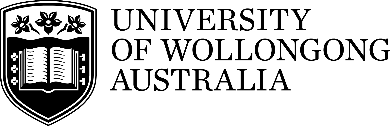
**SCHOOL OF COMPUTING AND INFORMATION TECHNOLOGY**

**  
INDIVIDUAL Assignment Coversheet**

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**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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## 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
   1. Queue type: FIFO (First-In-First-Out) queue
   2. 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**.

1. Algo #2 Depth-First Graph Search
   1. Queue type: LIFO (Last-In-First-Out) stack
   2. 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.

1. Algo #3 Uniform Cost Search
   1. Queue type: Priority queue sorted by path cost
   2. 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**.

1. Algo #4 *A Search*\*
   1. Queue type: Priority queue sorted by g(n) + h(n) (path cost + heuristic)
   2. 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.

1. Algo #5 Best-First Search
   1. Queue type: Priority queue sorted by heuristic value (h(n))
   2. 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.