Noun Phrase Recognition in Marathi Sentences: Experimental study

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Abstract :
Noun Phrase Recognition, also known as NP chunking, involves identifying and classifying sequences of words that function as noun phrases. Noun Phrase (NP) recognition is a crucial task in Natural Language Processing (NLP),providing foundation for various higher-level linguistic tasks such as machine translation, information extraction and syntactic parsing.
Marathi is morphologically rich and syntactically flexible Indo-Aryan language. While substantial work has been done for English and other resource-rich languages, Indian languages like Marathi pose unique challenges due to rich morphology, free word order and agglutinative features.
This paper explores noun phrase recognition in Marathi. This paper presents an algorithm for identifying noun phrases in Marathi language sentences. Based on this algorithm, a computational model has been developed which identifies noun phrases from a given sentence. The rule-based system with the approach of Local Word Grouping has been applied in the process of identifying noun phrases. This task can help in phrase structured based machine translation and thus identifying noun phrases can become the base for other Indian languages. We present an overview of the linguistic structure of noun phrases in Marathi, challenges in automatic recognition, and computational techniques employed. We evaluate both rule-based and machine learning-based approaches.

Keywords: noun phrase, local word group, rule based

Introduction: In this paper, we investigate NP recognition in Marathi language by analyzing its syntactic structure, morphological complexity, and the applicability of various computational approaches. Identification of noun phrases makes the task of Local Word Grouping and NER.

1. Linguistic Features of Marathi

Marathi is spoken by over 83 million people, primarily in the Indian state of Maharashtra. It is a SOV (Subject-Object-Verb) structure language with extensive inflectional morphology. In Marathi, just like in English, a noun phrase (T T ¸ T T Ū) is a group of words that functions as a noun in a sentence. It typically includes a noun (T) as its head and can be accompanied by modifiers like adjectives (Ū`), determiners (T T T₹) ***al***though Marathi doesn't have articles like "a" or "the" in English, it has **demonstratives and quantifiers** that function similar to determiners (T T T₹) ***in English language***, possessives (T¯ TT TK), and other nouns acting as modifiers.

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Morphological Characteristics

1. Case markers (r4): e.g., UT (la), न (ne), KT (chā), (sa)
2. Number and gender inflections : ¸U T, ¸U , Ų `
3. Compound nouns and postpositional phrases : UTU ¸ T?, T T T T K`O₹ etc

Nouns in Marathi (T /Nām) name, people, places, things, or ideas. They are inflected for gender (masculine, feminine, neuter), number (singular, plural), and case (nominative, accusative, dative, oblique, vocative) which reflects their role in a sentence. Marathi nouns can be broadly classified into **proper nouns** (D44 TK T / Vyaktivaachak Nām) that name specific entities, and **common nouns** (T T T / Saamaanya Nām) referring to general items or concepts.

Gender in Marathi Nouns

There are three Marathi nouns genders: masculine, feminine, and neuter.

- **Masculine Nouns**: Often end in aa/ा consonant. Example: " ¸U T" (Mulagaa/boy).
- **Feminine Nouns**: Usually end in " "/ī. Example: " ¸U " (Mulagī/girl).
- **Neuter Nouns**: Can end in ा/"a". Example: " T "(paan/page).

Number: Singular and Plural Forms

The plural form of Marathi nouns is typically formed by changing the ending of the singular form. The specific change can vary depending on the noun's gender and ending.

1. **Masculine to Plural**: Add " ` " (ē) or other changes. Example: " T" (Kidaa/insect) becomes " `" (kide/insects).
2. **Feminine to Plural**: Change " "*(ī)* to " T" *(yā)*. Example: " ¸K "(khurchi, chair) becomes " ¸ T T" (khurchyā, chairs).
3. **Neuter to Plural**: Often involves vowel changes or adding a suffix. Example: " ¸ "(Pustak, book) becomes " ¸ `" (Pustakē, books).

Cases in Marathi Nouns

Marathi employs seven cases to indicate the grammatical and relational function of nouns within sentences.

1. **Nominative Case (T, Prathamā)**: The subject of the sentence.
2. **Accusative Case (ि U T, Dvitīyā)**: The direct object.
3. **Instrumental Case (UŲ T, Tṛtīyā)**: Means by which or with whom an action is performed.
4. **Dative Case (KU¸ , Caturthī)**: The indirect object or recipient.
5. **Ablative Case (TK , Pañcamī)**: Indicates separation.
6. **Genitive Case (, Ṣaṣṭhī)**: Shows possession.
7. **Locative Case (, Saptamī)**: Indicates location.

2. Challenges in Noun Phrase Recognition in Marathi

1. Morphological Richness: Single-word inflections encode multiple grammatical features.
2. Free Word Order: Variable phrase order complicates pattern for recognition.
3. Ambiguity: Words may serve multiple grammatical roles.
4. imited annotated corpora for Marathi.
5.

Noun Phrase Structure

While defining noun phrase, Halliday (1997:7) said that "A noun can be accompanied by its determiner and any other modifier." In this, determiner and any modifier are optional elements of noun phrase whereas noun word is an essential element of any noun phrase. Without it, noun phrase cannot be imagined. Elements of noun phrase are in a particular order. Change in the order of its elements can happen according to interlinguistic rules.

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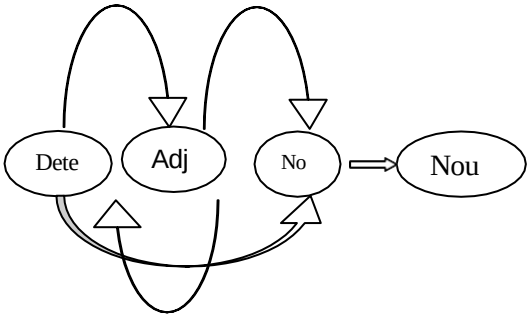
In a sentence, there are fixed places for the subject, object, complement, indeclinable and verb etc. where noun, adjective, verb, adverb etc. are used and play a specific role in the sentence. These places are also called functional places. The words or groups of words used at these functional places are called phrases. A typical noun phrase in Marathi may consist of: Determiner (optional), Adjective(s) (optional), Noun, Postpositions (equivalent of prepositions in English), Quantifiers (optional)

A noun phrase can contain determiners, adjectives and nouns. Determiners, adjectives and nouns join together in a specific order to form a noun phrase, which can be represented by a finite state automata graph as follows –



According to the above Finite State Automata (FSA), the number of determiners in a noun phrase can be zero or one, while adjectives can be zero or many. Here are some examples of Marathi noun phrases within sentences:

Here's Marathi noun phrases with different types of modifiers:

1. Head Noun Alone:

दा ₹ : ¸U T TU . (Mulgaa gaato.) - The boy sungs. (" ¸U T- boy - is the noun phrase here, consisting only of the head noun.)

दा ₹ : U U` UT ₹ आ `. (Pishvii tebalaavar aahe.) - The **bag** is on the table. (" U " – bag - is the noun phrase.)

2. Noun with an Adjective (U` - Visheshaan):

दा ₹ : T T ₹ आU . (Mothi manjar aali .) - A **big cat** came. (" T T ₹" - big cat - is the noun phrase." T T ₹ "– cat - is the head noun, and " " - big - is the adjective.)

दा ₹ : T दरT ¸दर आ `. (nila sadraa sundar aahe.) - The **blue shirt** is beautiful. (" T दरT" – blue shirt - is the noun phrase. " दरT" – shirt - is the head noun, and " T" – blue - is the adjective.)

3. Noun with a Possessive (T TT TK - Sambandhvachak):

दा ₹ : T आ5 ₹ ₹U`. (Majhi aai nokri karte .) – **My mother** is working . (" T आ5" - my mother - is the noun phrase. "आ5 " - mother - is the head noun, and " T " - my - is the possessive pronoun acting as a modifier.)

Other such Possessives are- T T, T , T `, T T, T T, आ KT, आ K , आ K`, आ T, आ K, आ UT, आ U , आ U`, आ T, आ U U, T, U, , U, `, U, T, U, T, U, म्ह TUT, UK`, UK , UKT, TKT, TK, TK`, TKT U, KT, U, KT, U, K`, U, T, U, K , T T KT, T T K, T T K`, T T T *etc.*

दा ₹ : UTK T T T U . (Sitaachii bangdi saapadlii.) - **Sita's bangle found**. (" UTK T T " - **Sita's bangle** - is the noun phrase. " T T " - **bangle** - is the head noun, and " UTK " - **Sita's** - is the possessive form of the noun.)

Other such Possessives are - KT, K , K`, T *etc.*

4. Noun with a Demonstrative (दUT - Darshak):

दा ₹ : U UT T KT T T U आ `. (Ti shala changli aahe.) - **That school** is good. (" U

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UT T" - that school - is the noun phrase. "UT T " - school - is the head noun, and "U " - that - is the demonstrative pronoun acting as a modifier.)

दT ₹ : T T¯ UT ¸T आ `. (haa bangalaa junaa aahe .) - **This bunglow** is old. *(*" T T UT " - this bunglow - is the noun phrase. " T UT " - bunglow - is the head noun, and " T" - this - is the demonstrative pronoun.)

Other such Possessives are - U ,U ,U`, T, `, T, , *etc.*

5. NounwithaQuantifier (T%T TK / ₹₹ T TK - Sankhyavachak/Parimanvachak):

दT ₹ : T ¸U UU आ `U. (Kahii muliia bolat aahet.) - **Some girls** are talking . *(*" T ¸U " - some girls - is the noun phrase. " ¸U " – girls - is the head noun, and " T " - some - is the quantifier.)

दT ₹ : T ₹ आ T. (Thodii saakhar aanaa.) – Bring **some sugar**. (" T ₹" - some sugar- is the noun phrase. " T ₹ " – sugar - is the head noun, and " " - some - is the quantifier.)

Other such Possessives are - `, , T, 4T, ₹T `, 5U `, 5U ` `, T KU, T , ₹ K, अ ` , ₹, Ur₹, Ur₹, TUrT₹, O₹r₹, T r₹, U` , T T T , आT , ¸₹` `, , r₹ ₹, , T , अ `, द , U` , T₹, ` , ए U₹ *etc*.

6. Noun with another Noun acting as a Modifier (often indicating material or type):

दT ₹ : `₹ ` ¸दि द U आ `U. (Soneri kes sundar disat aahet.) – Golden hair looks beautiful. *(*" `₹ ` " – Golden hair - is the noun phrase. " ` " - hair - is the head noun, and " न " – Golden - derived from the noun " न` " – gold - acts as an adjective modifier.)

दT ₹ : T द U OT. (Kagdi pishvi dya.) - Give me a paper bag. *(*" T द U " – paper bag - is the noun phrase. " U " – bag - is the head noun, and " T द " – papered - derived from the ***noun*** " T द" – paper- acts as an adjective modifier.)

Other such Possessives are - U ₹ ` , T₹T¯ ¸T, U T¯ 5, U द T, द T, T U , TU `, U¸ U rT T ¯`, U`U U TU , T द U *etc.*

7. Noun with a Postpositional Phrase (U अD T¸ T T Ü - Shabdyogi Avyay Vakyaansh) acting as a Modifier:

दT ₹ : UT ` U U OT UT₹ आ `U. (Shaaletiil vidyaarthi hushaar aahet.) - The **students from the school** are intelligent. ("UT `U U OT " - students from the school - is the noun phrase. " OT " - students - is the head noun, and "UT `U U" - from the school - which includes the postposition "U U" - from/of - acts as a modifier.)

दT ₹ : O₹T T ₹KT ₹ T ₹ द आ `. (Gharachya magcha rasta shant aahe.) – The **road infront of the house is narrow** . ("O₹T T ₹KT ₹ T" – road infront of the house - is the noun phrase. "₹ T" - road - is the head noun, and "O₹T T ₹KT " – infront of the house - which includes the postposition " ₹KT" – infront - acts as a modifier.)

Other such Possessives are- ... T T KT, ... T ¸ KT, ... T ₹KT *etc.*

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8. Complex Noun Phrases (combinations of the above):

दT ₹ :U¸ T U T K T₹ ¸ ¸द्द आ `. (Tujhya lahan bahinichi navin car khup sundar aahe.) - **Your younger sister's new car is very beautiful.** ("U¸ T U T K T₹ " - Your younger sister's new car - is a complex noun phrase with possessive "U¸ T " (**Your**), adjective "U T " (**younger**), possessive " K " (**sister's**), and adjective " " (new) modifying the head noun " T₹" (car)

In such type of complex sentences there can be one or more adjectives, possessives with noun to form a complex phrase**.**

5. MethodologyforNounPhraseIdentificon

The process of noun phrase formation is based on sequential grammar framework. For this task, it is important to identify word groups. Phrasal rules have been made for noun phrase group formation. Phrasal rules scan the sentence from left to right. The appropriate POS category of the sentence words is determined.

After this, all the words of the sentence and their POS category are included in the sentence scanning process. Based on this, various grammatical components are formed. The sequence of phrase rules plays an important role in the formation of these grammatical components. The sequence of phrase rules is from fewer words to rules with more words.

Noun phrase rules have been divided into the following categories –

1. Possessivepronounanddemonstrative pronoun group formation –

These are used as options in noun phrases. These pronouns can be noun phrases in any order and any one of these pronouns or both pronouns can be part of a noun phrase. For the formation of these pronoun groups, the word group rules are applied to the appropriate sequences of words.

2. Numeral and Intensifier Group Formation–

Numeral and Intensifier words contain Numeral Adjective and Quantifier. Numerals have two parts – **(1) Indefinite Numerals:** This shows the quantity which is not definitely measured. For example- T ‰TU T ?(Some more examples of Indefinite Numerals ***are*** – many (,अ ` , , T, ¸ ) more(अ T ), some ( T ), less ( ) T OT ₹ T द`W O¸ U (All the students left the exam), T T ग · U¯) (We understand everything) L¡ T T / ¸T न r `` ग (one yard of cloth/a yard full of cloth)

(2) Definite Numerals- These numerals are countable with fixed quantity. These neumerals are of the following types (Guru, 2013) –

a. Qualitative

i. Integer Indicators - ए , द , U , KT₹/one, two, three, four etc.

ii. Fraction Indicators - ¸ T, अT T T, ए KU¸ T T Ü, U KU¸ T T Ü, अ K, द , TW /quarter, quarter, one and a quarter, two and a half etc.

Quarter/¼	T
Half / ½	अT T T
Three fourth¾	TW
Full	¸ T
One & quarter1 ¼	T
One & half 1 ½	द
Quarter to two 1 ¾	T `द
Two & quarter 2 ¼	T द
Two & half 2 ½	अ K
Quarter to three 2 ¾	T `U
Three & quarter 3 ¼	T U
Three & half 3 ½	T `U

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b. Repetitive - U`, द ₹`, U ₹`/first, second, fourth

c. Ordinal - द U, U U, K U/double, triple, four times

d. Collective Indicators - द , U , KT₹ /both, three of three, four of four

e. Each Numeral - ` /every

The quantifires can occurs individualy or in a combination of the above types but if all types of quantifiers occurs in a sententence then its order is something like this –

(Each Numeral) (non-integer) (integer) (repetitive) (ordinal) (collective)

"NCD" is the POS tag category for numeral adjective while "QTF" is the POS tag category for quantifier. "QTF" is related to quantity. For example, 9th, 90th, 10th, etc. will be tagged with QTF. Adding T, to the numeric word determines masculine gender while adding to it will make it feminine genderand ` neutral(10th/ 5T T, 5T , 5T `, 8th/ T, , `)

Numbers and punctuation marks are used in writing date and time.

For example, T 11 T न - न7` (11:25 am), ¸ T न T UT (2 pm) and

dates 22/04/2025, 22.04.2025, 22-04-2025, 22-ि -2025 etc. have POS category "NCD".

Regular Expression can be used to identify all the above types of categories.

· T `, 5 `, ¸ ` /fiftieth, first, second etc. are placed in the POS category "NCD" of numeral nouns. It has been identified through the paradigm table.

Range – **One**/Ц

Ц7	Masculine	Feminine	Neutral
Singular	Ц7T	Ц7	Ц7-
Plural	Ц7`	Ц7 T	Ц7`
5			
Singular	5 T	5	5 -
Plural	5 `	5 T	5 `
ЦT	Masculine	Feminine	Neutral
Singular	ЦT T	ЦT	ЦT ·
Plural	ЦT `	ЦB	ЦT `
Ц	Masculine	Feminine	Neutral
	Ц	Ц	Ц

2° **Two/** न

¸	**Masculine**	**Feminine**	**Neutral**
Singular	¸ T	¸	¸ ·
Plural	¸ `	¸ T	¸ `
	Masculine	**Feminine**	**Neutral**
Singular	T		·
Plural	T-	·	`
न	5	5	5

3. Three/U न

U	**Masculine**	**Feminine**	**Neutral**
Singular	U T	U ~@	U `
Plural	U `	U T	U `
U	**Masculine**	**Feminine**	**Neutral**
Singular	U `	U	U ·
Plural	U T-	U ·	U T-
U न	U5	U5	U5

4. **Four/** T

थ	**Masculine**	**Feminine**	**Neutral**
Singular	थT	थ	थ
Plural	थ`	T	थ`
	Masculine	**Feminine**	**Neutral**
Singular	`		·
Plural	T-	·	T-
T	T	T	T

5° **Five/** T

T	**Masculine**	**Feminine**	**Neutral**
Singular	T T	T	T ⟩ T ·
Plural	T 5	T 5	T 5
5T	**Masculine**	**Feminine**	**Neutral**
Singular	5T T	5T	5T ⟩ 5T ·

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Plural	5T5	5T5	5T5

After 4 from number 5 some fixed suffixes occurs with number to form their masculine, feminine and neuter numbering. These suffixes are - T/ /DT/ ▪ etc.(5th/ T T, 6th/ 5T T, U T T, T Tetc.)

First/ 5 T, Second/ ¸ T, Third/U T, Fourth/ थT, Fifth/ T T, Sixth/ 5T T, Eleventh/ T T, Hundredth/ ▪ T T

Adjective and relational adjectives are present in noun group optionally. There are zero or more adjectives in noun group. Sometimes verb acts as the noun which is called Verb adjective in adjective group such as- T T T ¸ गT/running boy, T T T 7T ¸ गT/running little boy. Verb adjective always comes before qualitative adjective.

There are many types of qualitative adjectives which are

time – new, old,
place – long, wide, high, low,
shape – round, oblique,
colour – red, yellow,
condition – lean, thin, heavy and
quality – true, lie, good, bad.

There is a definite order of these different types of qualitative adjectives.

n*umeral–place-time-shape-condition-colour-quality* such as –

1. U न नT T T T 7` T T 5`. (Three years old wide heavy red wooden table is in my house.)

There are some such relational words which join the noun behind it or the adjective used like a noun and the noun coming before it together(T, , `, T, ', Tग`, ¸ `, , T ,).

Its POS category has been kept as PSP<>REL. PSP<>REL works to join the words coming before and after it. The POS category of the word formed after joining is similar to the POS category of the word coming at the end. For example, the formation of –NNPP word group can be seen –

`T T T T

((T [NNPL] T [PSP<>REL] (T T [JJ] T [NNPP]) [NNPP]) [NNPP])

4. Noun and Pronoun –

Noun or Pronoun is an essential member of a noun group. Noun or Pronoun is the head of a noun group and is located at the right end of the group. After this, postposition and particles are placed in the particle category which is part of the noun group. They generally come after the postposition. Its POS category is specified as PRT.

Every component has a head word/term. Since Marathi is a head-end language, the head term of every component is always at the end of the group. The POS rank of the components is the same as the POS rank of the head term of the components. The process of formation of components is called chunking. Hence, every time during the sentence scan, some components are formed. The word groups thus formed and the remaining words which are not yet part of any word group will all form a word group in the next word scan. Thus, this process continues until the root node of the phrase is obtained.

The process of word grouping in the noun group finding system is 3-level. First of all, the process of formation of different types of groups is done on the basis of POS tag. In this, the sequence of phrase rules has been set using the **indexical grammar method**. During group formation, rules are executed in a fixed order due to which different components are formed by five types of chunking process. Noun group consists of five types of chunk sets. Noun group is obtained by adding these five sets. The words which take part in the formation of each chunk set cannot be a part of the chunk set formation in the next level process because these words are already members of some chunk set.

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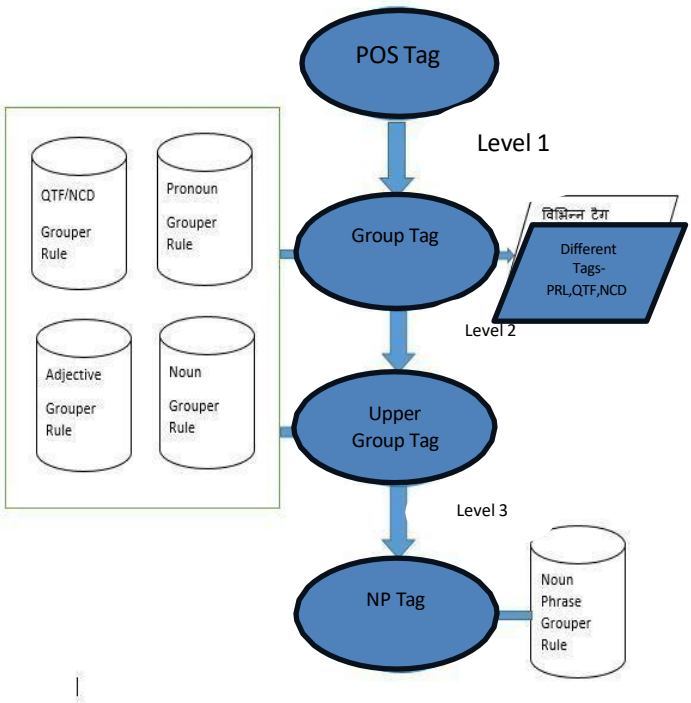
The words participating in each level will be those words which are not members of any chunk set till now and the chunk set tags formed in the previous level can also participate in the chunk set formation of the next level. In this way, chunk sets are formed at different levels. This process continues until the top tag NP of the noun group is obtained.

Flow chart of the process of noun phrase formation –

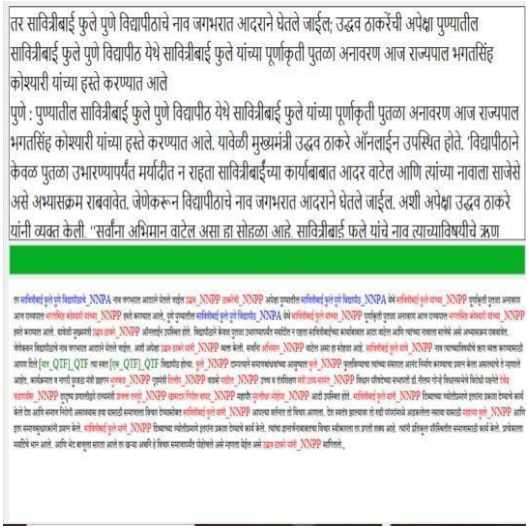


System Output :

parameters. The evaluation of the system on syntactic parameters was done by creating a confusion matrix for noun phrase (NP), adjective phrase (ADJP) and preposition parameters. The evaluation of the system on syntactic parameters was done by creating a confusion matrix for noun phrase (NP), adjective phrase (ADJP) and preposition phrase (PP). The percentage of precision, recall and F1-measure for each phrase was calculated from each confusion matrix. The F1-measure for noun phrase (NP), adjective phrase (ADJP) and preposition phrase (PP) was 0.92, 0.76, and 0.66 respectively. The

5. Evaluation and Conclusion:

The noun phrase detection system was tested on the development corpus of Marathi language. This corpus was developed by IIT MumbaiThe sentences selected for testing included simple, complex and compound sentences so that the system could be tested on all parameters. The evaluation of the system on syntactic parameters was done by creating a confusion matrix for noun phrase (NP), adjective phrase (ADJP) and preposition phrase (PP). The percentage of precision, recall and F1-measure for each phrase was


तर सावित्रीबाई फुले पुणे विद्यापीठाचे नाव जगभरात आदराने घेतले जाईल; उद्धव ठाकरेंची अपेक्षा पुण्यातील
सावित्रीबाई फुले पुणे विद्यापीठ येथे सावित्रीबाई फुले यांच्या पूर्णाकृती पुतळा अनावरण आज राज्यपाल भगतसिंह
कोश्यारी यांच्या हस्ते करण्यात आले
पुणे : पुण्यातील सावित्रीबाई फुले पुणे विद्यापीठ येथे सावित्रीबाई फुले यांच्या पूर्णाकृती पुतळा अनावरण आज राज्यपाल
भगतसिंह कोश्यारी यांच्या हस्ते करण्यात आले. यावेळी मुख्यमंत्री उद्धव ठाकरे ऑनलाईन उपस्थित होते. 'विद्यापीठाने
केवळ पुतळा उभारण्यापर्यंत मर्यादीत न राहता सावित्रीबाईंच्या कार्याबाबात आदर वाटेल आणि त्यांच्या नावाता साजेसे
असे अभ्यासक्रम राबवावेत. जेणेकरून विद्यापीठाचे नाव जगभरात आदराने घेतले जाईल. अशी अपेक्षा उद्धव ठाकरे
यांनी व्यक्त केली. "सर्वांना अभिमान वाटेल असा हा सोहळा आहे. सावित्रीबाई फुले यांचे नाव त्याच्याविषयीचे ऋण

overall performance of the system was shown as 0.90

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