured content tailored to meet the needs of students across various streams and levels Biomedical Signal Processing Ganesh R. Naik, Wellington Pinheiro dos Santos, 2023-09-27 This book presents the theoretical basis and applications of biomedical signal analysis and processing Initially the nature of the most common biomedical signals such as electroencephalography electromyography electrocardiography and others is described The theoretical basis of linear signal processing is summarized with continuous and discrete representation linear filters and convolutions Fourier and Wavelets transforms Machine learning concepts are also presented from classic methods to deep neural networks Finally several applications in neuroscience are presented and discussed involving diagnosis and therapy in addition to other applications Features Explains signal processing of neuroscience applications using modern data science techniques Provides comprehensible review on biomedical signals nature and acquisition aspects Focusses on selected applications of neurosciences cardiovascular and muscle related biomedical areas Includes computational intelligence machine learning and biomedical signal processing and analysis Reviews theoretical basis of deep learning and state of the art biomedical signal processing and analysis This book is aimed at researchers graduate students in biomedical signal processing signal processing electrical engineering neuroscience and computer science Currents in Biomedical Signals Processing - Methods and Applications Aleksandra Dagmara Kawala-Sterniuk, Mariusz Pelc, Radek Martinek, Grzegorz Marcin Wójcik, 2022-09-05 **Biomedical Signal Analysis** Rangaraj M. Rangayyan, 2015-04-24 The book will help assist a reader in the development of techniques for analysis of biomedical signals and computer aided diagnoses with a pedagogical examination of basic and advanced topics accompanied by over 350 figures and illustrations Wide range of filtering techniques presented to address various

applications 800 mathematical expressions and equations Practical questions problems and laboratory exercises Includes fractals and chaos theory with biomedical applications **Current Catalog** National Library of Medicine (U.S.), First multi vear cumulation covers six years 1965 70 National Library of Medicine Current Catalog National Library of Medicine **Journal of Engineering Education** ,2003 Engineering Approaches to Study Cardiovascular Physiology: (U.S.). Modeling, Estimation, and Signal Processing Riccardo Barbieri, Zhe Chen, With cardiovascular diseases being one of the main causes of death in the world quantitative modeling assessment and monitoring of the cardiovascular control system plays a critical role in bringing important breakthroughs to cardiovascular care Quantification of cardiovascular physiology and its control dynamics from physiological recordings and by use of mathematical models and algorithms has been proved to be of important value in understanding the causes of cardiovascular diseases and assisting the prognostic or diagnostic process Nowadays development of new recording technologies e g electrophysiology imaging ultrasound etc has enabled us to improve and expand acquisition of a wide spectrum of physiological measures related to cardiovascular control An emerging challenge is to process and interpret such increasing amount of information by using state of the art approaches in systems modeling estimation and control and signal processing which would lead to further insightful scientific findings In particular multi disciplinary engineering empowered approaches of studying cardiovascular systems would greatly deepen our understanding of cardiovascular functions e g heart rate variability baroreflex sensitivity and autonomic control as it would also improve the knowledge about heart pathology cardiovascular rehabilitation and therapy Meanwhile developing cardiovascular biomedical devices or heart machine interface for either clinical monitoring or rehabilitation purpose is of greater and greater interest for both scientific advancement and potential medical benefits This Research Topic will bring together established experts whose areas of research cover a wide range of studies and applications Contributions include but are not limited to state of the art modeling methodologies algorithmic development in signal processing and estimation as well as applications in cardiovascular rehabilitation and clinical monitoring The Research Topic will consider both invited reviews and original research **Lung Sounds** Hadji Hadjileontiadis, 2022-06-01 Lung sounds auscultation is often the first noninvasive resource for detection and discrimination of respiratory pathologies available to the physician through the use of the stethoscope Hearing interpretation though was the only means of appreciation of the lung sounds diagnostic information for many decades Nevertheless in recent years computerized auscultation combined with signal processing techniques has boosted the diagnostic capabilities of lung sounds The latter were traditionally analyzed and characterized by morphological changes in the time domain using statistical measures by spectral properties in the frequency domain using simple spectral analysis or by nonstationary properties in a joint time frequency domain using short time Fourier transform Advanced signal processing techniques however have emerged in the last decade broadening the perspective in lung sounds analysis The scope of this book is to present up to date signal processing techniques that have been applied to the area of lung sound

analysis It starts with a description of the nature of lung sounds and continues with the introduction of new domains in their representation new denoising techniques and concludes with some reflective implications both from engineers and physicians perspective Issues of nonstationarity nonlinearity non Gaussianity modeling and classification of lung sounds are addressed with new methodologies revealing a more realistic approach to their pragmatic nature Advanced denoising techniques that effectively circumvent the noise presence e g heart sound interference background noise in lung sound recordings are described providing the physician with high quality auscultative data The book offers useful information both to engineers and physicians interested in bioacoustics clearly demonstrating the current trends in lung sound analysis Table of Contents The Nature of Lung Sound Signals New Domains in LS Representation Denoising Techniques Reflective Implications

Unveiling the Energy of Verbal Beauty: An Mental Sojourn through **Multiple Choice Biomedical Signal Processing Final Exam**

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