Hindi-Chhattisgarhi Cross-Lingual Transfer Using RL-Guided Distillation

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1 Project Overview

This approach focuses on developing a specialized framework that efficiently transfers knowledge from Hindi (high-resource language) to Chhattisgarhi (low-resource language) using reinforcement learning and knowledge distillation techniques. We concentrate resources on optimizing core transfer learning mechanisms.

2 Key Components

- **NLLB-Enhanced Transfer Learning:** Utilizing the No Language Left Behind dataset as the foundation.

- **Reinforcement Learning for Selective Knowledge Transfer:** Using RL to dynamically determine optimal transfer parameters.

- **Bidirectional Lexical Mapping:** Leveraging existing Hindi-Chhattisgarhi parallel data.

- **Knowledge Distillation:** Implementing confidence-guided distillation techniques.

3 Project Timeline

3.1 Phase 1: Setup and Foundational Development (March 13-20, 2025)

- **Environment Setup and Data Collection**
  - Configure development environment with required libraries and frameworks.
  - Access and prepare the NLLB dataset components relevant to Hindi.
  - Collect and organize existing Hindi-Chhattisgarhi parallel corpus (40,000 sentences).
  - Set up evaluation metrics and benchmarks for cross-lingual transfer.

- **Base Model Architecture Design**
  - Design and implement the base encoder-decoder architecture using NLLB Hindi components.
  - Establish baseline model performance metrics.
  - Create data preprocessing pipelines for both Hindi and Chhattisgarhi corpora.

- **Knowledge Distillation Framework Implementation**
  - Develop teacher and student model architectures for knowledge distillation.
  - Implement confidence-guided distillation mechanisms based on DRL-Rec principles.
  - Design output-level distillation using list-wise KL divergence loss.
  - Implement intermediate-level distillation using Hint loss.

3.2   Phase 2: RL Framework Development (March 21-28, 2025)

- **RL Environment Design**

  - Define state space (model parameters, performance metrics).
  - Define action space (parameter selection for transfer: freeze/fine-tune/replace).
  - Implement reward function based on translation quality metrics (BLEU, METEOR).

- **Exploring and Filtering Module Implementation**

  - Develop the exploring mechanism to identify valuable transfer candidates.
  - Implement filtering strategies to select informative training instances.
  - Design confidence-guided filtering based on teacher model certainty.

- **Policy Network Development and Integration**

  - Implement RL policy network using Proximal Policy Optimization (PPO).
  - Integrate policy network with the transfer learning framework.
  - Establish monitoring metrics for RL agent performance.

3.3   Phase 3: Training and Optimization (March 29-April 5, 2025)

- Initial Model Training and Transfer Strategy Optimization.

- RL-Guided Distillation Process and extensive ablation studies.

3.4   Phase 4: Evaluation and Documentation (April 6-13, 2025)

- Comprehensive evaluation on Hindi-Chhattisgarhi test sets.

- Drafting research paper and final documentation.

4   Project Repository Structure

```
rich-cousin-poor-sister/
|--- README.md
|--- LICENSE
|--- requirements.txt
|--- .gitignore
|--- data/
   |--- raw/
   |--- processed/
   |--- embeddings/
   |--- parallel_corpus/
    evaluation/
|--- src/
   |--- models/
   |--- preprocessing/
   |--- training/
   |--- distillation/
   |--- reinforcement_learning/
   |--- evaluation/
    utils/
|--- experiments/
   |--- logs/
```

```
    |--- checkpoints/
     configs/
|--- results/
    |--- figures/
    |--- tables/
     metrics/
|--- docs/
    |--- paper/
    |--- methodology/
     tutorials/
 tests/
     |--- unit_tests/
      integration_tests/
```

5 Expected Outcomes and Novel Contributions

- **First RL-Guided Transfer Learning System for Hindi-Chhattisgarhi.**

- **Enhanced Distillation Techniques.**

- **NLLB Adaptation for Non-Included Languages.**

- **Quantitative Analysis of Hindi-Chhattisgarhi Transfer.**

By focusing resources on core components, this approach has the goal of supporting the "poor sister" language through knowledge transfer from its "rich cousin" while offering a streamlined and focused implementation path.