INSTITUTE	Institute for Artificial Intelligent Systems
CAMPUS(ES)	JBS Park
MODULE NAME	Natural Language Processing
MODULE CODE	ALP9X02
SEMESTER	Second
ASSESSMENT	Final Assignment

ASSESSMENT DATE	04 August 2025	**DUE DATE**	24 October 2025 (22:00)
ASSESSOR(S)	Prof. Mpho Primus / Mr. Koena Mabokela		

INFORMATION/INSTRUCTIONS:

- This is a take-home assessment.
- This is a practical assessment.
- A group should have 3 – 4 team members.
- Please handin all source codes
  - Dataset available
- The report must be submitted via Moodle, no other forms of submissions will be accepted.
- No handwritten submissions will be accepted.

Assignment: Automatic Extraction of Tone for Sesotho

Objective

The objective of this assignment is to develop a system for the automatic extraction of tone for Sesotho. Tone is a crucial phonetic feature in many African languages, and its accurate extraction can significantly enhance natural language processing (NLP) applications such as speech recognition, text-to-speech synthesis, and language learning tools.

Background

Tone in language refers to the use of pitch to distinguish meaning between words or syllables. In many African languages, tone plays a vital role in differentiating words that otherwise appear identical in their phonetic form. For example, in Sesotho, the phrase *"ke motho"* can mean *"I am a person"* or *"He/she is a person"* depending on the tone on *"ke"*. Automatic extraction of tone involves identifying the pitch contour of speech and mapping it to the appropriate tone category.

Assignment Tasks

1. **Literature Review**:
    - Research the role of tone in Sesotho, focusing on its linguistic and phonetic aspects.
    - Review existing methods and technologies used for tone extraction in tonal languages, both in African contexts and globally.
2. **Data Collection**:
    - A collection of utterances in Sesotho exists and will be made available to your team.
    - Students will have access to a small tone dataset, and they are encouraged to pursue a hybrid approach (e.g., combining rule-based and statistical or deep learning methods) to complete this assignment.
3. **Pre-processing and Annotation**:
    - Preprocess the audio data to remove noise and normalize volume levels.
    - Annotation
4. **Feature Extraction**:
    - Extract relevant acoustic features such as fundamental frequency (F0), intensity, and duration from the audio signals.
    - Analyze how these features correspond to different tones in the language.
5. **Model Development**:
    - Develop a computational model (e.g., machine learning, deep learning) for automatic tone extraction.
    - Train the model using the annotated dataset and evaluate its performance.
6. **Evaluation**:
    - Assess the accuracy of the tone extraction system using metrics such as precision, recall, and F1 score.
    - Compare the performance of your system with baseline methods or existing systems if available.
7. **Analysis and Discussion**:
    - Discuss the challenges encountered during the tone extraction process, such as data quality, speaker variability, and language-specific issues.
    - Analyze the implications of accurate tone extraction for applications like speech recognition, language education, and digital preservation of languages.
8. **Conclusion and Future Work**:

- Summarize the findings of the assignment and the effectiveness of the developed system.
- Propose future research directions or improvements, such as expanding the dataset, incorporating additional linguistic features, or extending the system to other languages.

Deliverables

1. **Written Report**:
   - A comprehensive report detailing each phase of the assignment, including the literature review, methodology, results, and discussion. The research report should use Journal of Digital Humanities of Southern Africa template. Please see author guidelines https://upjournals.up.ac.za/index.php/dhasa/about/submissions
2. **Code and Model**:
   - The code and model developed for tone extraction, along with instructions on how to use them.
3. **Presentation**:
   - A presentation summarizing the key findings and contributions of the assignment.

References and Resources

- Consult academic papers, books, and online resources on phonetics, African linguistics, and computational linguistics.
- Utilize software tools and libraries such as Praat, Python's librosa, and machine learning frameworks like TensorFlow or PyTorch.
- Mohasi, L., Mixdorff, H., Niesler, T. and Zerbian, S., 2014, May. Analysis of Sesotho Tone using the Fujisaki Model. In *Proceedings of the 7th International Conference on Speech Prosody*.
- Raborife, M., Ewert, S. and Zerbian, S., 2015. Improving a tone labeling algorithm for Sesotho. *Language Resources and Evaluation*, *49*(1), pp.19-50.
- Barnard, E. and Zarbian, S., 2010. From tone to pitch in Sepedi.
- Mohasi, L., Sečujski, M., Mak, R. and Niesler, T., 2014. A Comparison of Two Prosody Modelling Approaches for Sesotho and Serbian. In *Speech and Computer: 16th International Conference, SPECOM 2014, Novi Sad, Serbia, October 5-9, 2014. Proceedings 16* (pp. 34-41). Springer International Publishing.
- Pule, V.M.S. and Theledi, K., 2023. The impact of the presence of prosodic features (tone markings) on comprehending Setswana words in reading. *African Journal of Inter/Multidisciplinary Studies*, *5*(1), pp.1-12.
- Wissing, D. and Roux, J.C., 2017. The status of tone in Sesotho: A production and perception study. *Nordic Journal of African Studies*, *26*(4), pp.19-19.
- Onyenwe, I.E., 2017. *Developing methods and resources for automated processing of the african language igbo* (Doctoral dissertation, University of Sheffield).
- Adebara, I., Elmadany, A. and Abdul-Mageed, M., 2024. Cheetah: Natural Language Generation for 517 African Languages. *arXiv preprint arXiv:2401.01053*.

Timeline

- **Week 1-3**: Literature review and data collection
- **Week 4-5**: Preprocessing and annotation
- **Week 6-9**: Feature extraction and model development
- **Week 10-11-**: Evaluation and analysis
- **Week 12**: Conclusion, final report, and presentation preparation

Grading Criteria

- **Depth of Literature Review**: Understanding of tone in the selected language and relevant methodologies.
- **Quality of Data Collection and Annotation**: Accuracy and comprehensiveness of the dataset.
- **Effectiveness of Feature Extraction and Modeling**: Innovation and effectiveness of the chosen methods.
- **Analysis and Discussion**: Critical thinking and insight into the challenges and implications of the work.

- **Presentation and Report Quality**: Clarity, organization, and thoroughness of the final deliverables.

This assignment aims to enhance your understanding of phonetics, computational linguistics, and the challenges of processing tonal languages.