THE SECOND ROUND OF NYU-POLY SEED GRANTS

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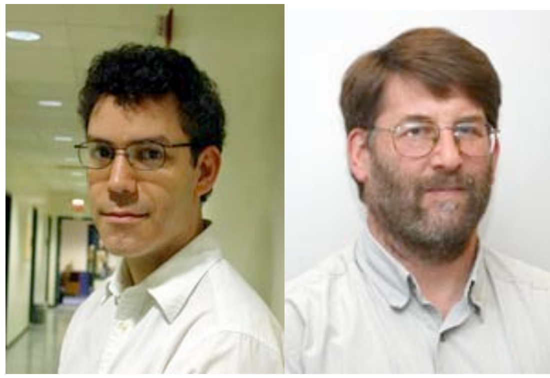
Improved Peak Finding in Next-Generation DNA Sequencing



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Abstract

The Sanger method for the sequencing of DNA was one of the most important biotechnologies developed in the 20th century. Nextgeneration DNA sequencing (NG-seq) technologies have the potential to transform biomedical research, allowing investigators to gain a deeper understanding of genome regulation and biology, to study entire populations of microorganisms in both environmental and medical contexts, to follow the evolution of viral and bacterial resistance in real time, to uncover the huge diversity of novel genes and alternative transcription of currently annotated gene loci, and to make personal genomics practical and affordable. However, the broad adoption of NG-seq technology is currently being hindered by a lack of robust computational tools for data management and analysis.

This proposal is aimed at improving the computational methods available for identifying and quantifying the sites of protein interaction on DNA using Chromatin Immunoprecipitation Sequencing (ChIP-seq). The collaborative approach between bioinformaticians and mathematicians used to address this problem is also broadly applicable to the many computational challenges created by NG-seq applications.

The proposed project has three specific aims: 1) to develop sets of data suitable for testing, validation, and machine learning of ChIP-seq peakfinding software; 2) to document the reproducibility of peak calls produced by all commercial and public domain software on synthetic data and technical replicate samples; and 3) to use advanced signal processing techniques to develop and validate an improved algorithm for identifying the sites of protein binding in next-generation DNA sequence data from ChIP-seq experiments with high accuracy, sensitivity, and robustness across the types of variation seen in typical experiments.

Influence of Air Plasma on Dental Microorganisms Adherence and Biofilm Formation


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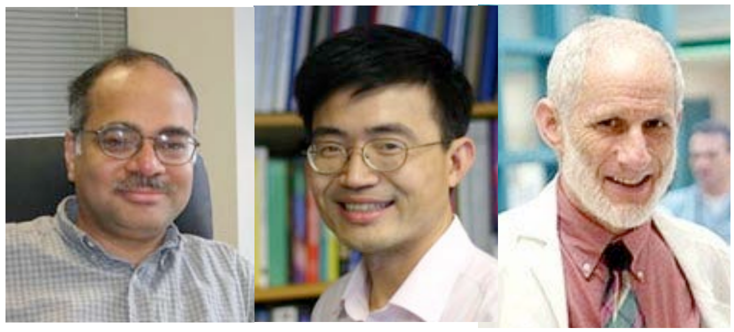
Abstract

The adherence of microorganisms to all the exposed surfaces in the oral cavity, human tooth tissues as well as restorative and reconstructive materials is recognized as the first step of dental biofilm formation, also called dental plaque, the major cause of caries, periodontal, and other oral infection-induced diseases. Restorative and reconstructive materials have gained importance due to strength, biocompatibility and aesthetic properties. However, each material has distinct chemical and surface energy properties, which may provide distinct patterns of protein adsorption and bacterial binding. Although the biological properties of dental materials may interfere with the success or clinical failure of the treatment, sparse attention has been given to studies examining the bacterial adherence on these hard surfaces.

The goal of this project is to test the source of plasma on the growth inhibition and killing of oral microorganisms, determine the influence of plasma treatment on a dental attachment and the availability of bacteria on different dental material surfaces, and to produce a prototype of a handheld air plasma torch to be used in dental practice. The data collected will determine whether the plasma treatment holds promise as an effective novel anti-adherence / anti-biofilm formation approach which may be evaluated in "in vivo" studies and clinical trials in the future. This step will reveal the best treatment plan with plasma, and how this treatment will influence the adherence and the initial biofilm formation on different dental material surfaces.

Solutions to Complex Issues in Emergency Management



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Abstract

PLAN C is a multi-agent based disaster simulation framework capable of modeling and simulating disaster scenarios in urban settings while permitting the study of behavioral dynamics of crowds in disaster scenarios and the effects of emergency interventions. PLAN C permits the study of behavioral dynamics of crowds in disaster scenarios and the effects of emergency interventions, and is designed to track and record the behavior of individual agents on a continuous basis, permitting planners to evaluate the time-dependent behavior of agents. PLAN C has been shown to be a practical, reality based emergency management tool.

We plan to refine the current optimal PLAN C design to 1) ensure sensitivity, internal validity, and methodological rigor; 2) enhance current simulation, database, and other platform linkages; 3) develop a comprehensive platform with strategic, operational, and tactical capabilities. We plan to improve sensitivity and reliability of this instrument by validating models against actual catastrophe scenarios utilized by federal, state and local agencies such as chemical point-source and/or large scale exposures utilizing retrospective (historical) data; identifying and studying currently available disaster model data, technologies and trends; and studying and acquiring expertise on `difficult to model' issues such as social dynamics. The general research goal proposed is to develop strategies to evacuate crowds, or to treat a large population of patients without overwhelming the capacity of individual hospitals.

Single Molecule Magnets in Resonators: Coupled Spin-Photon Modes

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Abstract

This project focuses on molecule-based-nanomagnets known as single-molecule magnets (SMMs) and, specifically, improving fundamental understanding of their spin dynamics and the coupling of spin-photon degrees of freedom. SMMs represent a molecular or 'bottom-up' approach to nanomagnetism. Their key advantages include chemical control of molecular structure, spin, and magnetic anisotropy as well as intra- and intermolecular magnetic interactions. They display properties of much larger ferro- or ferrimagnetic particles prepared by conventional lithographic methods, but in a manner that enables fundamental physics studies. For example, quantum tunneling of the magnetization (QTM) and quantum phase interference have clearly been demonstrated in these materials, leading to suggestions that SMMs could one day be utilized in quantum computational devices. Furthermore, it has recently become feasible to examine magnetic properties as the number of magnetic ions in a molecule is varied, enabling experiments at the frontier between classical magnetization reversal and quantum tunneling.

The aim of this project is to study SMMs in high quality factor electromagnetic resonators. A goal is to achieve strong coupling between the spin and cavity modes, so that energy may be coherently exchanged back and forth between the spin system and a single mode of the microcavity. We first plan to address the question of whether the effects of the interaction of the nanomagnets with the single mode of the microcavity are observable in experiment. If this is the case, then we will be able to study highly coherent coupled quantum evolution of the nanomagnet/cavity system, as is typically done for electronic systems, such as atoms in cavities in atomic physics.

Sustainable Mobile Systems for Developing Regions

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Abstract

The last few years have witnessed a radical shift in the penetration and utility of mobile devices around the developing world especially in rural areas. Most countries in Africa have over 50% cellular coverage and a significant fraction of their rural population owns or has access to a mobile phone. Given that these devices are programmable with open source tools and software, mobile devices offer a unique *computing* platform for developing new applications especially in rural regions that could not have been envisioned before. Mobile devices are much more appealing than other forms of low-cost computing devices since Internet penetration levels in these regions are comparatively low and none of the traditional wire-line connectivity solutions (fiber, broadband and dial-up) are economically viable for regions with low purchasing power and low-user densities.

In this project, we aim to develop a sustainable mobile platform for supporting a wide-range of essential services in rural developing regions. We focus on two specific challenges: (a) enhancing healthcare services using mobile devices; (b) providing new financial and commerce services using mobile devices. Any solution in this space has to be *low-cost and sustainable*; hence the underlying research challenges are not just technical, but also economic and social. To develop low-cost and sustainable solutions, our systems are primarily tailored to work on affordable low-end mobile devices ($20-$30 mobile phones) instead of high-end smart phones. Also, our platform relies on existing voice and messaging services (SMS and MMS) and not data connectivity solutions such as GPRS or EDGE or WiMax which are not economically viable in rural regions.

Currently, we are working on three important problems in the rural mobile healthcare space: 1) mobile health records that enable patients and health workers to retrieve and update their health records using a cell phone; 2) drug tracking which uses built-in functionality for tracking and verifying the pedigrees of pharmaceutical products throughout the distribution chain; and 3) sustainability modeling which aids in understanding the economic and technological needs in developing regions.

Smart Material-Based Platform for Studies of Free Locomotion in Fluid


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Abstract

The emergence of lightweight, low power consumption, and low activation voltage smart materials has opened the door to major scientific studies in the area of free locomotion. Specifically, recent developments in the electroactive polymers community have resulted in a promising artificial muscle technology for miniature laboratory-scale underwater propulsion.

This project seeks to develop a laboratory scale test-bed based on smart materials for understanding fundamental problems in free locomotion, including hovering of a free flapping body and schooling of swimming bodies. The collaborative team is composed of experts in complementary research areas who have the potential of establishing long-term research collaboration in the science and engineering of natural and robotic free locomotion. The proposed seed grant project is aimed at enabling interdepartmental collaboration through joint research, student advising, conference presentations, and publications in peer reviewed journals.