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COMPARATIVE STUDY OF MACHINE LEARNING METHODS USED FOR SKIN CANCER DETECTION AND CLASSIFICATION

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Abstract

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2.1 Skin

The skin is a complex organ a [9], it is interactive, self renewing and represents the first and primary defense line against hostile environment and it has several characteristics such as selective absoption, auto regeneration when injured, barrier to water loss, touch sensitivity ...etc [10]. It represents the largest sensory organ (15% of total body weight and a total area of 1.86 m^2) [11], it has a highly adaptive structure that makes it vital for the survival of the human body, the balance between its static and dynamic properties makes it highly adaptive to the variations of the outer world [12].

2.1.1 Skin Anatomy

The skin is primary composed of 3 main layers as shown in the figure 2.1, each layer has its unique properties and functions [11].

Epidermis the outer most layer which is constantly regenerating and it contains the pigment melanin that determins the skin color and it also represents a physical and biological barrier

Dermis the middle layer, it supports the flexibility and gives strength the epidermis and it is maily composed of connective tissue

Hypodermis the last layer which is composed of subcutaneous fat which gives it its properties of being a main support of the overall structure of the skin and shock absoption

2.1.2 Other entities also contained in the skin

Hair provides protection agains minor trauma, thermoregulation and filtering functions such as nasal hair and eyelashes

Sweat Glands it is foucd across the entire body, it provides lubrication, temprerature regulation and salt and water balance.

there anatomies are shown in the figure 2.2

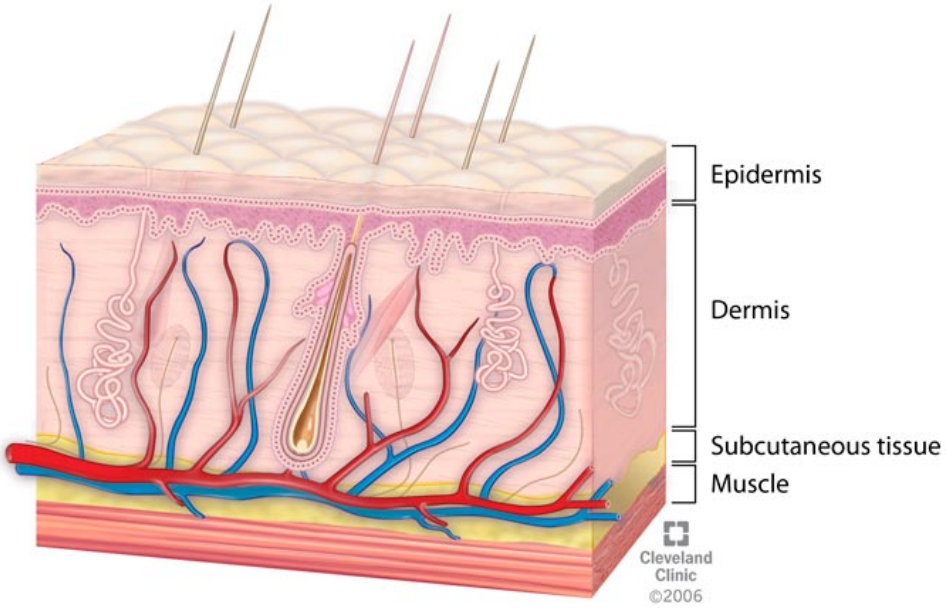

Figure 2.1: Skin Anatomy [1]

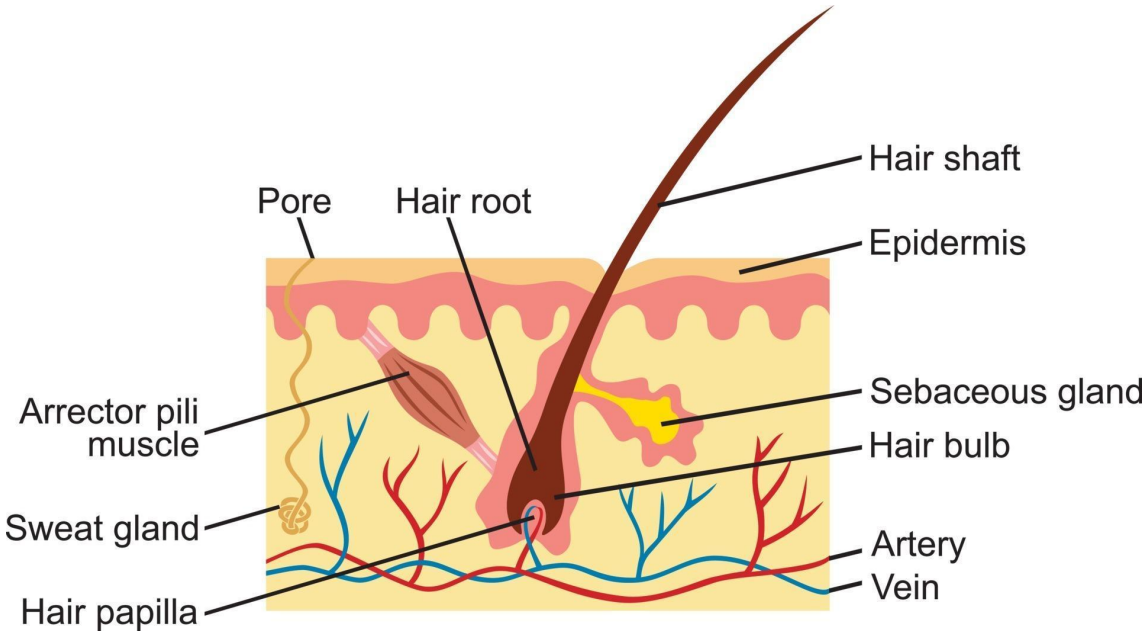

Figure 2.2: Hair and Sweat Glands Anatomy [2]

2.1.3 Functions of the Skin

The skin has 6 main functions that can be summarized as follows [11]

Protection the skin is a direct interface between the entarnal organs and the environment so it works as a protective barrier against harmful objects and pathogens (innate/adaptive immunity and unltra-violet light protection [10]) as shown in figure 2.3

Thermostat the skin works as a thermoregulator to keep the body at the optimal temperature of 37 C°, to achieve that is uses multiple strategies such as insensible perspiration, sweating ...etc

Neural relay network the skin contains a dense network of neural endings that works as receptors to various signals and provides sensations for touch, temperature and pain.

Expression and communication A more social function is the ability for skin to enable individuals to display emotions. It acts as an indicator of one's physical state. Skin is an important component of the stress response as it acts as an immediate stress perceiver and as a target of stress responses. the skin also works as a social tool for interactions between human beings by indicatings the physical state of the individual and by showing sign of stress.

Water storage this skin works as a conservative barrier agains water and body fluids leakage (18-20% of totla body water) as shown in figure 2.3

Synthesis of vitamin D the skin reperesents the main site of vitamin D production when exposed to the sun, it exists in the plasma membranes of basal and suprabasal keratinocytes in its inactive form then it is converted to previtamin D3 then to Vitamin D in the liver and kidneys [10] as shown in figure 2.4

2.2 Cancer

Cancer is an illness caused by the uncontrolled division and spreading of normal cells [13] unlike other diseases, cancer is caused by our own bodies and not by foreign entities, and it is one of the biggest causes of death among human beings nowadays (Table 2.1) and that is because of the ineffectiveness of traditional treatment methods such as hormones, surgery, radiation, and chemotherapy [14]. their ineffectiveness is due to there side effects that lead the body to deteriorate more and more. but it is worth mentioning that there are some new methods and approaches being developed by researchers, a couple of those methods are the study of stem cells in relation to cancer cells and the study of the normal cells that the cancer cells came from which are called "Cancer Origin Cells", the latter approach proposes that we should study these origin cells because of their big similarities with cancer cells which will give us a roadmap to its diagnosis and therapy [15]

2.2.1 Origin

One of the theories that discuss this is the "carcinogenesis multi-hit theory " which stipulates that for cancer to emerge there are some conditions (hits) that need to be

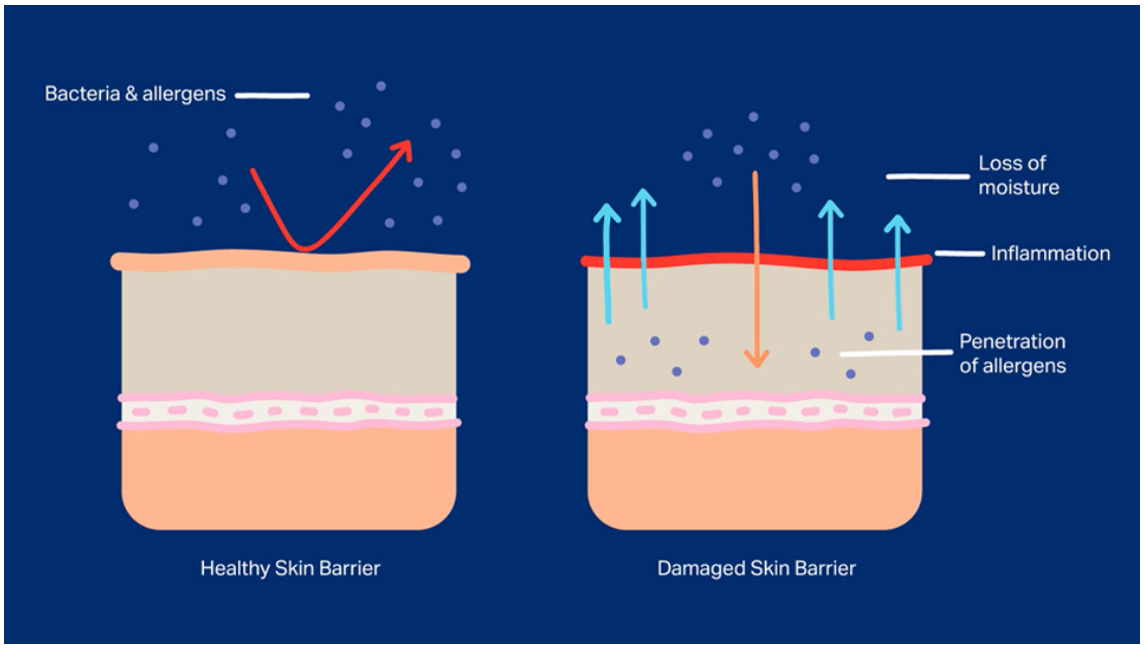

Figure 2.3: Protective/moisture Barrier Functions [3]

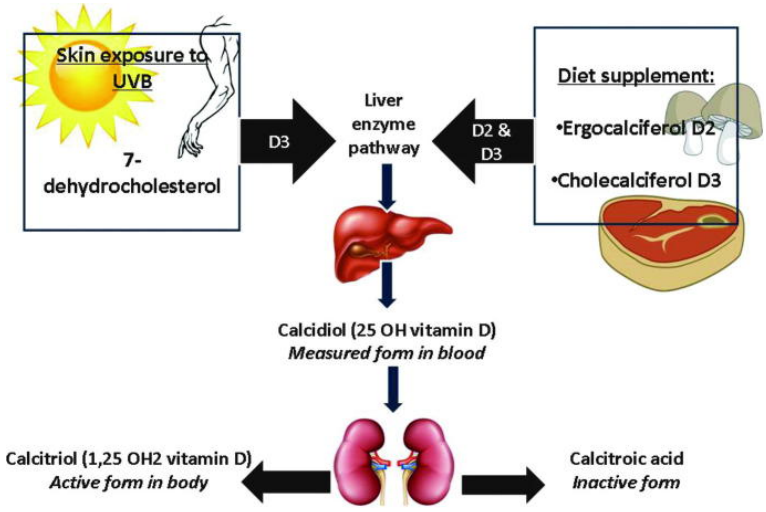

Figure 2.4: Hair and Sweat Glands Anatomy [4]

Deaths in 2020	nealry 10 million
Type	**New Cases** (millions) in 2020
Breast	2.26
Lung	2.21
Colon and Rectum	1.93
Prostate	1.41
Skin	1.20
Stomach	1.09

Table 2.1: Cancer Statistic [8]

satisfied these hits are produced by genetic mutations (figure 2.5) or rearrangements (figure 2.6) that occur over many years and the number of hits necessary is minimal ranging from 3 to 7 only [15]. but it is only fair to mention that there are some exceptions to the rule as there are some cancers caused by only one hit. and to go a step further these mutations can be caused by various elements in our environment such as chemicals in tobacco, ultraviolet rays...etc [13]

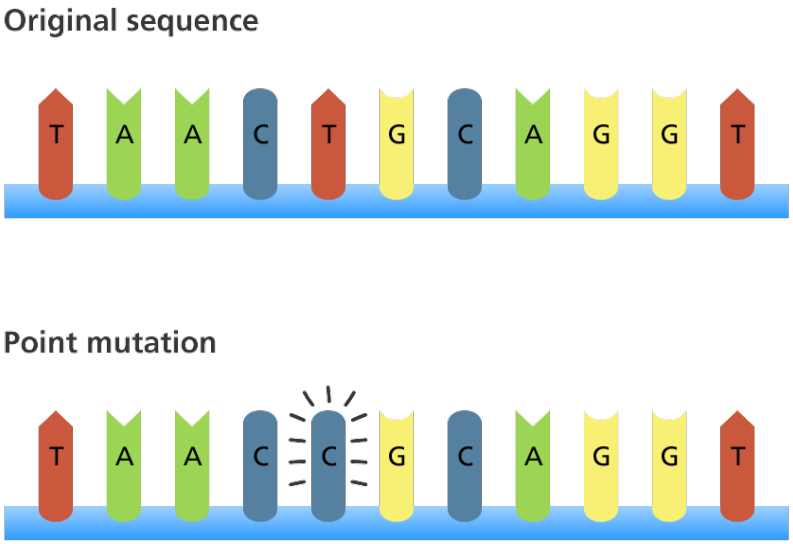

Figure 2.5: DNA Mutation [5]

2.2.2 Types

according to fatality

benign tumors are not very harmful because they do not spread to other organs and do not invade nearby tissue, and after removal, they usually don't grow back [13] as shown in figure 2.7

malignant tumors fatal if not treated, because they travel to distant places and form other tumors and invade nearby tissue [13] which makes it very hard to remove all its parts, as shown in figure 2.7

according to origin

cancer is also categorized according to where it originated or its origin cells, in this category, there are over 100 types because of the different places it can appear (lung cancer, brain cancer ...)and the different origin cells that it can come from [13].

carcinoma most common type formed by epithelial cells

sarcoma form in bone and soft tissue

leukemia form in bone marrow, this type does form a tumor but travels in the blood

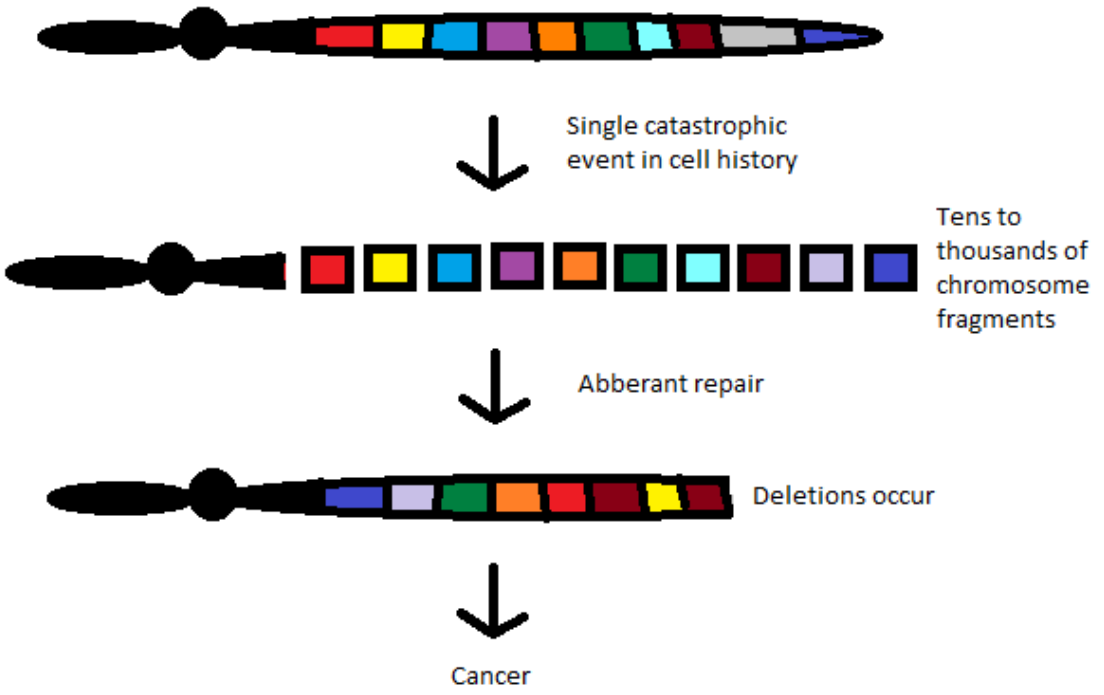

Figure 2.6: DNA Rearrangements [6]

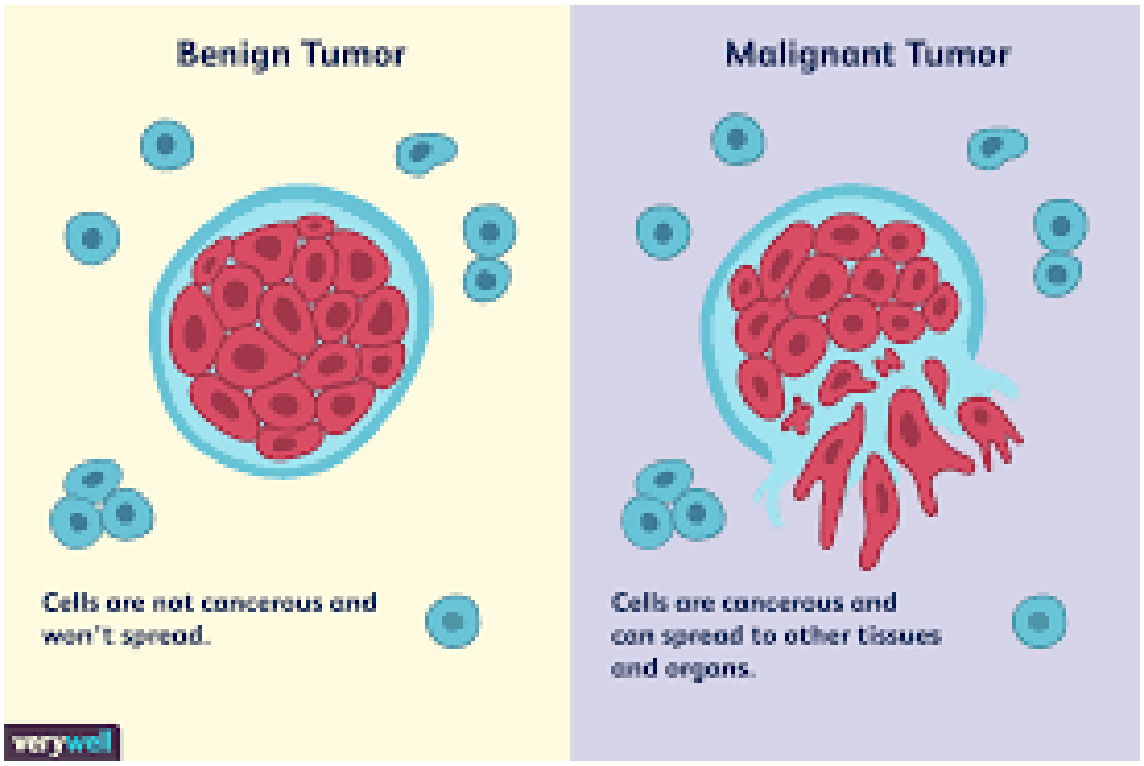

Figure 2.7: Benign and Malignant tumors [7]

melanoma formed by melanocytes (cells that make melanin that gives the skin its color) ...etc

2.3 skin cancer

Skin cancer is the abnormal growth of cells found in the epidermis (the outer layer of the skin) [16], it is one of the most common cancers in the world [17] and it falls under the category of a malignant tumor that is formed by fast multiplication of cells wich is caused by mutations/damage in the DNA of those cells, the damage in there DNA is due to the exposure to ultra violet rays [16] which can come from various sources but the most common are sun light and tanning beds [figure tannig bed] [16–18],,. the most common types of skin cancer are basal cell carcinoma, squamous cell carcinoma , melanoma. the good news is that if it is descovered in an early stage or pre cancurous stage it can be treated easily without leaving a scar

2.3.1 symptoms

skin cancer can appear in any place on the body that is exposed to sunlight like : face, scalp, chest ...etc, but there are some cases where the cancer appeared in areas not always exposed to sunlight such as palm, soles, under the finger neils [18] skin cancer can happen to people of any skin color but it is know that people with darcker skins are less likely to have it because of the protection against ultra violet rays provided by the melanin which present in darcker people in more quantities than pale people [18]

1. Basal cell carcinoma signs and symptoms Figure 2.8c
    - bump
    - flat brown scar
    - bleeding sore that heals and returns
2. Squamous cell carcinoma signs and symptoms Figure 2.8b
    - red nodule
    - flat lesion with crusted surface
3. Melanoma signs and symptoms Figure 2.8a
    - brownish spot
    - painful lesion that itches and burns
    - dark lesion

2.3.2 types

the 3 most common types are the following [16]

basal cell carcinoma the most common type with about 3.6 million new cases each year in the united states , if not treated early it can cause local destruction it can spread and in rare cases it is fatal

(a) Melanoma [19] (b) Squamous [20] (c) Basal [21]

Figure 2.8: 3 Most Common Types of Skin Cancer

squamous cell carcinoma the second most common type with about 1.8 million new cases in the united states each year, if not treated early it will spread and it is in some cases fatal (15000 deaths/year in the united states)

melanoma one of the most common types, by 2022 it is estimated that 197700 will appear in the united states although it is treatable if detected early it is considered to be the most dangerous among common types because of its death rates (7650 deaths projected for the united states in 2022)

2.3.3 causes

the most common and main cause of skin cancer is the exposure to ultra violet [16–18] radiations that can primarely be found in sun light and tanning beds, but there are some cases where the cancer appeard in areas not exposed to the sun like palms, soles, and under finger neils which indicates that other factors may contribute to the formation of skin cancer such as toxic substances, weak immune system, other types of radiation ...etc [18] the cells that the skin cancer originates from are squamous cells, basal cells and melanocytes. squamous cells is just below the outer surface, basal cells is beneath squamous cells and it produces new skin cells and melanocytes are the cells responsible of generating melanin which is the pigment resposible of the skin color. [18]

2.3.4 risk factors

factors that may increase your chances of getting skin cancer are [18]

Fair skin if you have less melanin which means your skin color is less dark then you are much more likely to get skin cancer then a person with a darcker skin because the melanin pigment is responsible of protecting the skin from ultra violet effects

history of sun burn having had sun burns before either in childhood or adulthood may increase your chances.

exposure to the sun for long periods of time being exposed to the sun alot or using tanning beds alot is also one of the factors, a tan is your skin's injury response of ultra violet rays.

high altitude climates living in higher places like mountains means that you are exposed to strong sunlight

Moles some types of irregular moles -which are bigger in size than normal moles- can turn cancerous

precancerous skin lesions there are some types of skin lesions -which are in them selfs not cancerous- that are likely to turn cancerous such as Bowen's disease and Actinic keratoses

family/personal history of skin cancer

weak immune system such as having HIV, AIDS or taking immunosuppressant drugs after an organ transplant...etc

exposure to radiation

exposure to certain substances some harmful/unharmful substances can increase your chances such as arsenic

2.3.5 prevention

as it is mentioned in [18, 22]

- avoid the sun at the middle of the day
- use sunscreen to protect against sunburn with an spf (Sun Protection Factor) over 30
- protective clothing especially when living in the desert
- avoid tanning beds
- always check your body for abnormalities and report them to your doctor
- see a dermatologist at lest once a year

2.3.6 treatement

before treatement we need diagnosis first, there are two methods [23] to know that you might have skin cancer. The first method is by observing you skin frequently to see if there are some marks or abnormalities, after that you check in with a doctor who will preform further examinations which will bring us to the second method, skin biopsy -taking a part of the suspecious area of the skin and preforming some laboratory tests on it to have accurate results- After confirming that you have a skin cancer further tests will determin what stage is it at which is often refered to with Roman numbers (I means small and limited to the area where it started - IV means advanced cancer that has spread to other parts of the body) treatement methods may vary depending on the size, type and stage of the cancer [17] but the main way to treate cancer is to remove it completely especialy if it is in early or pre-cacerous stages otherwise if additional treatement is needed, the options are as mentioned in [23]:

- freezing with liquid nitrogen
- Mohs surgery which is for difficult cases where the surrounding healthy skin cant be removed with cancerous cells (such as the nose area)

- Curettage and electrodesiccation to illiminate remaining cancerous cells
- Radiation therapy such as X-rays
- chemotherapy with substances that contain anti caner properties such as lotions if the cancer is on the surface
- Photodynamic therapy, a combination of laser and chemicals
- Biological therapy using the body's own immune system

Chapter 3

Artificial Intelligence

Chapter 4

State Of The Art

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