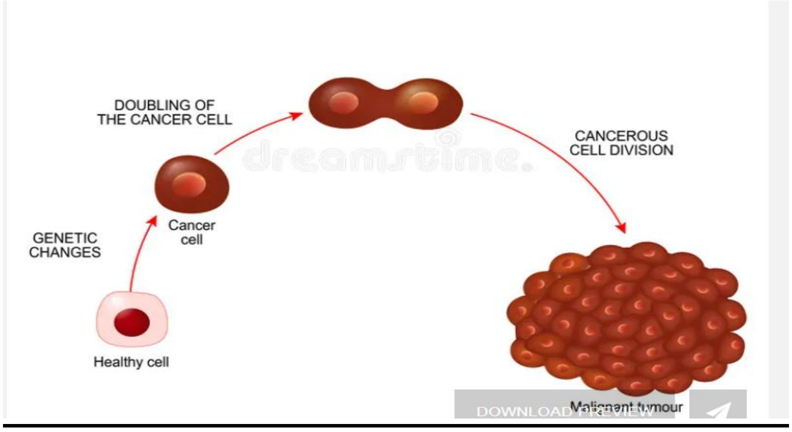
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING PROJECT

Cancer Detection



1. Project Objective: To detect whether a patient is suffering from cancer or not

Many of the times cancer remains undetected specially at earlier stages as a result the treatment is delayed. Many of the times patient has to suffer from seviour surgeries. In case of Benign tumors it can spread to other body parts too.

This project aims to detect cancer using Artificial Intelligence and Machine Learning concepts

2. Scope & Requirements

- Functional Requirements

- This project uses input from sensor and detect the presence of cancer.
- Rationalize the decision of Agent to get better results with least possible error
- Sensor = data (radius, texture, smoothness, mutation etc.)

- Agent = decision-making algorithm (linear model, search techniques, probability model etc.)

2.2 Non-Functional Requirements

- Data Representation to say the probability of having cancer or not
- Using different search algorithms for cancer detection and analyzing which will suit the best
- Using probability to know what is the probability of patient to suffer from cancer.
- Using Local maxima and local minima to say about the size of tumor
- There can be errors in detection the data can be because of overfitting and underfitting
- Using Bias and Variances in case of any error to correct it and make result more accurate
- Applying the concept of supervised learning to label the data and detect local maxima and local minima easily.
  It will help to detect the size to tumor in comparatively less time and the results can be shown earlier.

3. Technical Expectations

Code 1: about taking various samples and detecting the cancer

```
import random
# Rule-Based Cancer Detection
# SENSOR → small simulated dataset
# 0 = malignant, 1 = benign
samples = [
    {"radius": 14, "texture": 18, "smoothness": 0.3, "label": 0},
    {"radius": 10, "texture": 12, "smoothness": 0.4, "label": 1},
    {"radius": 17, "texture": 25, "smoothness": 0.2, "label": 0},
    {"radius": 11, "texture": 15, "smoothness": 0.5, "label": 1},
]
# AGENT → decision function
def agent(sample):
    score = 0
    if sample["radius"] > 15:
        score += 1
    if sample["texture"] > 20:
        score += 1
    if sample["smoothness"] < 0.25:
        score += 1
    if score >= 2:
        return 0  # Malignant
    else:
        return 1  # Benign
```

```
# AGENT makes predictions
for i, s in enumerate(samples):
    prediction = agent(s)
    print(f"\n--- Sample {i+1} ---")
    print(f"Sensor Data (Cell Features):")
    print(f"Radius: {s['radius']}")
    print(f"Texture: {s['texture']}")
    print(f"Smoothness: {s['smoothness']}")
    prediction = agent(s)
    print(f"\nAgent Decision: {'Malignant' if prediction==0 else 'Benign'}")
    print(f"Actual Label: {'Malignant' if s['label']==0 else 'Benign'}")
    print("------------------------------")
```

Output:

```
--- Sample 1 ---
Sensor Data (Cell Features):
Radius: 14
Texture: 18
Smoothness: 0.3

Agent Decision: Benign
Actual Label: Malignant
------------------------------

--- Sample 2 ---
Sensor Data (Cell Features):
Radius: 10
Texture: 12
Smoothness: 0.4

Agent Decision: Benign
Actual Label: Benign
------------------------------

--- Sample 3 ---
Sensor Data (Cell Features):
Radius: 17
Texture: 25
Smoothness: 0.2

Agent Decision: Malignant
Actual Label: Malignant
```

```
--- Sample 4 ---
Sensor Data (Cell Features):
Radius: 11
Texture: 15
Smoothness: 0.5

Agent Decision: Benign
Actual Label: Benign
------------------------------
```

Code 2: Cancer detection using Breadth Search Force

```
[9]: # BFS-Based Cancer Detection
def bfs_cancer_detection(features):
    queue = [["radius"], ["texture"], ["smoothness"]]
    visited = []
    score = 0
    while queue:
        path = queue.pop(0)
        current = path[-1]
        visited.append(current)
        # Rule-based check
        if current == "radius" and features["radius"] > 18:
            score += 1
        if current == "texture" and features["texture"] > 20:
            score += 1
        if current == "smoothness" and features["smoothness"] < 0.5:
            score += 1
        if len(visited) == 3:
            break
    if score >= 2:
        return "Cancer Detected by BFS"
    else:
        return "No Cancer (BFS)"
# TEST
data = {"radius": 19, "texture": 21, "smoothness": 0.4}
print(bfs_cancer_detection(data))
```

Output:

```
Cancer Detected by BFS
```

Code 3: Cancer detection using DFS (code with output)

```python
# DFS-Based Cancer Detection
def dfs_cancer_detection(features):
    stack = ["radius", "texture", "smoothness"]
    visited = []
    score = 0
    while stack:
        current = stack.pop()
        visited.append(current)
        if current == "radius" and features["radius"] > 18:
            score += 1
        if current == "texture" and features["texture"] > 20:
            score += 1
        if current == "smoothness" and features["smoothness"] < 0.5:
            score += 1
        if len(visited) == 3:
            break
    if score >= 2:
        return "Cancer Detected (DFS)"
    else:
        return "No Cancer (DFS)"
# TEST
print(dfs_cancer_detection(data))
```

```
Cancer Detected (DFS)
```

Code 4: about: Greedy Search for Cancer Detection

```python
# Greedy Search for Cancer Detection
def greedy_cancer_detection(features):
    priority = ["texture", "radius", "smoothness"]
    score = 0
    for current in priority:
        if current == "radius" and features["radius"] > 18:
            score += 1
        if current == "texture" and features["texture"] > 20:
            score += 1
        if current == "smoothness" and features["smoothness"] < 0.5:
            score += 1
        if score >= 2:
            break
    if score >= 2:
        return "Cancer Detected (Greedy)"
    else:
        return "No Cancer (Greedy)"
# TEST
print(greedy_cancer_detection(data))
```

```
Cancer Detected (Greedy)
```

Cade 5: about: Cancer detection using A* algorithm(code with output)

```python
# A* Cancer Detection
def astar_cancer_detection(features):
    open_list = [
        ("texture", 0),
        ("radius", 0),
        ("smoothness", 0)
    ]
    def heuristic(x):
        if x == "texture": return 1
        if x == "radius": return 2
        return 3
    score = 0
    # calculate f(n) manually
    for i in range(len(open_list)):
        feature, g = open_list[i]
        f = g + heuristic(feature)
        open_list[i] = (feature, f)
    # sort manually
    for i in range(len(open_list)-1):
        for j in range(i+1, len(open_list)):
            if open_list[i][1] > open_list[j][1]:
                open_list[i], open_list[j] = open_list[j], open_list[i]
    for feature, f in open_list:
        if feature == "radius" and features["radius"] > 18:
            score += 1
        if feature == "texture" and features["texture"] > 20:
```

```python
    for feature, f in open_list:
        if feature == "radius" and features["radius"] > 18:
            score += 1
        if feature == "texture" and features["texture"] > 20:
            score += 1
        if feature == "smoothness" and features["smoothness"] < 0.5:
            score += 1
    if score >= 2:
        return "Cancer Detected (A*)"
    else:
        return "No Cancer (A*)"
# TEST
print(astar_cancer_detection(data))
```

```
Cancer Detected (A*)
```

Code 6: about : Probability of cancer to be detected

```python
# Probability-based Cancer Detection
def cancer_probability(features):
    total_features = 3
    high_risk = 0
    # Conditions (simple medical-inspired rules)
    if features["radius"] > 18:
        high_risk += 1
    if features["texture"] > 20:
        high_risk += 1
    if features["smoothness"] < 0.5:
        high_risk += 1
    # Probability theorem
    probability = high_risk / total_features
    # Agent Decision
    if probability >= 0.67:   # 67% or more = likely cancer
        decision = "Cancer Detected"
    else:
        decision = "No Cancer Detected"
    return probability, decision
# TEST INPUT
data = {
    "radius": 19,
    "texture": 21,
    "smoothness": 0.4
}
prob, result = cancer_probability(data)
```

```
prob, result = cancer_probability(data)
print("Probability of Cancer:",prob)
print("Decision:",result)
```

```
Probability of Cancer: 1.0
Decision: Cancer Detected
```

Code 7: about: Linear Algebra Based Cancer Scoring (Dot Product Method)

```
# Linear Algebra Based Cancer Scoring (Dot Product Method)
def cancer_linear_algebra(features):
    # Feature vector
    X = [
        features["radius"],
        features["texture"],
        features["smoothness"]
    ]
    # Weight vector (manually set)
    W = [0.5, 0.3, -0.2]
    # Dot Product
    score = (W[0] * X[0]) + (W[1] * X[1]) + (W[2] * X[2])
    # Decision
    if score > 20:
        return score, "Cancer Detected"
    else:
        return score, "No Cancer"
data = {"radius": 19, "texture": 21, "smoothness": 0.4}
score, result = cancer_linear_algebra(data)
print("Score:", score)
print("Decision:",result)
```

```
Score: 15.72
Decision: No Cancer
```

Code 8: about: Variances in cancer detection

```
# Variance-Based Cancer Detection
def variance_cancer_detection(features):
    # Healthy average (manually set)
    mean_values = {
        "radius": 15,
        "texture": 17,
        "smoothness": 0.6
    }
    variances = {}
    # variance = (x - mean)^2
    variances["radius"] = (features["radius"] - mean_values["radius"]) ** 2
    variances["texture"] = (features["texture"] - mean_values["texture"]) ** 2
    variances["smoothness"] = (features["smoothness"] - mean_values["smoothness"]) ** 2
    # Total variance
    total_variance = variances["radius"] + variances["texture"] + variances["smoothness"]
    # Decision based on how abnormal the sample is
    if total_variance > 20:
        decision = "Cancer Detected (High Variance)"
    else:
        decision = "No Cancer (Low Variance)"
    return variances, total_variance, decision
# TEST SAMPLE
data = {
    "radius": 19,
    "texture": 22,
    "smoothness": 0.4
```

```
data = {
    "radius": 19,
    "texture": 22,
    "smoothness": 0.4
}
v, tv, d = variance_cancer_detection(data)
print("Individual Variances:",v)
print("Total Variance:",tv)
print("Decision:",d)
```

```
Individual Variances: {'radius': 16, 'texture': 25, 'smoothness': 0.03999999999999998}
Total Variance: 41.04
Decision: Cancer Detected (High Variance)
```

Code 9: about: probability of cancer using bias too for better results and minimizing the error

```
# Cancer probability calculation using bias
# doctor/test raw result (output)
raw_output = 0.62    # means 62% probability from test
# bias (model correction factor)
bias = 0.08          # means model believes +8% more chance
# using your formula: input = output + bias
final_probability = raw_output + bias
# probability should not exceed 1.0
if final_probability > 1.0:
    final_probability = 1.0
print("Raw test probability:", raw_output)
print("Bias added:", bias)
print("Final cancer probability after bias:", final_probability)
```

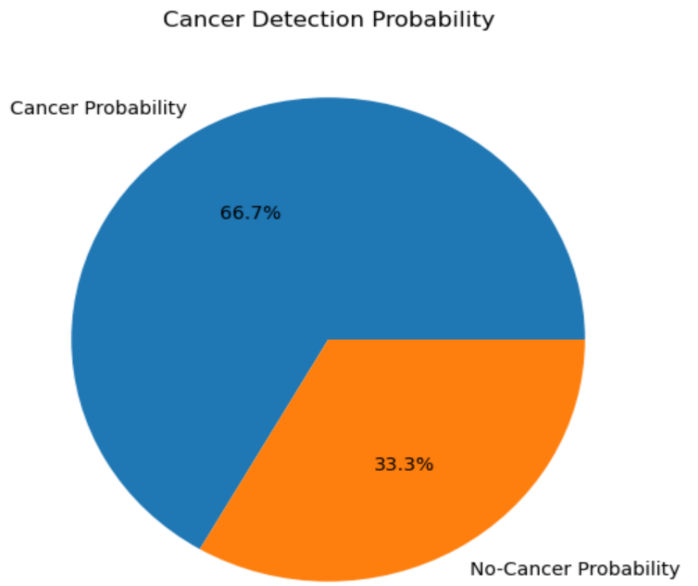
```
Raw test probability: 0.62
Bias added: 0.08
Final cancer probability after bias: 0.7
```

Code 10: about: CALCULATE CANCER PROBABILITY + data representation using PIE CHART

```
# CALCULATE CANCER PROBABILITY + data representation using PIE CHART
# Example input data (you can change these)
# 1 = symptom present, 0 = symptom absent
cell_size = 1
shape_irregularity = 1
DNA_mutation = 0
# Step 1: Probability logic (very simple model)
score = cell_size + shape_irregularity + DNA_mutation
cancer_probability = score / 3   # Maximum score = 3
no_cancer_probability = 1 - cancer_probability
print("Cancer Probability:", round(cancer_probability, 2))
print("No Cancer Probability:", round(no_cancer_probability, 2))
# Step 2: Draw PIE CHART
import matplotlib.pyplot as plt
labels = ['Cancer Probability', 'No-Cancer Probability']
sizes = [cancer_probability, no_cancer_probability]
plt.figure(figsize=(6,6))
plt.pie(sizes, labels=labels, autopct='%1.1f%%')
plt.title('Cancer Detection Probability')
plt.show()
```

Output:

```
Cancer Probability: 0.67
No Cancer Probability: 0.33
```



Code 11: about: Using supervised learning to label the data and then looking for local maxima and minima to compute the probability of patient suffering from cancer in comparatively less time and in a more organized way.

```python
import math
# ---- Labelled Data (Supervised) ----
# radius values (example)
data = [13, 14, 15, 14, 13, 16, 18, 12, 14, 13]
labels = [0, 0, 0, 0, 0, 0, 1, 0, 0, 0]   # 1 = cancer, 0 = no cancer
# ---- Local maxima / minima detection ----
def local_status(arr, i):
    left = arr[i-1] if i > 0 else None
    right = arr[i+1] if i < len(arr)-1 else None
    val = arr[i]
    greater_left  = (left is None) or (val > left)
    greater_right = (right is None) or (val > right)
    less_left     = (left is None) or (val < left)
    less_right    = (right is None) or (val < right)
    if greater_left and greater_right:
        return "max"
    if less_left and less_right:
        return "min"
    return "none"
# ---- Test input ----
test_radius = 14
# Find nearest value index
nearest_index = min(range(len(data)), key=lambda i: abs(data[i] - test_radius))
extrema = local_status(data, nearest_index)
# ---- Base probability (sigmoid of bias) ≈ 12% ----
bias = -1.99
base_prob = 1 / (1 + math.exp(-bias))   # ≈ 0.12
```

```
extrema = local_status(data, nearest_index)
# ---- Base probability (sigmoid of bias) ≈ 12% ----
bias = -1.99
base_prob = 1 / (1 + math.exp(-bias))   # ≈ 0.12
# ---- Adjust using local maxima/minima ----
if extrema == "max":
    final_prob = base_prob + 0.03
elif extrema == "min":
    final_prob = base_prob - 0.02
else:
    final_prob = base_prob
# Keep in range
final_prob = max(0, min(1, final_prob))
# ---- OUTPUT ----
print("Test radius:", test_radius)
print("Nearest data index:", nearest_index + 1)
print("Local extrema:", extrema)
print("Final cancer probability:", round(final_prob*100,1),"%")
```

```
Test radius: 14
Nearest data index: 2
Local extrema: none
Final cancer probability: 12.0 %
```

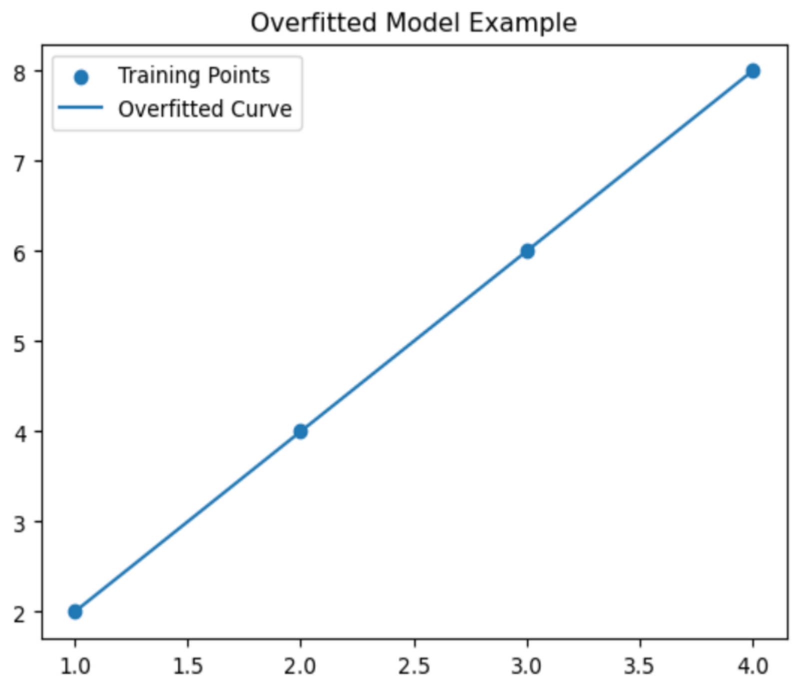
Code 12: about: challenges can be that the input data(sensed by sensor)does not exactly matches the output it can be in the form of overfitting or underfitting of the data.

[26]:

```
# challenges can be that the input data(sensed by sensor)does not exactly matches the output
#it can be overfitted or underfitted
import numpy as np
import matplotlib.pyplot as plt
# ----- Small Training Data -----
X_train = np.array([1, 2, 3, 4])
y_train = np.array([2, 4, 6, 8])   # perfect linear pattern
# ----- Overfitted Model (very high degree polynomial) -----
degree = 10  # TOO large for 4 data points → overfitting occurs
coeffs = np.polyfit(X_train, y_train, degree)
model = np.poly1d(coeffs)
# ----- Test Data -----
X_test = np.array([5, 6, 7])
y_pred = model(X_test)
print("Predictions on test data:", y_pred)
# ----- Plot for understanding -----
plt.scatter(X_train, y_train, label="Training Points")
plt.plot(X_train, model(X_train), label="Overfitted Curve")
plt.title("Overfitted Model Example")
plt.legend()
plt.show()
```

Output:

```
Predictions on test data: [ 17.34857792  78.70609483 366.14661267]
```



Conclusion:

This project aims to minimize time and enhance efficiency in the detection of cancer using various AI-ML concepts.