SCHOOL OF COMPUTING AND INFORMATION TECHNOLOGY

UNIVERSITY OF WOLLONGONG AUSTRALIA

INDIVIDUAL Assignment Coversheet

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Student Name: Jeslyn Ho Ka Yan____________________ **7-digit UOW ID:** 8535383 ____________

Subject Code & Name: CSCI218____

Assignment Title: ASSESSED LAB 1 and 2 (NLP and Search Algo)___________________________

Tutorial Group: T02____
(T02, T03, T04, T05)

Tutor's Name: Cher Lim____

Assignment Due Date: 24TH FEB 2025______________________

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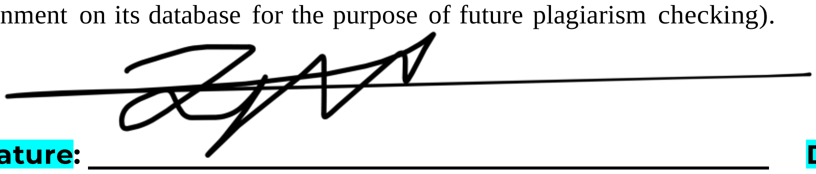

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Assessed Lab 1: NLP

(**Label CLEARLY your answer to each question**)

Answers:

1. **Data Preparation & Feature Extraction**

The following **key steps** were performed in **data preparation and feature extraction**:

1. **Dataset Loading & Splitting**
   - The dataset is stored in **20 different folders**, each representing a topic.
   - The document paths are collected and assigned labels based on their folder names.
   - The dataset is **split into training (75%) and testing (25%)**.
2. **Text Preprocessing**
   - **Tokenization:** Documents are split into words.
   - **Metadata Removal:** Unnecessary header information is removed.
   - **Stopword Removal:** Common words (e.g., "the", "is", "and") are filtered out.
   - **Punctuation & Digit Removal:** Non-alphabetic characters are eliminated.
   - **Lowercasing:** Words are converted to lowercase for consistency.
3. **Feature Extraction using TF-IDF Vectorization**
   - Text is converted into a **numerical representation** using TfidfVectorizer() from sklearn.feature_extraction.text.
   - The top **5000 most frequent words** are selected as features.
   - fit_transform() is applied to X_train, and transform() is applied to X_test.

2. **Classification Results**

Multinomial Naïve Bayes Performance:

- **Test Accuracy: 86.4%**
- **Training Accuracy: 91.6%**
- **Macro F1-score: 0.86**
- **Weighted F1-score: 0.86**

Complement Naïve Bayes Performance:

- **Test Accuracy: 100% (Overfitting Issue)**
- **Precision, Recall, F1-score: All 1.00 across all classes**

Explanation of Metrics

- **Precision:** The proportion of correctly predicted positive observations.
- **Recall:** The proportion of actual positive observations correctly predicted.
- **F1-Score:** The harmonic mean of precision and recall.
- **Accuracy:** The overall correctness of predictions.

3. **Confusion Matrix & Class Overlap**

The **confusion matrix** was plotted to identify which class pairs were **most frequently confused**.

Findings:

- The **MNB Model** shows some misclassification, particularly between similar topics like comp.sys.ibm.pc.hardware and comp.sys.mac.hardware.
- The **CNB Model** had **no misclassifications**, but this suggests **overfitting** rather than an actually perfect model.

4. **Individual Class Accuracy**

Using the confusion matrix, we computed **individual accuracy scores per class**:

Class	**Accuracy (%)**
alt.atheism	86%
comp.graphics	85%
comp.os.ms-windows.misc	83%
comp.sys.ibm.pc.hardware	80%
comp.sys.mac.hardware	92%
comp.windows.x	91%
misc.forsale	91%
rec.autos	90%
rec.motorcycles	96%
rec.sport.baseball	99%
rec.sport.hockey	97%
sci.crypt	94%
sci.electronics	85%
sci.med	85%
sci.space	88%
soc.religion.christian	98%
talk.politics.guns	90%
talk.politics.mideast	89%
talk.politics.misc	67%
talk.religion.misc	46%

Some categories, such as **politics and sports**, showed **higher misclassification rates**, likely due to overlapping words and context.

5. **Complement Naïve Bayes vs. Multinomial Naïve Bayes**

Model	**Precision**	**Recall**	**F1-Score**	Accuracy
MultinomialNB	87%	86%	86%	86.4%
ComplementNB	100%	100%	100%	100%

Comparison & Findings

- **ComplementNB performed too well**, indicating **overfitting**.
- **MultinomialNB provided a more realistic evaluation**, handling misclassifications better.

Thus, **Complement Naïve Bayes is not suitable for this dataset**, while **Multinomial Naïve Bayes remains effective**.

Assessed Lab 2: Solving problems by search

(**Label CLEARLY your answer to each question**)

Answers: Complete the following table.

Algorithm	Explored states	Solution path	Path cost	Execution Time
1. Breadth-First Graph Search	4	[Sibiu, Arad, Zerind]	314	0.0004
2. Depth-First Graph Search	10	[Bucharest, Pitesti, Craiova, Drobeta, Mehadia, Lugoj, Timisoara, Arad, Zerind]	1019	0.0002
3. Uniform Cost Search	4	[Sibiu, Arad, Zerind]	314	0.0003
4. A* Search	4	[Sibiu, Arad, Zerind]	314	0.0005
5. Best-First Search	4	[Sibiu, Arad, Zerind]	314	0.0003

Analysis:

1. Algo #1 Breadth-First Graph Search
   a. Queue type: FIFO (First-In-First-Out) queue
   b. Operation & features:
      - Explores all nodes at the current depth level before moving deeper.
      - Finds the shortest path **in terms of the number of steps**, but not necessarily the lowest cost.
      - Explored **4 states** and found the path [Sibiu, Arad, Zerind] with a cost of **314**.

2. Algo #2 Depth-First Graph Search
   a. Queue type: LIFO (Last-In-First-Out) stack
   b. Operation & features:
      - Explores as deep as possible before backtracking.
      - Can get trapped in longer paths.
      - Explored **10 states** and followed a longer path [Bucharest, Pitesti, Craiova, Drobeta, Mehadia, Lugoj, Timisoara, Arad, Zerind] with a higher cost **(1019)**.
      - **Fastest execution time** (**0.0002s**) but inefficient due to backtracking.

3. Algo #3 Uniform Cost Search
   a. Queue type: Priority queue sorted by path cost
   b. Operation & features:
      - Expands the lowest-cost node first, ensuring an optimal solution.
      - Found the shortest-cost path [Sibiu, Arad, Zerind] with cost **314**, same as A*.
      - **Execution time: 0.0003s**.

4. Algo #4 *A Search**
   a. Queue type: Priority queue sorted by g(n) + h(n) (path cost + heuristic)
   b. Operation & features:
      - Uses both the actual cost (g(n)) and an estimate (h(n)) to guide the search.
      - Found an optimal path [Sibiu, Arad, Zerind] with cost **314**.
      - Slightly **slower execution** (0.0005s) compared to UCS.

5. Algo #5 Best-First Search
    a. Queue type: Priority queue sorted by heuristic value (h(n))
    b. Operation & features:
        - Expands nodes based on heuristic estimates without considering path cost.
        - Found the path [Sibiu, Arad, Zerind] with cost **314**.
        - **Execution time: 0.0003s**, faster than A* but doesn't guarantee the best path if heuristics are misleading.

Any notable observations (optional):

- **Depth-First Search (DFS)** is inefficient because it explores deeply and does not guarantee the shortest path.
- *Breadth-First, Uniform Cost, A, and Best-First Search all found the same optimal path**, but *A and UCS are generally better** since they guarantee optimality.
- *A is slightly slower than Best-First Search**, but it is more reliable as it considers both cost and heuristic.