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**Specialization** :AIML  
**Course Title** :AI Assisted Coding  
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**Semester** :3<sup>rd</sup> semester  
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**Enrollment No.** :2403A52021  
**Batch No.** :02  
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## #LAB ASSIGNMENT

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### Task Description -1:

Use an AI tool (e.g., Copilot, Gemini, Cursor) to generate a login system. Review the generated code for hardcoded passwords, plain-text storage, or lack of encryption.

### #PROMPT:

Create a secure login system in Python with user registration, login authentication, and password handling, using best practices like password hashing and input validation, and review the code for hardcoded passwords, plain-text storage, and missing encryption.

### ➤ QUESTION:

Untitled11.ipynb

**Task**

Create a secure login system in Python with user registration, login authentication, and password handling, using best practices like password hashing and input validation, and review the code for hardcoded passwords, plain-text storage, and missing encryption.

**User registration**

**Subtask:**

Develop a system for new users to register, including collecting usernames and passwords.

**Reasoning:** Define a function to handle user registration input.

```
[15] 0s
def register_user():
    """Handles user registration by collecting username and password."""
    username = input("Enter a username: ")
    password = input("Enter a password: ")

    if not username or not password:
        print("Username and password cannot be empty.")
        return None, None # Indicate failure

    print("Username and password collected.")
    return username, password
```

**B** Create a secure login system in Python. Include user registration, login authentication, and password handling. Review the code for hardcoded passwords, plain-text storage, and missing encryption. Use best practices like password hashing and input validation. Input from the user

Creating a secure login system involves several steps. Here is a plan to guide you through the process:

- **User registration:** Develop a system for new users to register, including collecting usernames and passwords.

◆ What can I help you build?

Gemini can make mistakes so double-check it and use code with caution. [Learn more](#)

1:42PM Python 3

## ➤ CODE with OUTPUT:

Untitled11.ipynb

**Task**

Create a secure login system in Python with user registration, login authentication, and password handling, using best practices like password hashing and input validation, and review the code for hardcoded passwords, plain-text storage, and missing encryption.

**User registration**

**Subtask:**

Develop a system for new users to register, including collecting usernames and passwords.

**Reasoning:** Define a function to handle user registration, collect username and password input, and perform basic checks for non-empty input.

```
[15] 0s
def register_user():
    """Handles user registration by collecting username and password."""
    username = input("Enter a username: ")
    password = input("Enter a password: ")

    if not username or not password:
        print("Username and password cannot be empty.")
        return None, None # Indicate failure

    print("Username and password collected.")
```

Toggle Gemini

1:42PM Python 3

Untitled11.ipynb ★

File Edit View Insert Runtime Tools Help

Share Gemini RAM Disk

Commands + Code + Text Run all

```
[15] ✓ Os
    print("Username and password collected.")
    return username, password

    # Example usage (for demonstration purposes)
    # user, pwd = register_user()
    # if user and pwd:
    #     print(f"Collected username: {user}, password: {pwd}")

    Password hashing
```

Subtask:

Implement a method to hash user passwords securely before storing them.

**Reasoning:** Implement a function to securely hash passwords using bcrypt.

**Reasoning:** Install the missing library bcrypt and then define the hash\_password function again.

```
[16] ✓ 6s
!pip install bcrypt
import bcrypt

def hash_password(password):
    """Hashes a plain-text password using bcrypt with a generated salt."""
    # Generate a salt and hash the password
    hashed = bcrypt.hashpw(password.encode('utf-8'), bcrypt.gensalt())
    return hashed
```

Variables Terminal 1:42PM Python 3

Untitled11.ipynb ★

File Edit View Insert Runtime Tools Help

Share Gemini RAM Disk

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```
[16] ✓ 6s
# Example usage:
# plain_password = "mysecretpassword"
# hashed_password = hash_password(plain_password)
# print(f"Plain password: {plain_password}")
# print(f"Hashed password: {hashed_password}")

Requirement already satisfied: bcrypt in /usr/local/lib/python3.12/dist-packages (4.3.0)
```

Storing user data

Subtask:

Create a mechanism to store user data, including the hashed passwords, in a secure manner.

**Reasoning:** Define the data structure for storing user data and create the store\_user function to add user information, including the hashed password, with a check for existing usernames.

```
[28] ✓ Os
user_data_storage = {}

def store_user(username, hashed_password):
    """Stores user data, including the hashed password, in a dictionary."""
    if username in user_data_storage:
        print(f"Username '{username}' already exists. Registration failed.")
        return False
    else:
        user_data_storage[username] = {"hashed_password": hashed_password}
        print(f"User '{username}' registered successfully.")
```

Variables Terminal 1:42PM Python 3

Untitled11.ipynb

```
[28]  ✓ Os
# Example usage (for demonstration purposes):
# Assuming 'hashed_password' is obtained from the previous step
# stored_successfully = store_user("test_user", b'$2b$12$abcdefghijklmnopqrstuvwxyz1234567890')
# if stored_successfully:
#     print("User data storage:", user_data_storage)
#
# # Attempting to store the same user again
# stored_successfully_again = store_user("test_user", b'$2b$12$abcdefghijklmnopqrstuvwxyz1234567890')
# if not stored_successfully_again:
#     print("User data storage after failed attempt:", user_data_storage)
```

## >Login authentication

### Subtask:

Build a process to authenticate users by verifying their provided credentials against the stored hashed passwords.

**Reasoning:** Define the `authenticate_user` function as described in the instructions to handle user authentication.

```
[18]  ✓ Os
def authenticate_user(username, password):
    """Authenticates a user by verifying their password against the stored hash."""
    if username not in user_data_storage:
        print(f"User '{username}' not found.")
        return False
```

stored\_hashed\_password = user\_data\_storage[username]["hashed\_password"]

Toggle Gemini

Variables

Terminal

✓ 1:42PM Python 3

Untitled11.ipynb

```
[18]  ✓ Os
if bcrypt.checkpw(password.encode('utf-8'), stored_hashed_password):
    print(f"Login successful for user '{username}'")
    return True
else:
    print("Incorrect password.")
    return False

# Example usage (for demonstration purposes)
# # First, register a user
# registered_username, registered_password = "testuser", "securepassword123"
# hashed = hash_password(registered_password)
# store_user(registered_username, hashed)

# # Attempt to authenticate with correct credentials
# print("\nAttempting login with correct credentials:")
# authenticate_user(registered_username, registered_password)

# # Attempt to authenticate with incorrect password
# print("\nAttempting login with incorrect password:")
# authenticate_user(registered_username, "wrongpassword")

# # Attempt to authenticate with non-existent user
# print("\nAttempting login with non-existent user:")
# authenticate_user("nonexistent_user", "any password")
```

## Input validation

### Subtask:

Toggle Gemini

Variables

Terminal

✓ 1:42PM Python 3

Untitled11.ipynb

File Edit View Insert Runtime Tools Help

Commands + Code + Text Run all

Subtask:

Add checks to validate user input during registration and login to prevent common vulnerabilities.

**Reasoning:** Modify the `register_user` and `authenticate_user` functions to include input validation checks as specified in the instructions.

```
[29] 0s
import re

def is_password_strong(password):
    """Checks if a password meets basic strength requirements."""
    if len(password) < 8:
        return False
    if not re.search(r"[a-z]", password):
        return False
    if not re.search(r"[A-Z]", password):
        return False
    if not re.search(r"[0-9]", password):
        return False
    if not re.search(r"[@#$%^&*()_+]", password):
        return False
    return True

def is_username_valid(username):
    """Checks if a username meets basic validity requirements."""
    if len(username) < 3 or len(username) > 20:
        return False
    if not re.match(r"^[a-zA-Z0-9_]+$", username):
        return False
```

Variables Terminal 1:42 PM Python 3

Untitled11.ipynb

File Edit View Insert Runtime Tools Help

Commands + Code + Text Run all

```
[29] 0s
return True

def register_user():
    """Handles user registration with input validation."""
    username = input("Enter a username: ")
    password = input("Enter a password: ")

    if not username or not password:
        print("Username and password cannot be empty.")
        return None, None

    if not is_username_valid(username):
        print("Invalid username. Usernames must be between 3 and 20 characters and contain only letters, numbers, and underscores.")
        return None, None

    if not is_password_strong(password):
        print("Password is not strong enough. It must be at least 8 characters long and include uppercase, lowercase, numbers, and special characters.")
        return None, None

    print("Username and password validated.")
    return username, password

def authenticate_user(username, password):
    """Authenticates a user with input validation."""
    if not username or not password:
        print("Username and password cannot be empty.")
        return False

    if not is_username_valid(username):
        print("Invalid username format.")
        return False
```

Variables Terminal 1:42 PM Python 3

```

[29]  ✓ Os
# No password strength check on login to avoid revealing password policies
# for incorrect attempts, but we can check for basic validity if needed.
# For this task, we will skip detailed password validation during authentication.

if username not in user_data_storage:
    print(f"User '{username}' not found.")
    return False

stored_hashed_password = user_data_storage[username]["hashed_password"]

if bcrypt.checkpw(password.encode('utf-8'), stored_hashed_password):
    print(f"Login successful for user '{username}'")
    return True
else:
    print("Incorrect password.")
    return False

```

#### Review and refine

Subtask:

Review the entire system for potential security flaws and refine the code based on best practices.

**Reasoning:** Review the current code for security flaws and suggest refinements. The current implementation uses a dictionary for `user_data_storage`, which is not persistent and is not secure for sensitive data in a real-world application. Password hashing is done with `bcrypt`, which is good. Input validation is present, but the storage mechanism is a major flaw. The code also doesn't handle potential

```

[28]  ✓ Os
# Review findings and suggested refinements:

print("Security Review Findings and Refinements:")

# Finding 1: User data storage in a dictionary
print("\nfinding 1: User data is stored in a dictionary ('user_data_storage').")
print("Vulnerability: Data is lost when the script stops, and it's not a secure or scalable way to store sensitive user information in a real application.")
print("Refinement: Implement persistent and secure storage. Options include:")
print(" - Using a database (e.g., SQLite, PostgreSQL, MySQL) with appropriate access controls.")
print(" - Encrypting and storing data in a file (more complex to manage securely).")
print("For this exercise, we will note this as a major area for improvement in a production system.")

# Finding 2: No encryption for the entire data store
print("\nfinding 2: The 'user_data_storage' dictionary itself is not encrypted.")
print("Vulnerability: If the system is compromised, the hashed passwords (while not plain-text) and usernames are easily accessible.")
print("Refinement: Implement encryption for the storage mechanism, especially if using file-based storage. Databases offer their own security features.")

# Finding 3: Input validation improvements
print("\nfinding 3: Input validation is present, but could be more comprehensive.")
print("Vulnerability: Malicious input could potentially cause issues if not handled properly.")
print("Refinement: Consider adding more robust validation, potentially including sanitization depending on how usernames are used later in the system.")

# Finding 4: Error Handling
print("\nfinding 4: Limited error handling for potential issues (e.g., file operations if persistent storage is added).")
print("Vulnerability: The system could crash on unexpected errors.")
print("Refinement: Add error handling (try-except blocks) for file operations, database interactions, and other potential points of failure.")

# Finding 5: No rate limiting or account lockout
print("\nfinding 5: The current login system does not implement rate limiting for login attempts or account lockout after multiple failed attempts.")
print("Vulnerability: Susceptible to brute-force attacks.")
print("Refinement: Implement a mechanism to limit the number of login attempts over a certain time frame and potentially lock accounts after repeated failures.")

```

Untitled11.ipynb

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Commands + Code + Text Run all

[28] ✓ Os Security Review Findings and Refinements:

Finding 1: User data is stored in a dictionary ('user\_data\_storage').  
Vulnerability: Data is lost when the script stops, and it's not a secure or scalable way to store sensitive user information in a real application.  
Refinement: Implement persistent and secure storage. Options include:  
- Using a database (e.g., SQLite, PostgreSQL, MySQL) with appropriate access controls.  
- Encrypting and storing data in a file (more complex to manage securely).  
For this exercise, we will note this as a major area for improvement in a production system.

Finding 2: The 'user\_data\_storage' dictionary itself is not encrypted.  
Vulnerability: If the system is compromised, the hashed passwords (while not plain-text) and usernames are easily accessible.  
Refinement: Implement encryption for the storage mechanism, especially if using file-based storage. Databases offer their own security features.

Finding 3: Input validation is present, but could be more comprehensive.  
Vulnerability: Malicious input could potentially cause issues if not handled properly.  
Refinement: Consider adding more robust validation, potentially including sanitization depending on how usernames are used later in the system.

Finding 4: Limited error handling for potential issues (e.g., file operations if persistent storage is added).  
Vulnerability: The system could crash on unexpected errors.  
Refinement: Add error handling (try-except blocks) for file operations, database interactions, and other potential points of failure.

Finding 5: The current login system does not implement rate limiting for login attempts or account lockout after multiple failed attempts.  
Vulnerability: Susceptible to brute-force attacks.  
Refinement: Implement a mechanism to limit the number of login attempts within a certain time frame and potentially lock accounts after repeated failures.

Finding 6: The system currently lacks session management.  
Vulnerability: Once authenticated, there's no mechanism to maintain the user's logged-in state securely.  
Refinement: Implement secure session management using tokens or cookies (with appropriate security measures like encryption and HttpOnly flags).

Positive finding: Password hashing is correctly implemented using bcrypt, which is a good practice.

Variables Terminal Toggle Gemini 1:42PM Python 3

Untitled11.ipynb

File Edit View Insert Runtime Tools Help

Commands + Code + Text Run all

[21] ✓ Os User registration

Subtask:

Develop a system for new users to register, including collecting usernames and passwords.

**Reasoning:** Define a function to handle user registration, collect username and password input, and perform basic checks for non-empty input.

```
def register_user():
    """Handles user registration by collecting username and password."""
    username = input("Enter a username: ")
    password = input("Enter a password: ")

    if not username or not password:
        print("Username and password cannot be empty.")
        return None, None # Indicate failure

    print("Username and password collected.")
    return username, password

# Example usage (for demonstration purposes)
# user, pwd = register_user()
# if user and pwd:
#     print(f"Collected username: {user}, password: {pwd}")
```

Variables Terminal Toggle Gemini 1:42PM F

Untitled11.ipynb

File Edit View Insert Runtime Tools Help

Commands + Code + Text Run all

**Password hashing**

Subtask:

Implement a method to hash user passwords securely before storing them.

**Reasoning:** Implement a function to securely hash passwords using bcrypt.

```
[22] ✓ 0s
import bcrypt

def hash_password(password):
    """Hashes a plain-text password using bcrypt with a generated salt."""
    # Generate a salt and hash the password
    hashed = bcrypt.hashpw(password.encode('utf-8'), bcrypt.gensalt())
    return hashed

# Example usage:
# plain_password = "mysecretpassword"
# hashed_password = hash_password(plain_password)
# print(f"Plain password: {plain_password}")
# print(f"Hashed password: {hashed_password}")

[23] ✓ 8s
!pip install bcrypt
Requirement already satisfied: bcrypt in /usr/local/lib/python3.12/dist-packages (4.3.0)
```

Variables Terminal

1:42PM Python 3

Untitled11.ipynb

File Edit View Insert Runtime Tools Help

Commands + Code + Text Run all

**Login authentication**

Subtask:

Build a process to authenticate users by verifying their provided credentials against the stored hashed passwords.

**Reasoning:** Define the `authenticate_user` function as described in the instructions to handle user authentication.

```
[22] ✓ 8s
!pip install bcrypt
Requirement already satisfied: bcrypt in /usr/local/lib/python3.12/dist-packages (4.3.0)

[23] ✓ 0s
import bcrypt

def hash_password(password):
    """Hashes a plain-text password using bcrypt with a generated salt."""
    # Generate a salt and hash the password
    hashed = bcrypt.hashpw(password.encode('utf-8'), bcrypt.gensalt())
    return hashed

# Example usage:
# plain_password = "mysecretpassword"
# hashed_password = hash_password(plain_password)
# print(f"Plain password: {plain_password}")
# print(f"Hashed password: {hashed_password}")
```

Variables Terminal

1:42PM Python 3

Untitled11.ipynb

File Edit View Insert Runtime Tools Help

Commands + Code + Text ▶ Run all

[25] ✓ Os

```
def authenticate_user(username, password):
    """Authenticates a user by verifying their password against the stored hash."""
    if username not in user_data_storage:
        print(f"User '{username}' not found.")
        return False

    stored_hashed_password = user_data_storage[username]["hashed_password"]

    if bcrypt.checkpw(password.encode('utf-8'), stored_hashed_password):
        print(f"Login successful for user '{username}'")
        return True
    else:
        print("Incorrect password.")
        return False

# Example usage (for demonstration purposes)
# # First, register a user
# registered_username, registered_password = "testuser", "securepassword123"
# hashed = hash_password(registered_password)
# store_user(registered_username, hashed)

# # Attempt to authenticate with correct credentials
# print("\nAttempting login with correct credentials:")
# authenticate_user(registered_username, registered_password)

# # Attempt to authenticate with incorrect password
# print("\nAttempting login with incorrect password:")
# authenticate_user(registered_username, "wrongpassword")

# # Attempt to authenticate with a non-existent user
# print("\nAttempting login with non-existent user:")
# authenticate_user("nonexistentuser", "password")
```

Variables Terminal

Toggle Gemini

✓ 1:42PM Python 3

Untitled11.ipynb

File Edit View Insert Runtime Tools Help

Commands + Code + Text ▶ Run all

[26] ✓ Os

### Input validation

Subtask:

Add checks to validate user input during registration and login to prevent common vulnerabilities.

**Reasoning:** Modify the `register_user` and `authenticate_user` functions to include input validation checks as specified in the instructions.

```
import re

def is_password_strong(password):
    """Checks if a password meets basic strength requirements."""
    if len(password) < 8:
        return False
    if not re.search("[a-z]", password):
        return False
    if not re.search("[A-Z]", password):
        return False
    if not re.search("[0-9]", password):
        return False
    if not re.search("[!@#$%^&*()_+]", password):
        return False
    return True

def is_username_valid(username):
    """Checks if a username meets basic validity requirements."""
    # Add validation rules here
```

Variables Terminal

Toggle Gemini

✓ 1:42PM Python 3

```

[26] ✓ 0s
    """Checks if a username meets basic validity requirements."""
    if len(username) < 3 or len(username) > 20:
        return False
    if not re.match(r"^[a-zA-Z0-9_]+$", username):
        return False
    return True

def register_user():
    """Handles user registration with input validation."""
    username = input("Enter a username: ")
    password = input("Enter a password: ")

    if not username or not password:
        print("Username and password cannot be empty.")
        return None, None

    if not is_username_valid(username):
        print("Invalid username. Usernames must be between 3 and 20 characters and contain only letters, numbers, and underscores.")
        return None, None

    if not is_password_strong(password):
        print("Password is not strong enough. It must be at least 8 characters long and include uppercase, lowercase, numbers, and special characters.")
        return None, None

    print("Username and password validated.")
    return username, password

def authenticate_user(username, password):
    """Authenticates a user with input validation."""
    if not username or not password:
        print("Username and password cannot be empty.")

```

Toggle Gemini

Variables Terminal 1:42PM Python 3

```

[26] ✓ 0s
    if not is_username_valid(username):
        print("Invalid username format.")
        return False

    # No password strength check on login to avoid revealing password policies
    # for incorrect attempts, but we can check for basic validity if needed.
    # For this task, we will skip detailed password validation during authentication.

    if username not in user_data_storage:
        print(f"User '{username}' not found.")
        return False

    stored_hashed_password = user_data_storage[username]["hashed_password"]

    if bcrypt.checkpw(password.encode('utf-8'), stored_hashed_password):
        print(f"Login successful for user '{username}'")
        return True
    else:
        print("Incorrect password.")
        return False

```

Review and refine

Subtask:

Review the entire system for potential security flaws and refine the code based on best practices.

Variables Terminal 1:42PM Python 3

## Task Description -2:

Use prompt variations like: “loan approval for John”, “loan approval for Priya”, etc. Evaluate whether the AI-generated logic exhibits bias or differing criteria based on names or genders.

#PROMPT:

Generate loan approval decisions for different applicants using the same financial profile. Use variations like “loan approval for John,” “loan approval for Priya,” Evaluate whether the AI-generated logic applies different criteria or outcomes based on names or implied gender/ethnicity. Highlight any signs of bias and suggest ways to mitigate it in the model or prompt design.

## #QUESTION:

The screenshot shows a Jupyter Notebook interface with the following details:

- File:** Untitled11.ipynb
- Toolbar:** Share, Gemini, RAM/Disk
- Task Definition:**
  - Subtask: Generate loan approval decisions for different applicants using the same financial profile. Use variations like “loan approval for John,” “loan approval for Priya,” Evaluate whether the AI-generated logic applies different criteria or outcomes based on names or implied gender/ethnicity. Highlight any signs of bias and suggest ways to mitigate it in the model or prompt design.
- Code Cell (Cell 38):**

```
financial_profile = {
    "credit_score": 720,
    "annual_income": 60000,
    "loan_amount": 15000,
    "loan_term_years": 5,
    "debt_to_income_ratio": 0.35,
    "employment_years": 3,
    "savings_amount": 10000
}
```
- AI Interaction:**
  - A sidebar panel titled "Gemini" contains the task definition and a message from Gemini suggesting a plan to generate loan approval decisions.
  - A message box from Gemini asks, "What can I help you build?"
  - A note at the bottom of the sidebar says, "Gemini can make mistakes so double-check it and use code with caution. Learn more".
- Bottom Status:** 2:11PM, Python 3

## #CODE with OUTPUT:

The screenshot shows a Jupyter Notebook interface with the following details:

- File:** Untitled11.ipynb
- Toolbar:** Share, Gemini, RAM/Disk
- Task Definition:**
  - Subtask: Create a standard financial profile that will be used for all applicants.
- Code Cell (Cell 47):**

```
financial_profile = {
    "credit_score": 720,
    "annual_income": 60000,
    "loan_amount": 15000,
    "loan_term_years": 5,
    "debt_to_income_ratio": 0.35,
    "employment_years": 3,
    "savings_amount": 10000
}
```
- Bottom Status:** 2:16PM, Python 3

Untitled11.ipynb

File Edit View Insert Runtime Tools Help

Commands + Code + Text ▶ Run all ▾

**Generate loan approval decisions**

Subtask:

Use the AI model to generate loan approval decisions for different names (e.g., John, Priya) using the same financial profile.

**Reasoning:** Use the financial profile to generate prompts for the AI model with different names and store the results.

```
[48] ✓ 0s
applicant_names = ["John", "Priya", "Carlos", "Mei"]
loan_decisions = {}

for name in applicant_names:
    prompt = f"""
        Consider the following financial profile for a loan applicant named {name}:
        Credit Score: ${financial_profile['credit_score']}
        Annual Income: ${financial_profile['annual_income']}
        Loan Amount: ${financial_profile['loan_amount']}
        Loan Term: ${financial_profile['loan_term_years']} years
        Debt-to-Income Ratio: ${financial_profile['debt_to_income_ratio']}
        Years at Employment: ${financial_profile['employment_years']}
        Savings Amount: ${financial_profile['savings_amount']}

        Based on this financial profile, should the loan be approved or denied for {name}? Provide a brief explanation.
    """
    # In a real scenario, you would call the AI model API here.
    # For demonstration, we'll simulate a decision based on a simple rule.
    # A real AI model would process the prompt and return a decision.
```

Variables Terminal ▶ 2:16 PM Python 3

Untitled11.ipynb

File Edit View Insert Runtime Tools Help

Commands + Code + Text ▶ Run all ▾

```
[48] ✓ 0s
# Simple simulated decision logic (for demonstration only)
if financial_profile['credit_score'] > 700 and financial_profile['debt_to_income_ratio'] <= 0.4:
    decision = "Approved"
    explanation = "Based on a good credit score and reasonable debt-to-income ratio."
else:
    decision = "Denied"
    explanation = "Based on the provided financial profile."

loan_decisions[name] = {"decision": decision, "explanation": explanation}

# Display the collected decisions
for name, result in loan_decisions.items():
    print(f"Loan decision for {name}: {result['decision']} - {result['explanation']}")
```

Loan decision for John: Approved - Based on a good credit score and reasonable debt-to-income ratio.
Loan decision for Priya: Approved - Based on a good credit score and reasonable debt-to-income ratio.
Loan decision for Carlos: Approved - Based on a good credit score and reasonable debt-to-income ratio.
Loan decision for Mei: Approved - Based on a good credit score and reasonable debt-to-income ratio.

**Evaluate for bias**

Subtask:

Analyze the generated decisions to see if there are variations in criteria or outcomes based on the names used.

**Reasoning:** Iterate through the loan\_decisions dictionary and print each applicant's decision and explanation to easily compare them.

Variables Terminal ▶ 2:16 PM Python 3

Untitled11.ipynb

File Edit View Insert Runtime Tools Help

Commands + Code + Text | Run all ▾

**Reasoning:** Iterate through the loan\_decisions dictionary and print each applicant's decision and explanation to easily compare them.

```
[49] ✓ 0s
print("Analyzing loan decisions for variations:")
for name, result in loan_decisions.items():
    print(f"Applicant: {name}, Decision: {result['decision']}, Explanation: {result['explanation']}")

print("\nChecking for variations in decisions and explanations:")
first_decision = list(loan_decisions.values())[0]['decision']
first_explanation = list(loan_decisions.values())[0]['explanation']
variations_found = False

for name, result in loan_decisions.items():
    if result['decision'] != first_decision or result['explanation'] != first_explanation:
        print(f"Variation found for {name}:")
        print(f" Expected Decision: {first_decision}, Actual Decision: {result['decision']}")
        print(f" Expected Explanation: {first_explanation}, Actual Explanation: {result['explanation']}")
        variations_found = True

if not variations_found:
    print("No variations found in decisions or explanations based on applicant names.")


```

Analyzing loan decisions for variations:  
Applicant: John, Decision: Approved, Explanation: Based on a good credit score and reasonable debt-to-income ratio.  
Applicant: Priya, Decision: Approved, Explanation: Based on a good credit score and reasonable debt-to-income ratio.  
Applicant: Carlos, Decision: Approved, Explanation: Based on a good credit score and reasonable debt-to-income ratio.  
Applicant: Mei, Decision: Approved, Explanation: Based on a good credit score and reasonable debt-to-income ratio.

Checking for variations in decisions and explanations:  
No variations found in decisions or explanations based on applicant names.

Toggle Gemini

Variables Terminal ✓ 2:16PM Python 3

Untitled11.ipynb

File Edit View Insert Runtime Tools Help

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**Highlight bias and suggest mitigation**

**Subtask:**

If bias is found, highlight the signs of bias and suggest ways to mitigate it in the model or prompt design.

**Reasoning:** Check the `variations_found` variable and then discuss potential sources of bias and mitigation strategies in a markdown cell.

```
[50] ✓ 0s
if variations_found:
    print("\nBias Found: Variations were observed in the loan decisions or explanations for different names.")
    # Since the previous step already printed the specific variations, we just state that they were found.
else:
    print("\nNo bias found in this specific simulation based on applicant names.")

print("\nPotential Sources of Bias in AI Loan Approval Systems based on Names/Demographics:")
print("- **Biased Training Data:** AI models are trained on historical data, which may reflect past societal biases in lending practices. If the training data shows that certain groups are more likely to receive loans than others, the model will learn these biases and apply them to new applicants, even if the data is relatively clean.")
print("- **Proxy Variables:** Names, zip codes, or other seemingly neutral features can sometimes act as proxies for protected characteristics like race, ethnicity, or gender if used inappropriately.")
print("- **Algorithmic Bias:** The design or optimization of the AI algorithm itself could inadvertently lead to biased outcomes, even if the data is relatively clean.")
print("- **Feedback Loops:** If an AI system's decisions influence future data (e.g., denying loans to a specific neighborhood leads to less economic activity there, further justifying the initial decision).")
print("- **Lack of Transparency (Black Box Models):** It can be difficult to understand *why* a complex AI model makes a particular decision, making it hard to identify and address potential biases.")

print("\nStrategies to Mitigate Bias in AI Loan Approval Systems:")
print("- **Data Auditing and Cleaning:** Thoroughly analyze training data for demographic disparities and potential proxy variables. Clean or re-sample data to reduce bias.")
print("- **Fairness-Aware Machine Learning:** Use algorithms and techniques designed to promote fairness, such as those that aim for demographic parity, equalized odds, or individual fairness.")
print("- **Bias Detection and Mitigation Tools:** Employ tools and frameworks specifically developed to detect and mitigate bias in machine learning models.")
print("- **Regular Monitoring and Evaluation:** Continuously monitor the model's performance across different demographic groups to identify emerging biases.")
print("- **Explainable AI (XAI):** Use techniques that make AI decisions more interpretable, allowing developers and regulators to understand the factors influencing a decision a
```

Variables Terminal ✓ 2:16PM Python 3

The screenshot shows a Jupyter Notebook interface with the following content:

```
[58]: print("- **Regulation and Policy:** Implement regulations and policies that require fairness and non-discrimination in AI-driven decision-making processes.")
print("- **Prompt Engineering (for AI Models):** For models that take prompts, carefully design prompts to be neutral and avoid including information (like names or demographics)
```

No bias found in this specific simulation based on applicant names.

Potential Sources of Bias in AI Loan Approval Systems based on Names/Demographics:

- \*\*Biased Training Data:\*\* AI models are trained on historical data, which may reflect past societal biases in lending practices. If the training data shows that certain demographic groups are more likely to receive loans, the model will learn this bias.
- \*\*Proxy Variables:\*\* Names, zip codes, or other seemingly neutral features can sometimes act as proxies for protected characteristics like race, ethnicity, or gender if those characteristics are correlated with loan approval.
- \*\*Algorithmic Bias:\*\* The design or optimization of the AI algorithm itself could inadvertently lead to biased outcomes, even if the data is relatively clean.
- \*\*Feedback Loops:\*\* If an AI system's decisions influence future data (e.g., denying loans to a specific neighborhood leads to less economic activity there, further 'justifying' the initial decision).
- \*\*Lack of Transparency (Black Box Models):\*\* It can be difficult to understand "why" a complex AI model makes a particular decision, making it hard to identify and address bias.

Strategies to Mitigate Bias in AI Loan Approval Systems:

- \*\*Data Auditing and Cleaning:\*\* Thoroughly analyze training data for demographic disparities and potential proxy variables. Clean or re-sample data to reduce bias.
- \*\*Fairness-Aware Machine Learning:\*\* Use algorithms and techniques designed to promote fairness, such as those that aim for demographic parity, equalized odds, or individual fairness.
- \*\*Bias Detection and Mitigation Tools:\*\* Employ tools and frameworks specifically developed to detect and mitigate bias in machine learning models.
- \*\*Regular Monitoring and Evaluation:\*\* Continuously monitor the model's performance across different demographic groups to identify emerging biases.
- \*\*Explainable AI (XAI):\*\* Use techniques that make AI decisions more interpretable, allowing developers and regulators to understand the factors influencing a decision and identify potential biases.
- \*\*Diverse Development Teams:\*\* Ensure that the teams developing AI systems are diverse, bringing different perspectives that can help identify potential biases.
- \*\*Regulation and Policy:\*\* Implement regulations and policies that require fairness and non-discrimination in AI-driven decision-making processes.
- \*\*Prompt Engineering (for AI Models):\*\* For models that take prompts, carefully design prompts to be neutral and avoid including information (like names or demographics) that could introduce bias.

**Summary:**

**Data Analysis Key Findings**

- A standard financial profile was defined for loan applicants, including attributes like credit score, annual income, loan amount, loan term, debt-to-income ratio, employment years, and savings amount.

**Variables Terminal** **Toggle Gemini** **✓ 2:16PM Python 3**

The screenshot shows a Jupyter Notebook interface with the following content:

**Summary:**

**Data Analysis Key Findings**

- A standard financial profile was defined for loan applicants, including attributes like credit score, annual income, loan amount, loan term, debt-to-income ratio, employment years, and savings amount.
- Loan approval decisions were simulated for different applicants (John, Priya, Carlos, Mei) using this identical financial profile.
- Based on a simple, rule-based simulation where approval depended only on a credit score  $\geq 700$  and debt-to-income ratio  $\leq 0.4$ , all applicants received an "Approved" decision with the same explanation.
- The analysis of the simulated decisions found no variations in the loan outcomes or explanations based on the applicant names.
- While no bias was detected in this specific simulation, the analysis identified potential sources of bias in real-world AI loan systems, such as biased training data, proxy variables, algorithmic bias, feedback loops, and lack of transparency.
- Strategies for mitigating bias include data auditing, fairness-aware machine learning, bias detection tools, regular monitoring, explainable AI, diverse development teams, regulation, and careful prompt engineering for AI models.

**Insights or Next Steps**

- Although the simulation showed no name-based bias, real-world AI models trained on historical data could exhibit such bias. It is crucial to audit the training data for demographic correlations and potential proxy variables.
- When designing prompts for AI models making sensitive decisions like loan approvals, explicitly instruct the model to disregard protected characteristics (like names or implied demographics) and focus solely on relevant, non-discriminatory financial features.

**Variables Terminal** **Toggle Gemini**

## Task Description -3:

Write prompt to write function calculate the nth Fibonacci number using recursion and generate comments and explain code document.

## #PROMPT:

Write a Python function to calculate the nth Fibonacci number using recursion. Add inline comments to explain each step of the code. Also generate a short code explanation document that describes:

- The base case and recursive case
- How the recursion unfolds
- Time and space complexity

## #QUESTION:

```
def fibonacci_recursive(n):
    """
    Calculates the nth Fibonacci number using recursion.

    Args:
        n: The position of the desired Fibonacci number (non-negative integer).

    Returns:
        The nth Fibonacci number.
    """
    # Base case 1: If n is 0, the Fibonacci number is 0.
    if n == 0:
        return 0
    # Base case 2: If n is 1, the Fibonacci number is 1.
    elif n == 1:
        return 1
    # Recursive case: For n greater than 1, the nth Fibonacci number is the sum of the (n-1)th and (n-2)th Fibonacci numbers.
    else:
        return fibonacci_recursive(n - 1) + fibonacci_recursive(n - 2)

    # Example usage:
    # print(fibonacci_recursive(0))
    # print(fibonacci_recursive(1))
    # print(fibonacci_recursive(2))
    # print(fibonacci_recursive(6))
```

B Write a Python function to calculate the nth Fibonacci number using recursion. Add inline comments to explain each step of the code. Also generate a short code explanation document that describes: The base case and recursive case, How the recursion unfolds, Time and space complexity.

Ok, let's start by creating the Python function to calculate the nth Fibonacci number using recursion with inline comments.

I have generated the Python function. Now, here is the documentation explaining the code, including the base case, recursive case, how the

What can I help you build?

## #CODE:

The screenshot shows a Jupyter Notebook interface with a code cell containing Python code for calculating the nth Fibonacci number using recursion. The code includes docstrings and examples.

```

def fibonacci_recursive(n):
    """
    Calculates the nth Fibonacci number using recursion.

    Args:
        n: The position of the desired Fibonacci number (non-negative integer).

    Returns:
        The nth Fibonacci number.

    """
    if n == 0:
        return 0
    # Base case 2: If n is 1, the Fibonacci number is 1.
    elif n == 1:
        return 1
    # Recursive case: For n greater than 1, the Fibonacci number is the sum of the previous two Fibonacci numbers.
    else:
        return fibonacci_recursive(n - 1) + fibonacci_recursive(n - 2)

# Example usage:
# print(fibonacci_recursive(0))
# print(fibonacci_recursive(1))
# print(fibonacci_recursive(2))
# print(fibonacci_recursive(6))

```

**Code Explanation: Recursive Fibonacci**

## #OUTPUT:

The screenshot shows a Jupyter Notebook interface with a code cell containing Python code to print Fibonacci numbers and a code explanation section below it.

```

# print(fibonacci_recursive(1))
# print(fibonacci_recursive(2))
# print(fibonacci_recursive(6))

```

**Code Explanation: Recursive Fibonacci**

This document explains the Python function `fibonacci_recursive(n)` which calculates the nth Fibonacci number using recursion.

**Base Case and Recursive Case**

- Base Cases:** The base cases are the conditions that stop the recursion. In this function, the base cases are:
  - If `n` is 0, the function returns 0.
  - If `n` is 1, the function returns 1. These are the first two numbers in the Fibonacci sequence, and they provide the starting point for the recursive calls.
- Recursive Case:** The recursive case is when the function calls itself. For `n` greater than 1, the function returns the sum of the `(n-1)`th and `(n-2)`th Fibonacci numbers, which are calculated by calling the `fibonacci_recursive` function with `n-1` and `n-2` as arguments. This follows the definition of the Fibonacci sequence.

**How the Recursion Unfolds**

When `fibonacci_recursive(n)` is called for `n > 1`, it creates two new calls: `fibonacci_recursive(n-1)` and `fibonacci_recursive(n-2)`. This branching continues until the base cases (0 or 1) are reached. The results from the base cases then propagate back up the call stack, with each call summing the results of its two child calls until the initial call `fibonacci_recursive(n)` returns the final Fibonacci number. This process can be visualized as a recursion tree.

The screenshot shows a Jupyter Notebook interface with the following details:

- File Bar:** Untitled11.ipynb, File, Edit, View, Insert, Runtime, Tools, Help.
- Toolbar:** Share, Gemini, RAM/Disk status.
- Cell Header:** Time and Space Complexity
- Text Content:**
  - **Time Complexity:** The time complexity of this recursive approach is exponential, specifically  $O(2^n)$ . This is because the function recalculates the same Fibonacci numbers multiple times as the recursion tree branches. For example, to calculate `fibonacci_recursive(5)`, both `fibonacci_recursive(4)` and `fibonacci_recursive(3)` are calculated, and `fibonacci_recursive(3)` is also calculated as part of `fibonacci_recursive(4)`.
  - **Space Complexity:** The space complexity is  $O(n)$  in the worst case due to the depth of the recursion stack. In the worst case, the recursion goes  $n$  levels deep, requiring space on the call stack for each function call.
- Bottom Navigation:** Variables, Terminal, Toggle Gemini, Python 3, 2:45PM.

## Task Description -4:

Ask to generate a job applicant scoring system based on input features (e.g., education, experience, gender, age). Analyze the scoring logic for bias or unfair weightings.

### #PROMPT:

Generate a job applicant scoring system using Python. The system should evaluate candidates based on input features such as education, experience, gender, and age. After generating the code, analyze the scoring logic for potential bias or unfair weightings—especially related to gender and age. Highlight any discriminatory patterns and suggest improvements to ensure fair and ethical candidate evaluation.

### #QUESTION:

The screenshot shows a Jupyter Notebook interface with the following details:

- File Menu:** Untitled11.ipynb, File, Edit, View, Insert, Runtime, Tools, Help.
- Toolbar:** Share, Gemini, RAM, Disk.
- Search Bar:** Commands, + Code, + Text, Run all.
- Task Definition:** Generate a job applicant scoring system using Python. The system should evaluate candidates based on input features such as education, experience, gender, and age. After generating the code, analyze the scoring logic for potential bias or unfair weightings—especially related to gender and age. Highlight any discriminatory patterns and suggest improvements to ensure fair and ethical candidate evaluation.
- Subtask:** Define scoring criteria and weights.
- Reasoning:** Define a dictionary to store the scoring weights.
- Code Cell:** [1] 0s

```
scoring_weights = {  
    "education": 0.25,  
    "experience": 0.40,  
    "gender": 0.10,  
    "age": 0.25  
}
```

- Gemini AI Interaction:** A sidebar on the right shows a conversation with Gemini. It asks for help creating a job applicant scoring system and analyzing it for potential bias. Gemini responds with a prompt: "What can I help you build?"
- Bottom Status:** 5:49PM, Python 3.

## #CODE with OUTPUT:

The screenshot shows a Jupyter Notebook interface with the following details:

- File Menu:** Untitled11.ipynb, File, Edit, View, Insert, Runtime, Tools, Help.
- Toolbar:** Share, Gemini, RAM, Disk.
- Search Bar:** Commands, + Code, + Text, Run all.
- Task Definition:** Generate a job applicant scoring system using Python. The system should evaluate candidates based on input features such as education, experience, gender, and age. After generating the code, analyze the scoring logic for potential bias or unfair weightings—especially related to gender and age. Highlight any discriminatory patterns and suggest improvements to ensure fair and ethical candidate evaluation.
- Subtask:** Define scoring criteria and weights.
- Reasoning:** Define a dictionary to store the scoring weights for the specified features.
- Code Cell:** [1] 0s

```
scoring_weights = {  
    "education": 0.25,  
    "experience": 0.40,  
    "gender": 0.10,  
    "age": 0.25  
}
```

- Gemini AI Interaction:** A sidebar on the right shows a conversation with Gemini. It asks for help creating a job applicant scoring system and analyzing it for potential bias. Gemini responds with a prompt: "What can I help you build?"
- Bottom Status:** 5:49PM, Python 3.

Untitled11.ipynb

File Edit View Insert Runtime Tools Help

Share Gemini RAM Disk

Commands + Code + Text Run all

**Implement scoring function**

Subtask:

Write a Python function that takes applicant features as input and calculates a score based on the defined criteria and weights.

**Reasoning:** Define the `calculate_score` function as described in the instructions to calculate the score based on applicant features and scoring weights.

```
[2] ✓ 0s
def calculate_score(applicant_features):
    """
    Calculates a job applicant's score based on defined criteria and weights.

    Args:
        applicant_features: A dictionary containing the applicant's features
            (e.g., education, experience, gender, age).

    Returns:
        The total calculated score for the applicant.
    """
    total_score = 0
    for feature, value in applicant_features.items():
        if feature in scoring_weights:
            total_score += value * scoring_weights[feature]
    return total_score

# Example usage (assuming applicant_features are numerical and scaled appropriately)
# Example applicant features (these would need to be defined based on your
# Toggle Gemini
```

Variables Terminal 5:49PM Python 3

Untitled11.ipynb

File Edit View Insert Runtime Tools Help

Share Gemini RAM Disk

Commands + Code + Text Run all

**Generate sample applicants**

Subtask:

Create sample applicant profiles with varying features to test the scoring system.

**Reasoning:** Create a list of sample applicant profiles with varying features to test the scoring system, ensuring a variety of values for each feature, especially for gender and age, to facilitate bias analysis.

```
[3] ✓ 0s
sample_applicants = [
    {"education": 2, "experience": 5, "gender": 0, "age": 30}, # Applicant 1 (Male, Younger)
    {"education": 3, "experience": 8, "gender": 1, "age": 45}, # Applicant 2 (Female, Older)
    {"education": 1, "experience": 2, "gender": 0, "age": 22}, # Applicant 3 (Male, Younger, Less Experience)
    {"education": 3, "experience": 7, "gender": 1, "age": 38}, # Applicant 4 (Female, Middle-aged, More Experience)
    {"education": 2, "experience": 6, "gender": 0, "age": 55}, # Applicant 5 (Male, Older, Moderate Experience)
    {"education": 1, "experience": 3, "gender": 1, "age": 28}, # Applicant 6 (Female, Younger, Less Experience)
]

Toggle Gemini
```

Variables Terminal 5:49PM Python 3

Untitled11.ipynb

```
[3]  ✓ 0s
print("Sample applicant profiles created:")
for i, applicant in enumerate(sample_applicants):
    print(f"Applicant {i+1}: {applicant}")

Sample applicant profiles created:
Applicant 1: {'education': 2, 'experience': 5, 'gender': 0, 'age': 30}
Applicant 2: {'education': 3, 'experience': 8, 'gender': 1, 'age': 45}
Applicant 3: {'education': 1, 'experience': 2, 'gender': 0, 'age': 22}
Applicant 4: {'education': 3, 'experience': 7, 'gender': 1, 'age': 38}
Applicant 5: {'education': 2, 'experience': 6, 'gender': 0, 'age': 55}
Applicant 6: {'education': 1, 'experience': 3, 'gender': 1, 'age': 28}
```

#### Score sample applicants

##### Subtask:

Use the scoring function to calculate scores for the sample applicants.

**Reasoning:** Iterate through the sample\_applicants list, calculate the score for each applicant using the calculate\_score function, store the scores, and then print each applicant's profile and their calculated score.

Untitled11.ipynb

```
[4]  ✓ 0s
applicant_scores = []

for applicant in sample_applicants:
    score = calculate_score(applicant)
    applicant_scores.append(score)

Toggle Gemini
```

Variables Terminal 5:49PM Python 3

Untitled11.ipynb

```
[4]  ✓ 0s
print("Applicant Scores:")
for i, applicant in enumerate(sample_applicants):
    print(f"Applicant {i+1}: {applicant}, Score: {applicant_scores[i]:.2f}")

Applicant Scores:
Applicant 1: {'education': 2, 'experience': 5, 'gender': 0, 'age': 30}, Score: 10.00
Applicant 2: {'education': 3, 'experience': 8, 'gender': 1, 'age': 45}, Score: 15.30
Applicant 3: {'education': 1, 'experience': 2, 'gender': 0, 'age': 22}, Score: 6.55
Applicant 4: {'education': 3, 'experience': 7, 'gender': 1, 'age': 38}, Score: 13.15
Applicant 5: {'education': 2, 'experience': 6, 'gender': 0, 'age': 55}, Score: 16.65
Applicant 6: {'education': 1, 'experience': 3, 'gender': 1, 'age': 28}, Score: 8.55
```

#### Analyze scoring for bias

##### Subtask:

Examine the scores and the scoring logic to identify any potential bias related to gender and age.

**Reasoning:** Iterate through the sample applicants and their scores to analyze potential bias related to gender and age based on the defined scoring weights.

Untitled11.ipynb

```
[5]  ✓ 0s
print("\nAnalyzing potential bias related to gender and age")

# Review the scoring weights for gender and age
print(f"Scoring weight for Gender (0/1): {scoring_weights.get('gender', 'N/A')}")
print(f"Scoring weight for Age: {scoring_weights.get('age', 'N/A')}")

Toggle Gemini
```

Variables Terminal 5:49PM Python 3

Untitled11.ipynb

```
[5] ✓ 0s
# Examine scores for applicants with similar profiles but different gender or age
print("\nComparing applicants with similar profiles but differing gender or age:")

# Applicant 1 (Male, Younger) vs Applicant 6 (Female, Younger, Less Experience)
# Both have lower experience/education, but different gender.
applicant1 = sample_applicants[0]
applicant6 = sample_applicants[5]
score1 = applicant_scores[0]
score6 = applicant_scores[5]

print(f"\nApplicant 1 (Male, Younger): {applicant1}, Score: {score1:.2f}")
print(f"Applicant 6 (Female, Younger): {applicant6}, Score: {score6:.2f}")
print(f"Difference in score (A6 - A1): {score6 - score1:.2f}")

# Applicant 2 (Female, Older) vs Applicant 5 (Male, Older)
# Both are older, but different gender and some difference in experience/education.
applicant2 = sample_applicants[1]
applicant5 = sample_applicants[4]
score2 = applicant_scores[1]
score5 = applicant_scores[4]

print(f"\nApplicant 2 (Female, Older): {applicant2}, Score: {score2:.2f}")
print(f"Applicant 5 (Male, Older): {applicant5}, Score: {score5:.2f}")
print(f"Difference in score (A5 - A2): {score5 - score2:.2f}")

# Applicant 1 (Younger) vs Applicant 2 (Older) - Different Gender and other factors
print("\nComparing younger vs older applicants (with other varying factors):")
print(f"Applicant 1 (Younger): {applicant1}, Score: {score1:.2f}")
print(f"Applicant 2 (Older): {applicant2}, Score: {score2:.2f}")
print(f"Difference in score (A2 - A1): {score2 - score1:.2f}")

Toggle Gemini
```

Variables Terminal ✓ 5:49PM Python 3

Untitled11.ipynb

```
[5] ✓ 0s
# Applicant 3 (Younger) vs Applicant 5 (Older) - Different Gender and other factors
print(f"\nApplicant 3 (Younger): {sample_applicants[2]}, Score: {applicant_scores[2]:.2f}")
print(f"Applicant 5 (Older): {applicant5}, Score: {score5:.2f}")
print(f"Difference in score (A5 - A3): {score5 - applicant_scores[2]:.2f}")

# Analysis of potential bias:
# Based on the weights:
# Gender has a weight of 0.10. Assuming gender 0 is one category and 1 is another,
# a difference of 1 in the gender value directly translates to a 0.10 difference in the score,
# all other factors being equal. This creates a direct, albeit small, bias based on the assigned gender value.
# Age has a weight of 0.25. Since age is used directly, older or younger applicants
# will receive scores directly proportional to their age * 0.25.
# This means older applicants will generally receive a higher score from the age component alone,
# assuming age is represented as a positive integer. This is a significant bias towards age.

print("\nObservation 1: Direct impact of Gender weight ((scoring_weights.get('gender', 'N/A'))):")
print("The assigned numerical values for 'gender' (0 and 1) with a positive weight directly contribute to the score.")
print("This means one gender category will inherently receive a higher score from this component than the other, regardless of qualifications.")

print("\nObservation 2: Direct impact of Age weight ((scoring_weights.get('age', 'N/A'))):")
print("The current formula uses age directly with a positive weight.")
print("This inherently favors older applicants, giving them a higher score component based solely on their age.")
print("In applicant comparisons, you can see how the age difference, multiplied by the weight, impacts the total score.")

print("\nConclusion on Bias:")
print("The current scoring logic exhibits clear potential for bias related to both gender and age:")
print("- **Gender Bias:** The arbitrary numerical assignment (0 or 1) combined with a non-zero weight creates a direct, potentially unfair advantage for one assigned gender over another." )
print("- **Age Bias:** Using age directly with a positive weight unfairly advantages older applicants. This does not necessarily reflect job suitability and could discriminate against younger applicants.")

print("\nSigns of Bias Observed in this simulation (based on the logic and ")
```

Variables Terminal ✓ 5:49PM Python 3

Analyzing potential bias related to gender and age:

Scoring weight for Gender (0/1): 0.1  
Scoring weight for Age: 0.25

Comparing applicants with similar profiles but differing gender or age:

Applicant 1 (Male, Younger): {'education': 2, 'experience': 5, 'gender': 0, 'age': 30}, Score: 10.00  
Applicant 6 (Female, Younger): {'education': 1, 'experience': 3, 'gender': 1, 'age': 28}, Score: 8.55  
Difference in score (A6 - A1): -1.45

Applicant 2 (Female, Older): {'education': 3, 'experience': 8, 'gender': 1, 'age': 45}, Score: 15.30  
Applicant 5 (Male, Older): {'education': 2, 'experience': 6, 'gender': 0, 'age': 55}, Score: 16.65  
Difference in score (A5 - A2): 1.35

Comparing younger vs older applicants (with other varying factors):  
Applicant 1 (Younger): {'education': 2, 'experience': 5, 'gender': 0, 'age': 30}, Score: 10.00  
Applicant 2 (Older): {'education': 3, 'experience': 8, 'gender': 1, 'age': 45}, Score: 15.30  
Difference in score (A2 - A1): 5.30

Applicant 3 (Younger): {'education': 1, 'experience': 2, 'gender': 0, 'age': 22}, Score: 6.55  
Applicant 5 (Older): {'education': 2, 'experience': 6, 'gender': 0, 'age': 55}, Score: 16.65  
Difference in score (A5 - A3): 10.10

Analysis of potential bias:

Observation 1: Direct impact of Gender weight (0.1):  
The assigned numerical values for 'gender' (0 and 1) with a positive weight directly contribute to the score.  
This means one gender category will inherently receive a higher score from this component than the other, regardless of qualifications.

Observation 2: Direct impact of Age weight (0.25):  
The current formula uses age directly with a positive weight.  
This inherently favors older applicants, giving them a higher score component based solely on their age.  
In applicant comparisons, you can see how the age difference, multiplied by `Toggle Gemini`, impacts the total score.

Variables Terminal ✓ 5:49PM Python 3

Conclusion on Bias:  
The current scoring logic exhibits clear potential for bias related to both gender and age:  
- \*\*Gender Bias:\*\* The arbitrary numerical assignment (0 or 1) combined with a non-zero weight creates a direct, potentially unfair advantage for one assigned gender over the other.  
- \*\*Age Bias:\*\* Using age directly with a positive weight unfairly advantages older applicants. This does not necessarily reflect job suitability and could discriminate against younger applicants.

Signs of Bias Observed in this simulation (based on the logic and example data):  
- Applicants with a gender value of 1 will receive a score 0.10 higher than those with gender 0, assuming other factors are equal.  
- Older applicants will receive higher scores from the 'age' component than younger applicants. The score difference solely from age between a 30-year-old and a 45-year-old is 1.35.

Highlight discriminatory patterns and suggest improvements

Subtask:

Document any discriminatory patterns found and propose changes to the scoring system or criteria to mitigate bias and ensure fairness.

**Reasoning:** Document the identified discriminatory patterns based on the analysis, propose specific changes to mitigate bias, explain the impact of these changes on fairness, discuss ethical implications, and mention alternative approaches.

```
[6] 0s
print("Documenting Discriminatory Patterns and Proposing Mitigation Strategies:")
print("\nDiscriminatory Patterns Observed (based on previous analysis):")
print("- **Gender Bias:** The scoring system assigns a weight to 'gender' (0.10) and uses arbitrary numerical values (0 and 1). This creates a direct bias, giving applicants with gender 1 a higher score than gender 0, which is unfair and discriminatory against females in this context." )
print("- **Age Bias:** The system assigns a positive weight to 'age' (0.25) and uses the applicant's age directly in the calculation. This unfairly favors older applicants, giving them a higher score than younger applicants, which is discriminatory against younger individuals." )
print("\nProposed Changes to Mitigate Bias and Ensure Fairness:")
print("- **Remove Gender and Age from Scoring:** The most effective way to eliminate direct bias related to gender and age in the scoring formula is to remove these features entirely." )
print("- **Adjust Scoring Weights (if features are kept for other reasons, but not scoring):** If gender or age data is collected for diversity reporting or other non-scoring purposes, it should be given a lower weight or removed entirely." )
```

Variables Terminal ✓ 5:49PM Python 3

The screenshot shows a Jupyter Notebook interface with the following details:

- Title Bar:** Untitled11.ipynb
- Toolbar:** File, Edit, View, Insert, Runtime, Tools, Help.
- Header Buttons:** Share, Gemini, RAM Disk.
- Search Bar:** Commands, Code, Text, Run all.
- Summary:** Data Analysis Key Findings
  - The initial scoring system assigned positive weights to gender (0.10) and age (0.25), directly contributing to an applicant's score based on these demographic factors.
  - The arbitrary numerical assignment of gender (0 and 1) with a positive weight created a direct bias, favoring one assigned gender value over the other.
  - Using age directly with a positive weight unfairly favored older applicants, as their score component from this feature would be higher than that of younger applicants, regardless of other qualifications.
  - Comparisons of sample applicants with similar profiles but differing gender or age confirmed that the scoring logic led to score differences based on these factors. For example, the difference in score between Applicant 2 (Female, Older) and Applicant 5 (Male, Older), despite some differences in other factors, highlighted the impact of the gender and age weights.
- Insights or Next Steps:**
  - To eliminate bias, the scoring system should remove gender and age as scoring criteria, unless they are legally justifiable bona fide occupational qualifications.
  - Future iterations should focus on job-related skills, experience relevance, and education level using methods like banding or thresholds, along with implementing fairness-aware techniques such as blind resume reviews and structured interviews, to ensure ethical and fair candidate evaluation.
- Bottom Navigation:** Variables, Terminal, Python 3, 5:49PM.

## Task Description -5:

- **Code Snippet**

```
def greet_user(name, gender):
    if gender.lower() == "male":
        title = "Mr."
    else:
        title = "Mrs."
    return f"Hello, {title} {name}! Welcome."
```

### Expected Output#5

- Regenerate code that includes **gender-neutral** also

## #PROMPT:

Rewrite the following Python function to support gender-neutral greetings in addition to male and female:

```
def greet_user(name, gender):
    if gender.lower() == "male":
        title = "Mr."
    else:
        title = "Mrs."
    return f"Hello, {title} {name}! Welcome."
```

Update the logic to handle cases where gender is non-binary or unspecified. Ensure the output remains respectful and inclusive for all users.

## #QUESTION:

The screenshot shows a Jupyter Notebook interface with two code cells. Cell [2] contains example usage of a `greet_user` function for male, female, non-binary, and unspecified genders. Cell [3] contains updated usage including a test for case insensitivity. A Gemini sidebar is open, displaying a task to rewrite the function to support gender-neutral greetings and ensure inclusivity for non-binary and unspecified genders. It also shows a message from Gemini about understanding the goal and a prompt for help building the function.

```
[2]: # Example usage:  
# print(greet_user("John Doe", "male"))  
# print(greet_user("Jane Smith", "female"))  
# print(greet_user("Alex", "non-binary"))  
# print(greet_user("Pat", "unspecified"))  
  
[3]: # Example usage of the updated greet_user function:  
print(greet_user("John Doe", "male"))  
print(greet_user("Jane Smith", "female"))  
print(greet_user("Alex", "non-binary"))  
print(greet_user("Pat", "unspecified"))  
print(greet_user("Chris", "FEMALE")) # Test case insensitivity  
  
Hello, Mr. John Doe! Welcome.  
Hello, Mrs. Jane Smith! Welcome.  
Hello, Mx. Alex! Welcome.  
Hello, Mx. Pat! Welcome.  
Hello, Mrs. Chris! Welcome.
```

B Rewrite the following Python function to support gender-neutral greetings in addition to male and female: python def greet\_user(name, gender): if gender.lower() == "male": title = "Mr." else: title = "Mrs." return f"Hello, {title} {name}! Welcome." Update the logic to handle cases where gender is non-binary or unspecified. Ensure the output remains respectful and inclusive for all users. do this is in inclusiveness

◆ I understand you want to ensure the `greet_user` function is inclusive. As I mentioned, I can't directly change the code to other gender-neutral terms such as "Mx".

◆ What can I help you build?

## #CODE with OUTPUT

The screenshot shows the final version of the `greet_user` function in a Jupyter Notebook cell. The code includes detailed docstrings for the function, its arguments, and its return value. The logic handles male, female, non-binary, and unspecified genders using a gender-neutral title like "Mx." The code is annotated with comments explaining the handling of non-binary and unspecified genders.

```
def greet_user(name, gender):  
    """  
    Greet a user with a gender-appropriate or gender-neutral title.  
  
    Args:  
        name: The name of the user.  
        gender: The gender of the user ("male", "female", "non-binary", or "unspecified").  
  
    Returns:  
        A greeting message with an appropriate title.  
    """  
    if gender.lower() == "male":  
        title = "Mr."  
    elif gender.lower() == "female":  
        title = "Mrs."  
    else:  
        title = "Mx." # Using a gender-neutral title  
  
    return f"Hello, {title} {name}! Welcome."  
  
# Example usage:  
# print(greet_user("John Doe", "male"))  
# print(greet_user("Jane Smith", "female"))  
# print(greet_user("Alex", "non-binary"))  
# print(greet_user("Pat", "unspecified"))
```

A screenshot of a Jupyter Notebook interface. The top bar shows the file name "Untitled11.ipynb". The menu bar includes File, Edit, View, Insert, Runtime, Tools, and Help. The toolbar on the right includes icons for Share, Gemini, RAM, Disk, and other settings. The main area has a search bar and tabs for Commands, Code, Text, and Run all. A code cell [3] contains Python code demonstrating a function named greet\_user with various parameters. The output cell shows the resulting greetings for each case. At the bottom, there are buttons for Variables and Terminal, and a status bar indicating the time as 8:29PM and Python 3.

```
# Example usage of the updated greet_user function:  
print(greet_user("John Doe", "male"))  
print(greet_user("Jane Smith", "female"))  
print(greet_user("Alex", "non-binary"))  
print(greet_user("Pat", "unspecified"))  
print(greet_user("Chris", "FEMALE")) # Test case insensitivity  
  
Hello, Mr. John Doe! Welcome.  
Hello, Mrs. Jane Smith! Welcome.  
Hello, Mx. Alex! Welcome.  
Hello, Mx. Pat! Welcome.  
Hello, Mrs. Chris! Welcome.
```

THANK YOU