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Exploratory Prediction in Marathi

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DEP 405 B.Des Design Project 1

Autumn 2025

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Declaration

I declare that this written submission represents my ideas in my own words and where others' opinions or words have been included, I have adequately cited and referenced the sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been appropriately cited or from whom proper permission has not been taken when needed.

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Approval Sheet

This B.Des Design Project-I titled “Untitled” by Rhuturaj Mirashi, Roll Number 22B3613, is approved, in partial fulfilment of the B.Des Degree at the IDC School of Design, Indian Institute of Technology Bombay.

Project Guide *Chairperson* *External Examiner* *Internal Examiner*

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01 Abstract

This project explores novel interaction mechanisms for text prediction in Marathi, specifically addressing the friction points caused by the language's agglutinative nature. This project investigates an alternative "Exploratory Prediction" interface that allows users to construct complex words using numbered shortcuts. The design aims to balance the trade-off between Ease of Automation and User Agency. Quantitative evaluation focused on metrics such as Words Per Minute (WPM) and Keystroke Savings.

02 Introduction

2.1 Background

Text entry is one of the most frequent interactions on mobile devices. While predictive text has matured for languages like English, Indian languages **specifically Marathi** presents a unique opportunity for design intervention due to **agglutination**, where words are formed by stringing together multiple morphemes (root + suffix + inflection).

2.2 Motivation

The project initially began as an exploration of voice input methods to reduce labor in typing. However, preliminary investigations revealed a critical friction point in Human-Computer Interaction (HCI): the trade-off between Ease of Typing and User Agency. Users often find aggressive autocompletion intrusive, yet manual typing is laborious. This project pivots to explore prediction input methods that restore agency to the user while maintaining speed.

02 Introduction

2.3 Problem Statement

Current predictive text input treat Marathi words as unique dictionary entries. This approach creates fundamental usability issues due to the language's structure:

1. The Prediction Shadow: As defined in previous IDC studies (Ghone, 2016), agglutinative variations (e.g., Ghara-chya-khali) are statistically less frequent than root words. Because predictive algorithms prioritize high-frequency root words, complex inflections fall into a "shadow" and are rarely displayed in the limited prediction bar, rendering the feature useless for long words.
2. The Corpus Complexity (Vocabulary Explosion): Unlike English, where a dictionary of 50,000 words covers the majority of daily usage, Marathi's agglutinative nature results in a theoretically infinite vocabulary. A single root can spawn hundreds of variations. Standard dictionary-based prediction models struggle to cover this massive corpus, leading to poor prediction accuracy for inflected words and forcing users to revert to manual typing for a significant portion of their input.

03 Research & Methodology

3.1 Methodology: Research through Design

Following the precedent of exploratory interaction design studies in this domain (Ghone, 2016), this project did not follow the classical linear design process of extensive user interviews followed by ideation. Instead, it adopted an iterative, "Research through Design" approach, the focus of this project was on hypothesizing and prototyping novel interaction mechanics. The primary research question was: **How can we redesign the selection mechanism to support word/sentence construction rather than just word completion?**

3.2 Research Objectives

- RO1 (Design): To explore and prototype novel interaction mechanisms..
- RO2 (Evaluate): To assess the efficacy of the proposed prototype interaction mechanism against standard typing methods using quantitative metric of Keystrokes Per Character.

04 Ideation

4.1 Confidence-Based Inline Suggestions

This concept attempts to solve the Visual Discontinuity problem by bringing longer predictions directly into the text line.

- Mechanism: As the user types a sentence (e.g., "भारताची राजधानी"), relevant continuations appear inline, distinguished by a **darker color for higher confidence** (e.g., " नवी दिल्ली") **lighter color for lower confidence** (e.g., ", देशाचे राजकीय केंद्र आहे").
- Pros: Keeps the user's eye focus in one place; mimics natural thought completion.
- Cons: Can be visually distracting if predictions are wrong; might lead to accidental acceptances and increase keystrokes due to removing or editing the suggestions. Not very different from current methods.

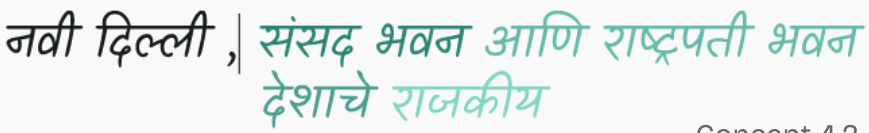
Concept 4.1

04 Ideation

4.2 Contextual Drop-down Menu

This concept explores a more traditional but context-aware menu that appears below the active word, rather than in a bar above the keyboard.

- Mechanism: When typing (e.g., "राजकीय"), a list of relevant predictions appears next to the word one below another (e.g., "संसद भवन", "राष्ट्रपती भवन").
- Pros: Familiar interaction pattern; still more options than inline text.
- Cons: Still requires a shift in focus from typing to reading a list. Not very different from current methods.



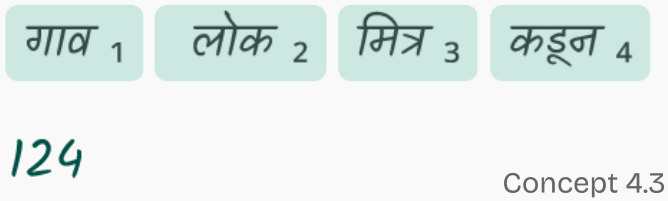
Concept 4.2

04 Ideation

4.3 The "Numbered Shortcut" Constructor

This concept combines the keystroke saving and speed of just hot-keying numbers with the logic of Morpheme Construction. It acknowledges that selecting a long word is faster than typing it..

- Mechanism: A distinct list of morphemes (roots, suffixes, or related words) is assigned to specific number keys.
  a. User types a word (e.g., "दुपारी चौकात बसून ").
  b. System suggests numbered options below the text: 1. गाव, 2. लोक, 3. मित्र.
  c. User presses 12 to instantly insert "गावातीललोक".
- Pros: Rapid selection without moving fingers from the home row; enables fast "construction" of complex sentences piece-by-piece; significantly reduces keystrokes.
- Cons: How do you type numbers? .



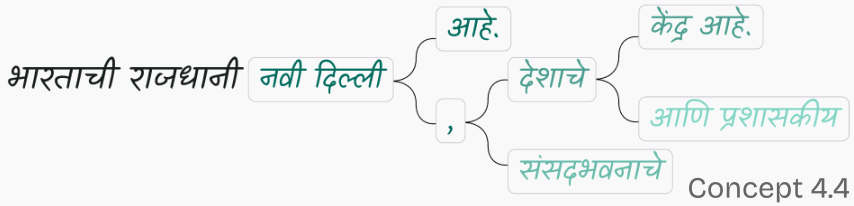
Concept 4.3

04 Ideation

4.4 Branching Tree Predictions

This concept attempts to map the Mental Model of sentence construction directly onto the UI.

- Mechanism: When a root phrase is entered, a visual tree branches out showing potential grammatical or logical continuations. For example, from "नवी दिल्ली", branches extend to "आहे", "देशाचे", and further into "केंद्र आहे".
- Pros: Highly intuitive for understanding sentence structure; visually represents the "construction" of a sentence.
- Cons: Visually cluttered; requires too much screen real estate; complex to navigate with a keyboard.



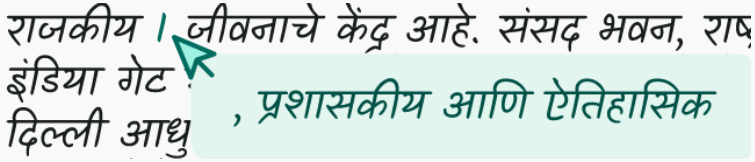
Concept 4.4

04 Ideation

4.5 Interactive Hover-to-Expand

This concept explores a mouse-based interaction (for desktop scenarios) where hovering over a word reveals predictions that can be scrolled through and selected.

- Mechanism: Hovering over a word like "राजकीय" expands a tooltip with a predictions like ("प्रशासकीय आणि ऐतिहासिक").
- Pros: Good for editing; keeps the interface clean until interaction is needed.
- Cons: Not suitable for rapid typing; relies on mouse input which breaks keyboard flow.



Concept 4.5

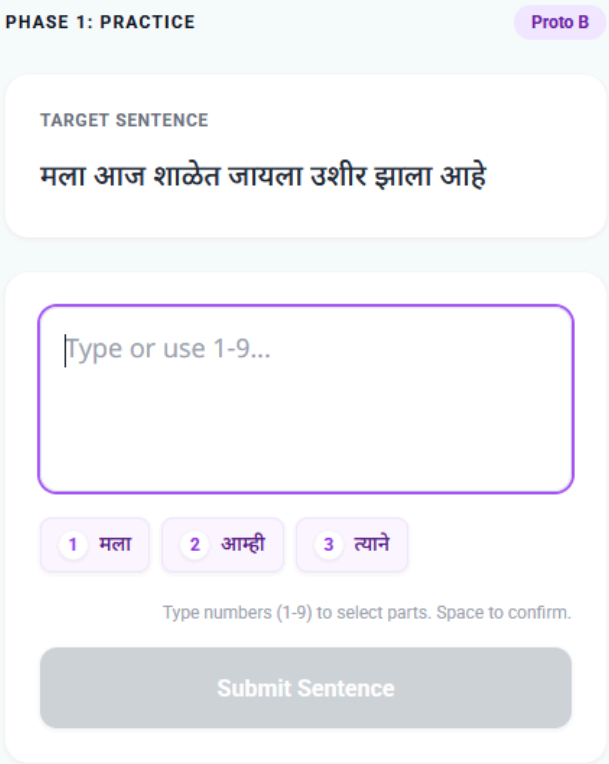
05 Design & Implementation

5.1 Prototype

The final concept was developed into a functional Single Page Application.

- Technology: HTML, CSS, and Vanilla JavaScript.

Prototype A: Standard n-gram backoff 1 word prediction.
Prototype B: 4.3 'Numbered shortcut' prototype.



https://ryutwome.github.io/mtp

06 Evaluation

6.1 Evaluation Goal

To validate the efficiency of the "Numbered Shortcut" interface selected in the previous phase, a quantitative study was designed.

6.2 Hypothesis

The Numbered Shortcut interface will not result in a lower Keystroke Per Character (KPC) count compared to the standard Inline predictions.

06 Evaluation

6.3 Methodology

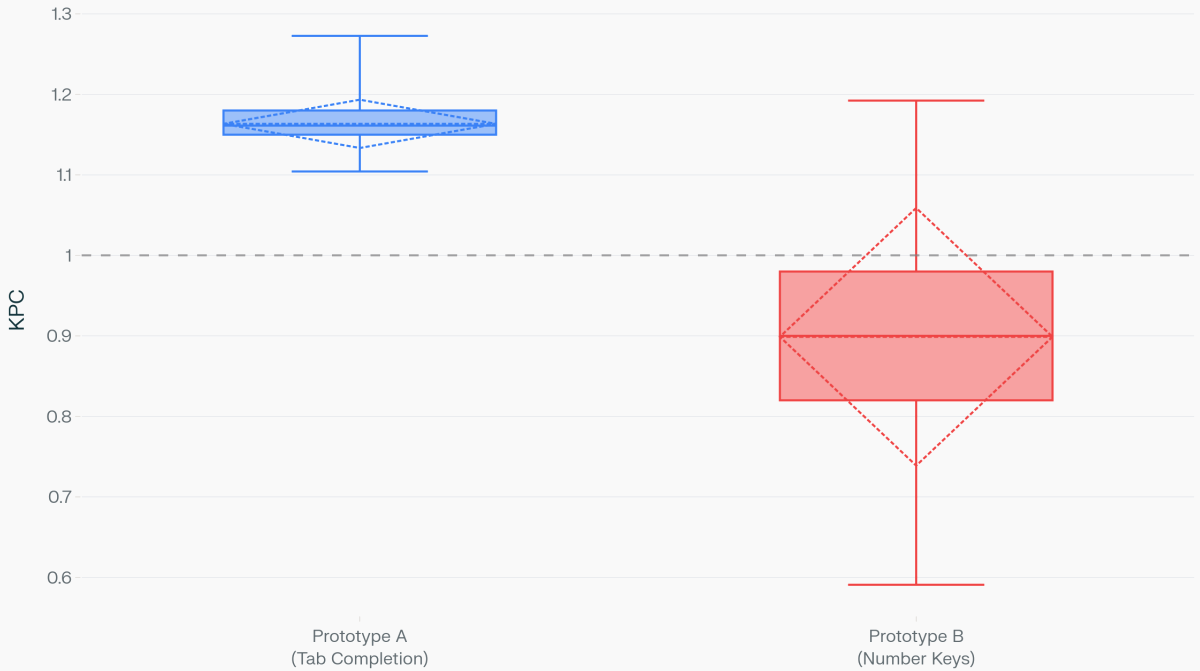
- Simulation was run emulating a perfect user transcribing a set of 300 standard Marathi sentences with a mean KPC of 1.5 and an SD of 0.07 using both prototype A and Prototype B

6.4 Metrics

The performance was measured using KPC (Keystrokes Per Character): To measure the efficiency of the prediction method. A lower KPC indicates the prediction is successfully saving effort.

06 Evaluation

6.5 Results



- PROTOTYPE A (Tab Completion)
  Mean KPC: 1.1634
  Median: 1.1613
  Std Dev: 0.0251
  Range: 1.10 - 1.27

  ✗ Always >1.0 KPC

- PROTOTYPE B (Number Keys)
  Mean KPC: 0.8989
  Median: 0.9000
  Std Dev: 0.1288
  Range: 0.59 - 1.19

  ✓ More efficient (22.7% better)
  ✓ Sub-1.0 KPC possible

07 Conclusion & Future Scope

7.1 Conclusion

- The exploration of "Exploratory Prediction" for Marathi text input has yielded findings that might suggest to numbered constructor to be a novel approach to predictive text systems for agglutinative languages. The simulation assumes perfect users, zero errors, and biased corpus. Also KPC is not the most realistic measure of a text input system and thus needs to be conducted with real users with large standard Marathi corpus measuring speed, error and learning curve.

7.1 Future Scope

- Longitudinal Study: As noted in Ghone's study, building a conceptual model of a predictive system takes time. A longer study with a better prototype is needed to measure accurate real world potential through better and more standardized metrics like speed and error.