A chemical review on cancer immunology and immunodeficiency

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Abstract

Cancer is the most popular reason of death worldwide that many people struggle with it. Although the cancer is dangerous, but if it detects in early stages increases the chance of patient survival. The miRNAs are one of the important ways for early cancer detection that it caused to return an interesting field for researches. All the miRNAs haven't any role in cancer detection. The Quantum Genetic Algorithm (QGA) is a developed Genetic Algorithm (GA) that by using of quantum computing on top of the genetic algorithm to alleviate the pre convergence problem. The interest of this study is to adopt the QGA for solving of informative miRNAs selection and irrelevant miRNAs removing problem. However, in the suggested algorithm, SVM classifier performance and the dimension of the selected feature vector are dependent on heuristic information for QGA. As a result, the proposed approach selects the adaptive feature subset with respect to the shortest feature dimension and the improved performance of the classifier. The performances of this method are evaluated on the popular data set which the experimental results show that since QGA-SVM is used as one of wrapper methods, as a result, its overall performance is better separation between normal and cancer expression for all types of cancer and better classification rate.

Keywords: *Cancer; Immunology; Immunodeficiency.*

1. Introduction

Counting mitotic figures present in tissue samples from a patient with cancer, plays a crucial role in assessing the patient's survival chances [1-52]. In clinical practice, mitotic cells are counted manually by pathologists in order to grade the proliferative activity of breast tumors. However, detecting mitoses under a microscope is a laborious, time-consuming task which can benefit from computer aided diagnosis [53-93]. In this research we aim to detect mitotic cells present in breast cancer tissue, using only texture and pattern features. To classify cells into mitotic and non-mitotic classes, we use an AdaBoost classifier, an ensemble learning method which uses other (weak) classifiers to construct a strong classifier [94-131]. 11 different classifiers were used separately as base learners, and their classification performance was recorded. The proposed ensemble classifier is tested on the standard MITOS-ATYPIA-14 dataset, where a 64×64 pixel window around each cells center was extracted to be used as training data. It was observed that an AdaBoost that used Logistic Regression as its base learner achieved a F1 Score of 0.85 using only texture features as input which shows a significant performance improvement over status quo. It is also observed that Decision Trees provides the best recall among base classifiers and Random Forest has the best Precision [132-165].

Children are one of the easiest affected group from environmental deterioration and detrimental factors, Due to their biological and behavioral differences. And childhood cancer has considered as one of the most common cause of death in children in developing countries. Exposure to some environmental factors during childhood can increase the risk of cancer in the offspring [166-196]. This study aimed to evaluated the role of living in the pollutant regions and exposure to cigarette or hookah smoke on the incidence of cancer in children. This case control study was considered 22 cases and 100 controls, under 10 years, who was born and lived in pollutant regions of world in 2014-2015. Regarding to the important risk factors, familial background of underlying diseases or cancer [197-240]. However, in this ages, Familial background of cancer is considered as the most crucial risk factor of the incidence of cancer in children (P=0.000, OR=7.639, CI 95% 4.230-13.794). Moreover, the second most significant item is live in regions with polluted air (P=0.019, OR=4.222, CI 95% 1.172-15.211) [241-356].

In the present research, nano studies on synthesised Dihydroimidazo [2,1-a] isoquinoline derivative named (Z)-methyl2-(1-(benzo[d]thiazol-2-yl)-2oxo-1,2-dihydroimidazo[2,1-a]isoquinolin-3(10bH)-ylidene)acetate, are described. Determination of particles size was suitably characterized by means of X-ray diffraction patterns (XRD) and scanning electron microscopy (SEM). In addition, anticancer activity on human breast cancer T-47D cell lines was investigated.

2. Tumor immunology

According to world health organization, breast cancer is one of the deadliest cancers occurred in women. Therefore, accurate diagnosis and prediction is important to decrease the high death rate. The aim of this work is twofold. First, improving breast cancer detection accuracy using Modified Fuzzy Logic (MFL) then improving the performance of MFL algorithm using GPU platform. The experimental results show that the accuracy of the breast cancer detection using FL is higher than other techniques. In addition, by exploiting loop-level parallelism and pipeline parallel communication pattern in MFL algorithm, its performance is improved up to 19.17 for different image sizes.

3. Neoplasia

Nowadays, a range of analysis exists for biological databases that can easily analyze the available information on diseases; especially the cancer of human societies. Oral cancer is one of the six most common head and neck cancer varieties in the world. So, a number of new results are obtained here by applying bioinformatics analysis on the available data on oral cancer. In this study, 103 genes associated with head and neck cancer were analyzed by genetrail2 database. This database collected different analyses which we used in miRNA database to find miRNA genes regulation in oral cancer. Results were taken from mirDB, miRWalk, miRTarbase, Transfac-miRNA, miRecord and target scan. The common miRNAs recognized from 4 miRNAs databases include mir-128a, 148a and Let7a. On the other hand, the comparison of 5 databases just detected 148a. All of these miRNA have been proved to associate with oral cancer and all were down regulated. The purpose of this study to determine the common microRNA in different analysis in this database is to study and find a therapeutic target in oral cancer, used reported microRNA. In addition to use them as diagnostic biomarkers, they can be applied as drugs to convert the carcinogenesis.

With advances in diagnosis and treatment of breast cancer the number of patients who survive is more than the number of patients who die, So the breast cancer data sets have been imbalanced. An imbalanced problem is a challenging issue for Data Mining. In this study, we propose the hybrid approach to build a more accurate prediction model for 5-year survivability of breast cancer patients in presence of outliers and an imbalanced data set problem. To achieve this goal after data preprocessing and classifying data set into two classes, firstly outliers in minority class eliminated and boundary of minority class became stronger based on Borderline-SMOTE. Then three data mining techniques, such as Bayes Nets, Decision tree (C4.5) and 1-nearest neighbor search are applied to final improved data set. Some assessment metrics such as accuracy, sensitivity, specificity, and G-mean were utilized in order to evaluate the performance of proposed hybrid approach. Results showed that among all combinations, proposed approach with C4.5 presents best efficiency in criteria of accuracy, sensitivity, specificity, and G-mean with 98.962%, 0.926, 0.989 and 0.956, respectively.

4. Natural history of neoplasia

The detrimental effects of chemotherapy to fight the cancer cells and drug-resistant in the body are to the extent that they can be even more lethal than cancer if not concerned. Therefore, this study aims to provide a short-time solution for the cancer treatment. In this research, a comprehensive mathematical model of cancer treatment including radiotherapy, chemotherapy, and metastasis is presented. An in-depth investigation of the mentioned model reveals the instability of the system around the equilibrium point. Hence, in order to stabilize the system around the equilibrium point, a solution considering the detrimental effects caused by chemotherapy should be provided. The sliding mode control in which the sliding surface is extracted by using the optimal control theory can well meet the above objectives. The suggested optimal sliding mode control, in addition to flexibility in designing the control protocol of non-linear models, is highly resistant against the uncertainties of the presented mathematical cancer model. Finally, the proposed protocol is investigated for two patients. The effectiveness of the proposed technique regarding a short-time full treatment and removing the need for receiving drugs at the end of period is well established.

The breast cancer is one of the widespread causes of mortality in today's world. The exact and precise diagnosis is considered as the vital point in the process of treatment. So, a lot of screening and diagnostic procedures regarding this issue have been proposed. Thermography considered as a widespread, safe, non-invasive, fast and economical procedure comparing with other screening procedures such as mammography. In this study, a classification algorithm of thermograms with the purpose of detection of breast cancer based on the extraction of statistical and fractal features has been proposed. For this purpose, 74 images from the breast of healthy people and with the positive symptoms of breast disorder from the data were collected. The preprocessing of data and segmentation of images for both right and left breast in gray level for the creation of temperature matrix was performed. The fractal and gray level co-occurrence matrix base features was extracted from the temperature matrix and the collection of features was the input for support vector machine and weighted K-nearest neighbor classifier. The weighted K-nearest neighbor classifier with the fractal features of with the accuracy of 88.7 was selected as optimal structure couponing with the other method.

4.1. Chemical carcinogens

For the detection of DNA/RNA hybridization, a new electrochemical biosensor was developed on the basis of the interaction of Oracet Blue (OB) with 22-mer oligonucleotides (from human Colorectal cancer) a simple bio sensing design to yield an ultrasensitive electrochemical biosensor for cancer biomarker detection on Screen Printed Gold Electrodes (SPGE) without use of any modification on electrode surface perhaps direct detection with the help of electroactive label (OB) and MicroRNA92a (miRNA) as an biomarker selected for being up-regulated in Colorectal cancer. The biosensor was assembled in two stages the immobilization of the probe that was modified on an SPGE and second stage of target hybridization of completely match strand electroactive label OB has been used after hybridization process which is an intercalator with our miRNA strands as a redox indicator for amplifying the electrochemical signal of miRNA 92a. For conformation electrochemical techniques including Cyclic Voltammetry (CV) and Differential Pulse Voltammetry (DPV). were used and hybridization was observed successfully. The final biosensor provided a sensitive detection of miRNA 92a with good selectivity.

4.2. Viruses

In this study, separation of malignant breast cancer cells from white blood cells by means of hybrid AC-electro kinetics in medium of blood plasma (a highly conductive real biological fluid) is numerically investigated. The simultaneous time dependent, three dimensional modelling of electrical, thermal and hydrodynamic phenomena, followed by tracing the particles, is achieved by using the Finite Element method. Simulation of the two-way coupled equations of highly frequent electricity and time dependent heat transfer, is accomplished in this research by using a new computational approach. Moreover, previously deemed inevitable assumptions of diluting the fluid, lowering the electrical conductivity or unwarranted decoupling of equations, are all avoided in this research, while nonzero electrical charge density, thermal gradients of electrical properties and the components of electro thermal force are computed and spatial separation of cells is successfully achieved. The applied numerical approach and results are validated by a previously approved experimental observation.

5. T lymphocytes and antitumor immunity

For first time father of medicine (Socrates) to reveal cancer and explain new debate in this field, until now propose various ways for therapy cancer but a lot of these way do not reach the tumor site and produce side-effects.at this time open new gateways for cancer and another malady that one of them is drug delivery system (DDS). A drug is transported to the place of action, hence, its influence on vital tissues and undesirable side effects can be minimized. Various nanostructures, including liposomes, polymers, dendrimers, micelles, carbon and metal nanoparticles have been tested as carriers in DDS, but in this between polymers have different and important role.in this review we focus on polymer drug delivery system for cancer treatment by responsivity to temperature and pH.

6. B lymphocytes and antibodies

Carboplatin is chemotherapy drug which is used against some forms of cancer such as ovarian and lung carcinoma. This research was investigated to optimize and assess the Cytotoxicity of carboplatin Nano liposomes on ovarian and lung cancer cell lines. Nanoparticles were prepared using reverse phase evaporation technique and characterized for spectrophotometryanddrug-release properties. In the next step, A2780S and A2780CP (ovarian) and TC1 (lung) cell lines were used to determine the rate of Nano liposomal carboplatin cytotoxicity. In this research, size and zeta potential are 244.3 ± 16.7nm and -22.9 ± 1.7 mV, respectively. High encapsulation capacity ($78.6\pm3.7\%$) confirmed the efficiency of reverse phase evaporation technique. The cytotoxic effect of this Nano liposome on all cell lines was significantly increased when compared with free drug ($P<0.05$). Our findings suggest that carboplatin liposomal Nano carriers could serve as alternative chemotherapy modality for ovarian and lung cancer therapy.

7. Macrophages, monocytes, and dendritic cells

Alkaloids are naturally occurring nitrogen containing biologically active heterocyclic compounds. Over the last few years, a large number of biologically important alkaloids with antiviral, antibacterial, anti-inflammatory, antimalarial, antioxidant and anticancer activities have been isolated from marine source. Present work to use of method quantitative structure-activity relationship (QSAR) study has been done on some marine natural alkaloids as anticancer agents in cancer leukemia. Multiple linear regression (MLR), partial least squares (PLS) and principal component regression (PCR) were used to create QSAR models. For this purpose, geometry optimization performed at B3LYP level with a known basis set (6–31G (d)). Hyperchem, ChemOffice, Gaussian03W and Dragon software were used for geometry optimization of the molecules and calculation of the quantum chemical descriptors. Finally, unscramble program was used for analysis of data. For the compounds in the gas phase RMSEtrain, RMSEtest and R2 with jack-knife method 0.1972, 0.7356 and 0.68 respectively. The values of R and R2 to GA-stepwise MLR model 0.984 and 0.969 respectively and also RMSEtrain and RMSEtest with Genetic algorithm-Artificial neural network (GA-ANN) respectively 0.1388 and 0.4208 are obtained. In end The GA-stepwise MLR method other than the method most appropriate for this cell is known.

8. Natural killer cells (NK), and antibody-dependent cellular cytotoxicity

Colorectal cancer (CRC) Considered as the most common fatal cancer and ranked as the third worldwide and the third and the fifth in American women and men respectively. There are several methods for analyzing time to event data. Although Cox proportional hazards model is popular but when the absolute change risk instead risk ratio (hazard ratio), is of primary concern or when the proportionality assumption does not hold the additive hazard regression models may be more suitable. The main objective of this study was to apply additive hazards models beside Cox proportional hazards model to study of survival CRC patients. The data were used in this study includes 561 colorectal cancer patient information that is recorded in the American Institute for Cancer Research, United Sates during the 2005 to 2010 years and they followed until December 2015. The nonparametric Aalen's additive hazard model and semiparametric Lin and Ying's additive hazard model besides Cox proportional hazards model were used for data analysis. The proportionality assumption for Cox model was evaluated by a test based on correlation between the Schoenfeld residuals and also for test goodness of fit in additive models ranked survival times beside graphical methods and Cox-Snell residual plots were used. The analysis was done with SAS 9.2 and R3.2 software. The median follow-up time was 49 months. The five-year survival rate and the mean survival time after cancer diagnosis were 59.6% and 68.12 ± 1.4 months respectively. The multivariate analysis using the Lin and Ying's additive model and Cox proportional model identified that the age of diagnosis, site of tumor, stage, proportion of positive lymph nodes, lymphovascular invasion and type of treatment were observed as factors influencing survival of the CRC patients. When the interest is evaluating absolute change risk the additive models or the proportionality assumption is violated the additive models are a suitable alternative to Cox proportionality model.

9. Cytokines, lymphokines, and immune mediators

Multiclass pattern recognition is a problem of building a system that accurately maps an input feature space to an output space of more than two pattern classes. K-class pattern classification can be implemented in a single neural network with K output nodes. Such a model can be extended to make predictions about patients" probability of survival over time. This research proposes a multiple time-point ANN model for predicting the probability of survival at different time intervals for patients with gastric cancer. More specifically, survival is

modeled using a multiple-output ANN, with a structure modulated to produce different values as the probability of survival for each time interval. The model's performance in outcome prediction is investigated with a real gastric cancer data set.

10. Cytokines and the pathogenesis of cancer

In this study, we present a design and simulation a low cost and high sensitivity biosensor based on metamaterials for cancer cell detection by COMSOL Multiphysics software. This biosensor worked in the microwave waves. In structure this biosensor using of SRR (Split-Ring Resonator) because it has high sensitivity to electromagnetic waves. We present structure have a high sensitivity approximately 0.56 GHz (560 MHz). This biosensor has also fine ability to separate the between cancer cell types. Important advantages of this biosensor are low cost manufacturing and free label that it can be produced locally.

10.1. Tumor-specific antigens (TSA) and tumor-associated antigens (TAA)

Breast cancer is the most common cancer among women. Prediction of breast cancer recurrence is the most vital element for its successful treatment. Breast cancer recurrence can appear every time. Developed data mining techniques can be used for finding models and hidden relations. Review of data mining methods applications for developing prediction models for recurrence of breast cancer is the purpose of this work. Three algorithms such as: decision trees (DTs), support vector machines (SVMs) and artificial neural networks (ANNs) are investigated in this research. The predictive models discussed here are based on various supervised machine learning (ML) techniques as well as on different input features and data samples. Suggested techniques results reached to acceptable results on different database.

10.2. Immunological surveillance

Laccases (benzenediol: oxygen oxidoreductases, EC (1.10.3.2) belong to the group of blue oxidases and represent the largest subgroup of multicopper oxidases. the most common Enzymes were found from Teammates versicolor. The optimum temperature and pH are determined for laccase. Noisome containing laccase are prepared in optimum conditions by method film hydration. the best formulations are selected according the size and morphology so encapsulation percent are measured. zeta potential and size distribution of noisome are measured by Malvern, Nano sizer and zeta sizer. Kinetic parameters for both free and encapsulated enzymes by two methods are measured and the results confirmed the immobilized parameters. Cytotoxcicity test was done on two A549(lung cancer) and MCF7(breast cancer) cell lines due to determination of % Ic50.

10.3. Factors limiting antitumor immune reactions

Leukemia is a particular type of cancer characterized by the failure of cell death or disability in differentiation of hematopoietic cells. Chronic myelogenus leukemia (CML) is the most studied kind of this cancer. In this study, anti-cancer effect of acetanilide and Para-nitroacetophenone derivatives were investigated in the human leukemia K562 cells. K562 cell line was cultured by initially seeding 1×106 cells per milliliter in RPMI 1640 medium. Cell viability was investigated using try pan blue exclusion and MTT assays. Cell death in cancer and normal cells was quantified using propidium iodide (PI) and acridine-orange (AO) double staining. The one-way analysis of variance (ANOVA) and the Excel software were used for data analysis. Acetanilide and Para-nitroacetophenone derivatives had strong fatal and concentration-dependent effect on K562 cells and caused cell death mainly through induction of apoptosis. Statistical analysis of cells under fluorescence microscope revealed significant difference in apoptotic cells populations between treated and untreated cells. The results of this investigation clearly indicated that Acetanilide and Para-nitroacetophenone derivatives have cytotoxic effects in the K562 cell line. This information revealed also that these compounds may prepare a new therapeutic approach for the treatment of leukemia.

11. Enhancing antibodies and immunostimulation

11.1. Enhancing antibodies

Breast Cancer is the most widespread Cancer among women. Breast cancer is the second leading cause of cancer death in women. The number of new cases of breast cancer was 124.8 per 100,000 women per year. The number of deaths was 21.9 per 100,000 women per year. These rates are age-adjusted and based on 2008-2012 cases and deaths. This represents about 12% of all new cancer cases and 25% of all cancers in women. Conventional diagnosis methods of Breast Cancer include biopsy, mammography, thermography, and Ultrasound imaging. Among these methods, mammography is the most efficient method for the early diagnosis of Breast Cancer. Detecting Breast Cancer and classifying mammography images are the standard clinical procedures for the diagnosis of Breast Cancer. In order to classify mammography, is provided automated computer-based detection methods. In this study, Gray-Level Co-occurrence Matrix and Cumulative Histogram features were used. We also use a Decision Tree as a classifier system. Then we introduce a new algorithm that called Discrete Version of Imperialist Competitive Algorithm as a global optimization algorithm in discrete space, and we use this algorithm for finding the best features of the extracted features.

11.2. Immuno-stimulation

Today breast cancer is one of the dangerous diseases in all over the world. Early detection of breast cancer is affecting health and lives of women's. Mammography is the best available radiological technique for early detection of breast cancer. In this study, we proposed a novel method base on combining wavelet transform and LBP algorithm. The proposed method archived accuracy of 96/2 for normal cancer and 94/7 for abnormal cancer.

11.3. Blocking factors

The present study was conducted with the aim of investigating the effectiveness of Acceptance and Commitment Therapy on reducing symptoms of depression and quality of life among cancer patients in the American Institute for Cancer Research. The study employed a pretest-posttest quasi-experimental method with the control group. A number of 20 cancer patients suffering from depression were selected after primary assessment and confirmation of qualifications of the research and then, they were randomly divided into two 10 participant experimental and control groups. After that, they received 8 sessions of ACT. Beck's Depression Inventory and Quality of Life Questionnaire were selected as instruments of the research in pretest and posttest stages. The data were analyzed using MANCOVA. The results obtained from MANCOVA indicated that ACT has a significant effect on reducing depression symptoms and the increase in quality of life among cancer patients ($p<0.001$). This intervention method may independently or with other treatment method such as pharmacotherapy for reducing depression symptoms and the increase in quality of life in cancer patients.

12.   Conclusions

Every woman is at risk of ovarian cancer; about 90 percent of women who develop ovarian cancer are above 40 years of age, with the high number of ovarian cancers occurring at the age of 60 years and above. Early and correct diagnosis of ovarian cancer can allow proper treatment and as a result reduce the mortality rate. In this work, we proposed a hybrid of Synthetic Minority Over-Sampling Technique(SMOTE) and Artificial Neural Network (ANN) to diagnose ovarian cancer from public available ovarian dataset. The dataset was firstly preprocessed using SMOTE before employing Neural Network for classification. This study shows that performance of Neural networks in the cancer classification is improved by employing SMOTE preprocessing algorithm to reduce the effect of data imbalance in the dataset. To justify the performance of the proposed approach, we compared our results with the standard neural network algorithms. The performance measurement evaluated was based on the accuracy, F-measure, Recall, ROC Area Margin Curve and Precision. The results showed that SMOTE + MLP (with above96% accuracy) performed better than SMOTE + RBF and standard RBF and MLP.

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