




May 18th, 11:40 AM - 12:00 PM

Analytical approach for Monitoring the Behavior of Patients with Pancreatic Adenocarcinoma at Different Stages as a function of time

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**"This innovation is accepted for provisional US Patent:
Application No. 63/416,414"**

Abstract

This present study is divided in two phases. In the first phase, a predictive model was developed using several pancreatic cancer risk factors. To check the validity of the model, we compared the model's performance with ten deep neural network models, grown sequentially with different activation functions and optimizers. Our proposed XGBoost model outperformed all competing models we considered with regards to the RMSE & MAE. After developing the model, we ranked all the individual risk factors according to their individual contribution to the response predictions, which is extremely important for pancreatic research organizations to spend their resources on the risk factors causing/influencing the particular type of cancer.

In the second phase, we introduced an analytical approach to monitor the behavior of survival times of pancreatic adenocarcinoma patients by introducing two new concepts in context of Survival data: Survival Index (SI), and Stochastic Growth Intensity Function, $\zeta(t)$. Survival times of patients from three race groups (Caucasian, African-American, and Others) at four different cancer stages, categorized into three different age groups ([40-59), [60-79), and [80-above)) were considered. A total of 108 patient groups receiving three different treatments; only chemotherapy (C), only radiation (R), and a combination of chemotherapy and radiation (C + R) were constructed for the study using the SEER Cancer Database. Our analytical method was helpful to predict the pattern of survival times of patients based on the Survival Index (SI), as a function of time t ; which necessarily provides information if the specific treatment has been useful for the particular patient group. That is, $(SI) > 1$ implies the treatment has an adverse effect on the patient's survival. $(SI) \approx 1$ implies the survival rate is approximately constant by the implementation of the treatment, and $(SI) < 1$ implies the treatment has been effective on the patient's survival. Our analytical methodology based on Survival Index (SI) and stochastic growth intensity function $\zeta(t)$ is useful and effective for any subject cancer and can be implemented as a modern approach to monitor and evaluate cancer mortality rate as a function of time. The adaptability of our technique stems from the fact that our algorithm may be used for any number of patient groups of any age, of any race, at any specific cancer stage, and receiving any unique treatment or combination. If a doctor/medical professional knows beforehand that a treatment has been effective for a specific patient group (out of 108 patient groups that we considered), that information can be utilized to treat any future patient from that particular group.

Keywords: Pancreatic Adenocarcinoma, Survival Index, Stochastic Growth Intensity Factor (SGIF), Relative Change in Intensities (RCI), SEER Cancer Database