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Intuitionistic Fuzzy Set (IFSM) Model (Based on hormonal misbalanced and malignant disorder) to diagnose Breast Cancer

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ABSTRACT: Among the most common type of cancer in women, breast cancer accounts for 14% of cancers in Indian women.(Sourse:breastcancerindia.net) It is reported that with every four minutes, an Indian woman is diagnosed with breast cancer. Breast cancer is on the rise, both in rural and urban area of India. A 2023 report of Breast Cancer statistics recorded 1, 85,256 new registered cases and 36145 reported deaths. Breast cancer is a worldwide spread cancer and occupies the 5th position in India, with a high incidence in urban area in comparison of rural area of India. In the last decades, Brest cancer was an intensively studied process but there is no amelioration noticed in its prognostic. More than 80% of breast cancers are squamous cell carcinomas developed from hormonal misbalanced, wrong diet plan and malignant disorders Cancer survival becomes more difficult in higher stages of its growth, and more than 50% of Indian women suffer from stage 3 and 4 of breast cancer. Post cancer survival for women with breast cancer was reported 60% for Indian women, as compared to 80% in the U.S. Women can self-diagnose their condition and know of the presence of lumps or masses that suggest cancerous outgrowths. The very common reason for a low breast cancer survival rate of women in India accounts from its lack of awareness and poor early screening and diagnosis rates.

Although there are a number of clinical methods to detect breast cancer, here we will discuss a new approach "Intuitionistic Fuzzy set model"(IFSM) to detect Breast cancer. Any decision making requires large quantities of information. During breast cancer the present paper proposes the use of Intuitionistic fuzzy set logic (IFSL) – a machine-learning algorithm - to assess cancer risk in screening breast potentially malignant disorders. An effective alternative to the existing prediction tools is artificial intelligent prediction.Researchers designed and used machine-learning algorithms proved to be of great value. Various numerous studies propose the use of artificial intelligence in medicine, with a particular emphasis on cancer. The majority of them identify, classify, detect, or distinguish tumors and only a few predict or prognoses cancer. This method is based on human-like learning ability in pattern recognition and generalization known as machine learning.

Key Words: IFSM- Intuitionistic fuzzy set model, μ_A,- First Isoform of ESTROGEN hormone receptors, μ_B – Second Isoform of ESTROGEN hormone receptors, $1/\beta$ = Growth rate of cancer cells, ER Positive- Cell and tissues have estrogen receptors. ER Negative- Cell and tissues have not estrogen receptors

INTRODUCTION: Breast cancer is a disease in which abnormal breast cells grow out of control and form tumors. If left unchecked, the tumors can spread throughout the body and become fatal.

Breast cancer cells begin inside the milk ducts and/or the milk-producing lobules of the breast. The earliest form (in situ) is not life-threatening and can be detected in early stages. Cancer cells can spread into nearby breast tissue (invasion). This creates tumors that cause lumps or thickening. Invasive cancers can spread to

nearby lymph nodes or other organs (metastasize). Metastasis can be life-threatening and fatal. In 2022, there were 2.3 million women diagnosed with breast cancer and 670 000 deaths globally. Breast cancer occurs in every country of the world in women at any age after puberty but with increasing rates in later life.

Global estimates reveal striking inequities in the breast cancer burden according to human development. For instance, in countries with a very high Human Development Index (HDI), 1 in 12 women will be diagnosed with breast cancer in their lifetime and 1 in 71 women die of it.

In contrast, in countries with a low HDI; while only 1 in 27 women is diagnosed with breast cancer in their lifetime, 1 in 48 women will die from it.

Signs and symptoms

Most women will not experience any symptoms when the cancer is still early hence the importance of early detection.

Breast cancer can have combinations of symptoms, especially when it is more advanced. Symptoms of breast cancer can include:

- a breast lump or thickening, often without pain
- change in size, shape or appearance of the breast
- dimpling, redness, pitting or other changes in the skin
- change in nipple appearance or the skin surrounding the nipple (areola)
- Abnormal or bloody fluid from the nipple.

Women with an abnormal breast lump should seek medical care, even if the lump does not hurt. Most breast lumps are not cancer. Breast lumps that are cancerous are more likely to be successfully treated when they are small and have not spread to nearby lymph nodes. Breast cancers may spread to other areas of the body and trigger other symptoms. Often, the most common first detectable site of spread is to the lymph nodes under the arm although it is possible to have cancer-bearing lymph nodes that cannot be felt. Over time, cancerous cells may spread to other organs including the lungs, liver, brain and bones. Once they reach these sites, new cancer-related symptoms such as bone pain or headaches may appear.

Methods Available to detect Brest Cancer: Number of methods are available in medical science to diagnose Breast cancer, here is the overview on methods to diagnose breast cancer

For breast cancer, confirmation further clinical investigation is required.

1: Breast ultrasound: It is done by an ultrasound machine. The machine takes pictures of inside breast by using sound waves. This is called a sonogram of breast. By this method initial formation of irregular tissues or development of unwanted growths of tissues may be recognized by pictures, then an oncologist may predict a breast cancer, but this is not the confirmation

2: **Diagnostic mammogram.** If you have a problem in your breast, such as lumps, or unwanted tissues growth, in ducks or nipples, or if an area of the breast looks abnormal on a screening mammogram, doctors may have you get a diagnostic mammogram. This is a more detailed X-ray of the breast using sound waves.

3: Breast magnetic resonance imaging (MRI). A kind of body scan that uses a magnet linked to a computer. The MRI scan will make detailed pictures of areas inside the breast.

4: Biopsy. This is a test that removes tissue or fluid from the breast to be looked at under a microscope and do more testing. There are different kinds of biopsies (for example, fine-needle aspiration, core biopsy, or open biopsy)

My Research Problem: The objective of this paper is to develop an Intuitionistic fuzzy set Logic (IFSm) model to diagnose breast cancer, with the help of hormonal misbalanced and malignant disorder.

IMPORTANT CONCEPTS OF FUZZY SETS AND INTUITIONISTIC FUZZY SETS(IFS) :

In his classical work in 1965, Zadeh [6] initiated the notion of fuzzy set theory as a generalization of the ordinary set theory, which turned out to be of far reaching implications. Vague notions can be modeled using this theory. A fuzzy set is a class of objects in which the transition from membership to non-membership is gradual rather that abrupt. Such a class is characterized by a membership function which assigns to an element a grade or degree of membership between 0 and 1.

set U are determined to A set can be described either by list method or by the rule method. We know that the process by which individuals from the universal are either members or nonmembers of a subset can be defined by a characteristic

Function or discrimination function $c_A : U \rightarrow \{0, 1\}$.

For a given subset A of U, this function assign a value $C_A(x)$ to every $x \in U$

such that

$$C_A(x) = 1 \quad \text{iff} \quad x \in A$$

$$= 0 \quad \text{iff} \quad x \notin A$$

or not. Thus in the classical theory of sets, very precise bounds separate the elements that belong to a certain subset from the elements outside the subset. In other words, it is quite easy to determine whether an element belongs to a set

The membership of the element x in set A is described in the classic theory of sets by the characteristic function C_A or μ_A and calling it in another Terminology by 'membership function', we say that

$$\mu_A(x) = \begin{cases} 1, & \text{if and only if } x \text{ is member of A} \\ 0, & \text{if and only if } x \text{ is not member of A} \end{cases}$$

In above figure in the graph shows the belongingness and non-belongingness.

Intuitionistic fuzzy sets (Vague sets): An important and very potential generalization of fuzzy set theory came in the form of intuitionistic fuzzy set theory of Atanassov [13]. All fuzzy sets can be viewed as intuitionistic fuzzy sets, but the converse is not true. Many authors have asserted that there are a large number of real life problems for which IFS theory is a more suitable tool than fuzzy set theory.

In most cases of judgments, evaluation is done by human beings (or by an intelligent agent) where there is certainly a limitation of knowledge or intellectual functionaries. Naturally, every decision- maker hesitates more or less,

fuzzy set theory (IFS theory)introduced by Atanassov [13] is *have been used with same meaning and objectives.*of interest to us. Recently Gau and Buehrer reported in IEEE [15] the theory of vague sets. *But vague sets and intuitionistic fuzzy sets are same concepts as clearly justified by Bustince and Burillo in [14]*

Intuitionistic Fuzzy Set (IFS)

An intuitionistic fuzzy set (IFS) A in a universe of discourse E is defined as an object of the following form

$$A = \{ (x, \mu_A(x), \nu_A(x)) \mid x \in E \}$$

where the functions:

$$\mu_A : E \rightarrow [0,1], \text{ and}$$

$$\nu_A : E \rightarrow [0,1]$$

define the 'degree of membership' and the 'degree Of no n-membership' respectively of the element $x \in E$ to be in A,

And for every $x \in E$ we have the constraint

$$0 = \mu_A(x) + \nu_A(x) = 1.$$

Let us call this constraint $0 \leq \mu_A(x) + \nu_A(x) \leq 1$ by "Atanassov Constraint".

Obviously, each ordinary fuzzy set may be written as

$$\{ (x, \mu_A(x), 1-\mu_A(x)) \mid x \in E \}$$

And thus every fuzzy set is an intuitionistic fuzzy set but not conversely.

Important terms for our (IFSM):

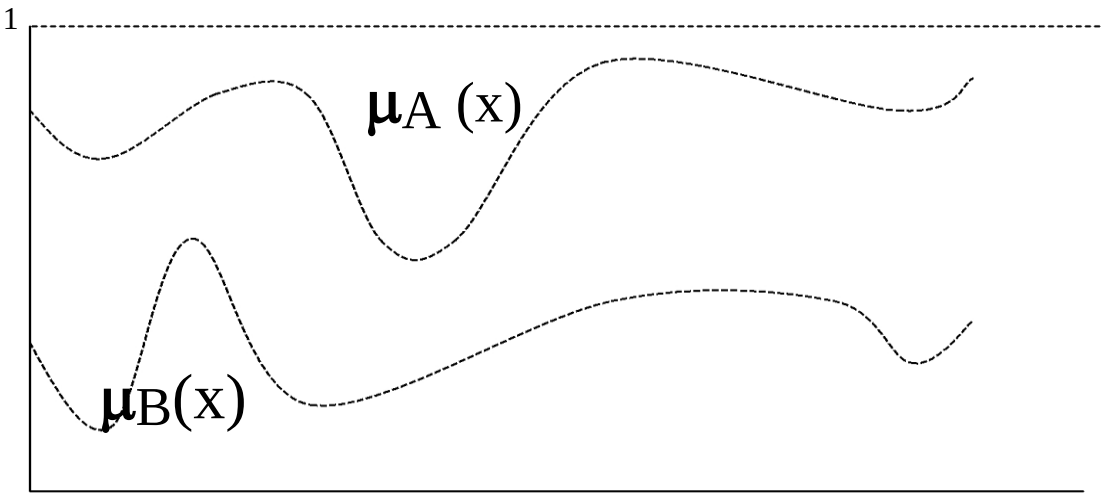
HORMON RESPOSIBLE FOR BREAST CANCER: The HORMON which is mainly responsible for the breast cancer is Estrogen. This Hormone (Natural chemical) is made by your body, and your body carries ESTROGEN to cells and tissues throughout your body. Estrogen plays an important role in sexual development and reproductive system. But Estrogen is also a carcinogen, which means it has the potential to cause cancer. In Estrogen dependent cancer, Estrogen fuels the cancer cells growth in female body. Generally, we can consider Estrogen is a female HORMONE, the ovaries part of the female reproductive system produced most of the Estrogen hormone, but Breast tissues and fat cells also makes Estrogen in all genders.
In women Estrogen and progesterone (another sex hormone) bring on puberty. Estrogen stimulates the growth of breasts and pubic hair. It also regulates menstruation. (Periods). In men, estrogen promotes brain development, sexual function and libido.
How are Estrogen – dependent cancers diagnosed: your healthcare provider sends tissues sample from a tumor to a lab called biopsy. The lab tests the cells in the samples for hormone receptors. A hormone receptors positive (HR+) results means estrogen, progesterone or both hormone fuels cancer growth.

INTUITIONISTIC FUZZY SET MODEL (IFSM)FOR DIAGNOSE BREAST CANCER: Let μ_A, and μ_B be two Isoform of ESTROGEN hormone receptors, in the patients have similar other body checks, or are similar in other functional organizations and structure. Both inceptors μ_A, and μ_B, react in the same way with malignant disorder, which is denoted by set a (IFS) . ASSUMING that $1/\beta$, plays an important role in the development of growth of cancer cells, therefore $1/\beta$ should also be the member of IFS, A. now The oncogenic function of estrogens is considered in both classical and non-classical hormone-sensitive carcinomas such as prostate, breast, endometrial, lung, colon, and ovarian cancers. The molecular basis of cancer. The molecular basis of cancer initiation by estrogen has been suggested through the production of aromatic estrogen metabolites (catechol

estrogens quinines) that are derived from normally formed catechol estrogens. Chemically, depurating DNA-adducts are formed by the reaction of 4- $OHE_{1/2}$ or 2-$OHE_{1/2}$ with Adenine/Guanine bases which leads to DNA mutations
The blood sample of 16 women were taken with the help of All Indian medical sciences(AIIMS) Delhi, and was tested for hormone estrogen, and malignant disorder, where especially the values of inceptors μ_A, and inceptors μ_B was tested. The result is shown by the following table.

Women	inceptors μ_A,	inceptors μ_B	Malignant disorder (IFS) A	Result
W1	0.1125	0.1120	$\in A$	μ_A, $\mu_B$is a member of A
W2	0.1130	0.1130	$\in A$	μ_A, $\mu_B$is a member of A
W3	0.1135	01140	$\in A$	μ_A, $\mu_B$is a member of A
W4	0.1140	0.1150	$\in A$	μ_A, $\mu_B$is a member of A
W5	0.1145	01160	$\in A$	μ_A, $\mu_B$is a member of A
W6	0.1150	0.1165	$\in A$	μ_A, $\mu_B$is a member of A
W7	0.1155	0.1170	$\in A$	μ_A, $\mu_B$is a member of A
W8	0.1160	0.1175	$\in A$	μ_A, $\mu_B$is a member of A
W9	0.1165	0.1180	$\in A$	μ_A, $\mu_B$is a member of A
W10	0.1170	0.1185	$\in A$	μ_A, $\mu_B$is a member of A
W11	0.1175	0.1190	$\in A$	μ_A, $\mu_B$is a member of A
W12	0.1180	0.1195	$\in A$	μ_A, $\mu_B$is a member of A
W13	0.1185	0.1200	$\in A$	μ_A, $\mu_B$is a member of A
W14	0.1190	Nil	$\notin A$	$\mu_A \in A, \mu_B \notin A$
W15	0.1195	Nil	$\notin A$	$\in A, \mu_B \notin A$
W16	0.1200	Nil	$\notin A$	$\in A, \mu_B \notin A$

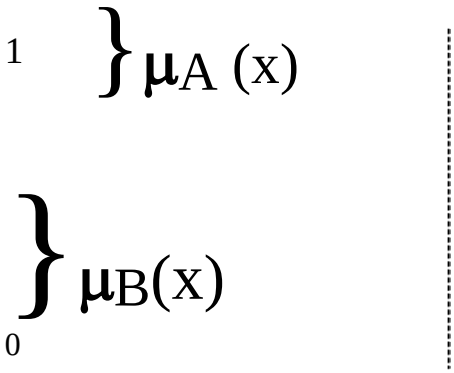
Now the graphical representation of this proposed model is:



Melignant Disorder

0

Figure 1.1



Result and Discussion: It is clear from the above table and corresponding graphical representation of the blood test done on 16 different women, keeping in the mind that other clinical examinations are normal, on the behalf of above result obtained clinically we proposed a fuzzy set model value for the breast cancer. According to this model the values for inceptorsμ_A, and inceptors μ_B are not equal in all the women, in the result of w1, w2, w3,…….. w13, the values of inceptors μ_A, and inceptors μ_B have some degree of relationship, wheares in the w14, w15, and w16 the clinical values have no relationship between , inceptors μ_A, and inceptors μ_B.$The\ factor\ is\ charasmetic,$ while other factors in all the women are same, then why w13, w14, w15, inceptors μ_A, and inceptors μ_B have no relationship. Also all the relational values of w1, w2, w3,……..w13. belongs to the IFS malignant disorder, whereas the values for the w14, w15, w16 does not belongs to the IFS Malignant disorder.to clarify further, ER-positive tumors overexpress the ER while tumors that contain a small number of receptors and sometimes no receptors are called ER-negative which is directing the treatment options. Patients with ER-negative have lower survival rates in the first few years and their tumors are usually more aggressive. However, 10 years after the initial diagnosis of the tumor without being associated with other health problems, the possibility of relapse is more in patients who have ER-positive. In addition, other factors affect the life of a breast cancer patient, such as the infiltration of lymphocytes, especially for patients who have the disease before the age of forty, as the presence of a large number of $CD8^+$ T lymphocytes contributes to the high survival rates of the patient, and this shows It is more clearly in patients who have ER-negative compared with patients with ER-positive.

Conclusion

Artificial intelligence could improve the methods used in predicting concretization of Breast potentially malignant disorders. Intuitionistic Fuzzy set logic, in particular, has the advantage of allowing the use of ambiguous values as input data unreliable to other methods; and facilitating a correspondence between the numerical values of the disease parameters and linguistic terms, easier to process by the user.This multi-criteria decision support system proposed by us can be integrated into a more complex computerized decision support system. A user-friendly (interface-user) integrated computer system that uses first and/or only minimum invasive sampling (serum or saliva) markers to estimate the cancer risk of oral potentially malignant disorders can be, in our opinion, an important clinicians aid in screening and establishing future medical decision.

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