FUNCTIONS OF THE RUSSIAN LANGUAGE

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The Integration of Mathematical Modeling and Classification in Russian Grammar Education: A Pathway to Enhanced Learning

The application of mathematical modeling and classification techniques to the study of Russian grammar offers a transformative approach to language acquisition, particularly for students with a background in mathematics and the sciences. Russian grammar, with its complex system of cases, declensions, and word transformations, can be challenging to master. By constructing mathematical models that represent these grammatical structures, educators can provide students with a systematic framework to understand and memorize rules. For instance, the six cases in Russian (nominative, genitive, dative, accusative, instrumental, and prepositional) can be modeled as a set of transformations, where each case represents a specific function or relationship within a sentence.

For mathematically inclined students, this approach aligns with their analytical strengths, enabling them to visualize grammar as a series of logical operations rather than abstract rules. Classification techniques, such as grouping nouns by their declension patterns or verbs by their conjugation types, further simplify the learning process. These methods not only enhance memorization but also foster a deeper understanding of the underlying logic of the language.

Moreover, integrating language and mathematics at an early age has broader educational benefits. It cultivates logical reasoning, pattern recognition, and problem-solving skills, which are essential for success in mathematics and related fields. By connecting the structured nature of language to mathematical principles, students develop a more holistic approach to learning, strengthening their ability to analyze and model complex systems.

In conclusion, the use of mathematical modeling and classification in teaching Russian grammar provides a powerful tool for students, particularly those from scientific disciplines. This interdisciplinary approach not only simplifies language acquisition but also reinforces critical thinking and mathematical skills, preparing students for *advanced academic and professional challenges. By bridging the gap between language and mathematics, educators can create a more engaging and effective learning experience for students of all ages.*

STRUCTURES:

First, the learner must become familiar with the rules and structures of the paper.

What are the symbols used for? What is a function, and how do these functions work?

*In both mathematics and linguistics, a **function** is an operator that transforms an input into a corresponding output according to a defined rule. Formally, a function f **maps** elements from a domain X to a codomain Y.*

$$f : X \to Y$$

- *A **washing machine** performs a function—it takes clothes, washes them, and returns them clean.*
- *A **mathematical function** operates similarly—it takes a number, transforms it, and yields a new number.*
- *A **case function** is an operator that transform a base word (lemma) into an inflected form, altering its syntactic role while preserving its semantic core.*

*In this process, **letters** (or variables) act as the changing elements. To simplify learning, we assign names to these **variables** (the letters that undergo modification) for clarity and consistency.*

*To rigorously model these transformations, we adopt a **functional** perspective, treating words as ordered sequences of variable segments subject to discrete transformations. Let:*

- ***α**: The root (invariant lexical core).*
- ***Ψ**: The pre-ending segment (may shift under inflection).*
- ***Ω/ω**: The ending (primary site of case-driven changes).*

A word's structure is thus:

$$X = \alpha \ldots \Psi\Omega$$

One of the challenges of learning the Russian language is the frequent changes in vocabulary, which can confuse readers and learners. In Russian, some words can take on more than six different forms, known as cases, depending on the context in which they are used. To learn Russian more easily, it helps to categorize these cases and understand how they work together. The difficulty in learning the language doesn't stop there; there are many exceptions to the rules for each case, making it even more challenging.

*To overcome these difficulties, we can follow two important principles: **modeling** and **classification**.*

First, we need to identify the relationships between these different cases and the rules governing them, and then classify them based on these relationships. This process involves not just recognizing the patterns but also creating functional rules that clearly show how words and their cases relate to each other.

To start, we must determine which types of words are affected by cases. In the Russian language, cases influence four main categories of vocabulary: 1) nouns, 2) numbers, 3) adjectives 4) pronouns. Additionally, there are other groups that behave like adjectives, including active and passive participles.

*Next, we can break these categories into smaller subgroups, which is **classification**. This classification will include the following distinctions:*

1. ***Singular-Plural** (X-x)*
2. ***Feminine-Masculine-Neuter** (W-M-N)*
3. ***Animate-Inanimate** (L-D)*

With these foundations established, we can begin to explore the patterns in how cases functioned and organize them into meaningful categories.

The changes that occur at the end of a word based on its role in a sentence are known as "cases." We can represent the general changes of words in the case system using the function "$\Pi(x)$" ,where the Greek letter pi represents changes in cases and "x" stands *for any word that can change forms based on its case. In this function, "x" is always in its base form, which is the same as the nominative case (the form of the word used as the subject in a sentence).*

$$x = E(x)$$

In this formula, the function "E" represents the nominative case, also known as the subjective case. In this discussion, each of the six case functions is denoted by its initials in Russian:

- ***Nominative Case:*** *E(x)*
- ***Genitive Case:*** *R(x)*
- ***Dative Case:*** *D(x)*
- ***Accusative Case:*** *V(x)*
- ***Instrumental Case:*** *T(x)*
- ***Prepositional Case:*** *P(x)*

In all of these functions, an unmarked function signifies the singular form, while the notation "ΣΠ(x)" indicates the plural function.

Another crucial aspect of identifying patterns in these functions is the consideration of prepositions. The presence or absence of prepositions can completely alter the meaning, significance, and position of a word in a sentence. Therefore, it is important to note that these functions are intended to help readers understand how words transform across different cases, while the meaning and usage context do not affect the underlying function.

One step in classifying these functions involves examining the equivalence between them. This equivalence demonstrates that two different functions can apply to the same words under the same conditions, even though the meanings and roles of these words in the sentence may differ.

A significant point of consideration is the presence of exceptions, particularly when the plural form of a word in the nominative case exhibits irregularities. These irregularities can often extend to other case functions as well.

Initially, we will focus on how these case functions interact with vocabulary and adjectives, and subsequently explore their conceptual differences, both with and without the use of prepositions.

The first function we will study is the nominative function. This function affects words that serve a subjective role in the sentence. A key characteristic of this function is that for each input, whether it is a noun or an adjective, it produces the same output. This principle can be represented as follows:

$$x = E(x)$$

This principle is not related to gender, quantity, or even the types of nouns and adjectives; it is a fixed principle. For example, the nominative function of the word "Студент" (student) is the same as the word itself:

$$E(\text{Студент}) = \text{Студент}$$

Since the nominative function is independent of the type and role of the noun, it changes only in two cases: singular and plural. The relationship between the plural and the singular form can be expressed as follows:

$$\Sigma E(x) = x + \text{Ы}, \text{И}$$

Using the same example, the plural form of "студент" is "студенты," so we have:

$$\Sigma E\ (\text{Студент}) = \text{Студенты}$$

However, it is important to note that if the word is feminine, the feminine ending must be removed before applying the plural endings. The rules for forming the plural are as follows:

$$\text{if } x \text{ is } M \quad \Sigma E(x) = x - (\text{й}, \text{ий}) + \text{ы}, \text{и}$$

$$\text{if } x \text{ is } W \quad \Sigma E(x) = x - (\text{а}, \text{я}, \text{ия}) + \text{ы}, \text{и}$$

$$\text{if } x \text{ is } N \quad \Sigma E(x) = x - (\text{о}, \text{и}, \text{ие}) + \text{а}, \text{я}$$

It is also essential to recognize that nouns in the Russian language change in the plural form based on their nominative form. Thus, instead of using the plural form directly, we refer to the nominative form:

$$\Sigma E(x) = X$$

In fact, all case functions can be considered polynomial functions that change according to gender, role, and number of words.

These rules apply to the nominative function when the variable in question is a noun. However, if the variable is an adjective, numeral, or participle, how does the function change? To address this question, we first establish an equivalence function to simplify the analysis. All of the aforementioned variables (adjectives, numerals, and descriptive aspects) change similarly to adjectives. Therefore, we can derive an equivalence among all of them:

$$\Pi(Adj) \sim \Pi(Num) \sim \Pi(Par)$$

In this equation, the pi function represents the case functions. From this point onward, we will use the letter "a" to denote each of these variables. This follows the same fundamental principle of the nominative function, where the value of each variable is equal to the variable itself:

$$E(a) = a$$

Thus, for the adjectives in the nominative case, we have:

If x is M $\quad \Sigma E(a) = a - (\text{ыи, ой, ий}) + \text{ые, ие}$

If x is W $\quad \Sigma E(a) = a - (\text{ая, яя}) + \text{ые, ие}$

If x is N $\quad \Sigma E(a) = a - (\text{ое, ее}) + \text{ые, ие}$

In this pattern, words ending in "ь" are not included because they are studied separately in the exceptions section. Additionally, masculine words that behave like feminine words are treated as feminine in this context.

Case functions that include prepositions take on new meanings and uses. It is noteworthy that the nominative case does not accommodate any additional letters in its structure.

Genitive Function

The possessive function is one of the most commonly used cases in the Russian language. This function provides a "prepositional role" or indicates possession. Unlike *the nominative function, the possessive function exists in two modes: with and without prepositions. This distinction creates various concepts associated with this function, including references to place, time, quantity, absence, ownership, and more.*

The general form of the genitive case is as follows: when two or more nouns are combined, the desired case affects only the first word, while the subsequent words all take the form of the genitive case. If an adjective is attached to the second noun or beyond, it will also conform to the genitive case.

$$x_1 + x_2 + x_3 + \cdots$$

Only the first word changes in different forms based on its role in the sentence, while the other words take the form of the genitive case. This can be represented as follows:

$$\Pi(x_1) + R(x_2) + R(x_3) + \cdots$$

Functional Equivalences:

This function has two general forms in the singular, and this is because it acts similarly on masculine and neuter nouns. Thus, we can state that the function is equivalent for masculine and neuter gender variables in the singular:

$$R(x_m) \sim R(x_n)$$

For singular values, the genitive function is as follows:

If x is M $\quad R(x) = x - (\text{й, ь , ий}) + (\text{а , я , ия})$

If x is W $\quad R(x) = x - (\text{а, я,ия, ь}) + (\text{ы ,и, ии})$

If x is N $\quad R(x) = x - (\text{о, е , ие}) + (\text{а , я , ия})$

In contrast to singular nouns, the plural forms of neuter and feminine nouns change similarly and have equivalent forms:

$$\Sigma R(x_m) \sim \Sigma R(x_n)$$

Therefore, we have the genitive state for the plural:

If x is M $\quad \Sigma R(x) = X - (\text{а, я, и, ы}) + \text{ов, ев, ей}$

If x is W $\quad \Sigma R(x) = X - (\text{ы , и, }) + \text{-, ь, ий, ей}$

If x is N $\quad \Sigma R(x) = X - (\text{а, я, и, ы}) + \text{-, ей, ий}$

The genitive function and the object function are the only cases where, in the plural form, the number of letters may remain unchanged or decrease. This phenomenon occurs in the plural case of feminine and neuter nouns!
For singular adjectives in the possessive case, we have

$$\text{If } x \text{ is } M \qquad R(a) = a - (\text{ыи, ой, ий}) + \text{ого, его}$$
$$\text{If } x \text{ is } W \qquad R(a) = a - (\text{ая, яя}) + \text{ой, ей}$$
$$\text{If } x \text{ is } N \qquad R(a) = a - (\text{ое, ее}) + \text{ого, его}$$

It is clear that neuter nouns and adjectives in the singular state always change in the same way. Therefore, this equivalence can be extended to all cases:

$$\Pi(x_m) \sim \Pi(x_n) \quad \text{and} \quad \Pi(a_m) \sim \Pi(a_n)$$

As we have studied the plural form of adjectives in the possessive case, we observe that their endings follow a general rule. To articulate this general rule, we can simply remove the "base of the word" and add the appropriate suffix for each case. This rule applies to all plural cases. From this point forward, we will use the Greek letter "omega" (Ω) to refer to the base of the word. Thus, we have:

$$\Sigma R(a) = A - \Omega + \text{ых, их}$$

*The **Dative** function represents the third addition in the Russian language, playing the role of a complement or indirect object. The key distinction between these terms and the direct object is that complements can be removed without rendering the sentence meaningless. In contrast, omitting the object makes the sentence incomplete. This functions as a complement without a preposition, but in translation, it often includes the preposition "to."*
So for singular values, we have a supplementary function:

$$\text{If } x \text{ is } M \qquad D(x) = x - (\text{-, й, ь , ий}) + (\text{у, ю, ию})$$
$$\text{If } x \text{ is } W \qquad D(x) = x - (\text{а, я, ия, ь}) + (\text{е, и, ии})$$
$$\text{If } x \text{ is } N \qquad D(x) = x - (\text{о, е , ие}) + (\text{у, ю, ию})$$

For addition values, we can write a general rule:

$$\Sigma D(x) = X - \Omega + \text{ам, ям}$$

And for the singular adjectives in dative case we have :

$$\text{If } x \text{ is } M \qquad D(a) = a - (\text{ыи, ой, ий}) + (\text{ому, ему})$$

$$\text{If } x \text{ is } W \qquad D(a) = a - (\text{ая, яя}) + (\text{ой, ей})$$

$$\text{If } x \text{ is } N \qquad D(a) = a - (\text{ое, ее}) + (\text{ому, ему})$$

For the plural form, a comprehensive formula can be written:

$$\Sigma D(a) = A - \Omega + \text{ым, им}$$

*The **Accusative** function can be understood as the outcome of combining both the nominative function and the genitive function. It is specifically used to introduce the object in a sentence without relying on a preposition. The absence of this function renders the sentence incomplete, making it meaningless if the object is omitted.*
This function exhibits dual behavior based on whether the input variable is animate (alive) or inanimate (non-living). However, the equivalence between these two categories arises only in certain cases and should not be generalized. The rules governing the object function are as follows:

$$\text{if } x \text{ is } L:$$

$$\text{If } x \text{ is } M \qquad V(x) \sim R(x)$$

$$\text{If } x \text{ is } W \qquad V(x) = x - (\text{а, я, ия, ь}) + (\text{у, ю , ию, ь})$$

$$\text{If } x \text{ is } N \qquad V(x) \sim E(x)$$

And if the variable is non-living, we have:

$$\text{if } x \text{ is } NL:$$

$$\text{If } x \text{ is } M \qquad V(x) \sim E(x)$$

$$\text{If } x \text{ is } W \qquad V(x) = x - (\text{а, я, ия, ь}) + (\text{у, ю , ию, ь})$$

$$\text{If } x \text{ is } N \qquad V(x) \sim E(x)$$

Nouns also show the same behavior in the plural form, so we have:

$$\text{if } x \text{ is } L:$$

$$\text{If } x \text{ is } M \qquad \Sigma V(x) \sim \Sigma R(x)$$

$$\text{If } x \text{ is } W \qquad \Sigma V(x) \sim \Sigma R(x)$$

$$\text{If } x \text{ is } N \qquad \Sigma V(x) \sim \Sigma E(x)$$

But if the noun is not animate, the accusative function is completely equivalent to the nominative function:

$$\text{if } x \text{ is } NL:$$

$$\Sigma V(x) \sim \Sigma E(x)$$

Adjectives follow the same rule and the function is written for them in two ways:

$$\text{if } a \text{ is } L:$$

$$\text{If } a \text{ is } M \qquad V(a) \sim R(a)$$

$$\text{If } a \text{ is } W \qquad V(a) = a - (\text{а, я, ия, ь}) + (\text{ую , юю})$$

$$\text{If } a \text{ is } N \qquad V(a) \sim E(a)$$

And if the variant of the adjective is non-living, we have:

$$\text{if } a \text{ is } NL:$$

$$\text{If } a \text{ is } M \qquad V(a) \sim E(a)$$

$$\text{If } a \text{ is } W \qquad V(a) = a - (\text{а, я, ия, ь}) + (\text{ую , юю})$$

$$\text{If } a \text{ is } N \qquad V(a) \sim E(a)$$

For the plural state of the accusative function, we have living attributes:

$$\text{if } a \text{ is } L:$$

$$\text{If } a \text{ is } M \qquad \Sigma V(a) \sim \Sigma R(a)$$

$$\text{If } a \text{ is } W \qquad \Sigma V(a) = a - (\text{а, я, ия, ь}) + (\text{ую , юю})$$

$$\text{If } a \text{ is } N \qquad \Sigma V(a) \sim \Sigma E(a)$$

For the same function, we have non-living nouns:

$$\text{If } x \text{ is } NL:$$

$$\Sigma V(a) \sim \Sigma E(a)$$

The ***Instrumental*** *case, also known as the state case, typically indicates the condition or state under which an action is performed. It describes how or by whom an action is carried out and can convey different meanings when used with or without a preposition. For singular nouns and adjectives, we can outline the function and structure of this case as follows:*

$$\text{If } x \text{ is } M \qquad T(x) = x - (\text{-, й, ь , ий}) + (\text{ом, ем, ём, ием})$$

$$\text{If } x \text{ is } W \qquad T(x) = x - (\text{а, я, ия, ь}) + (\text{ой, ей, ью, ией})$$

$$\text{If } x \text{ is } N \qquad T(x) = x - (\text{о, е , ие}) + (\text{ом, ем, ием})$$

And for the plural form, we can write a general formula:

$$\Sigma T(x) = X - \Omega + \text{ами, ями}$$

And for singular adjectives in this case, we have:

$$\text{If } x \text{ is } M \qquad T(a) = a - (\text{ыи, ой, ий}) + (\text{ым, им})$$

$$\text{If } x \text{ is } W \qquad T(a) = a - (\text{ая, яя}) + (\text{ой, ей})$$

$$\text{If } x \text{ is } N \qquad T(a) = a - (\text{ое, ее}) + (\text{ым, им})$$

A general formula can also be used for their plural state:

$$\Sigma T(a) = a - \Omega + \text{ыми, ими}$$

The ***Prepositional*** *case, known as "предложный падеж" in Russian, is the sixth and final case in the Russian language. A major difference between this case and other cases is that it is always used with a preposition. This case provides crucial information regarding the location or person involved and helps explain the context of a sentence:*

$$P(x) = x - \Omega + (е, и)$$

For the plural form, a general rule can be applied as follows:

$$\Sigma P(x) = X - \Omega + (ах, ях)$$

And for singular adjectives, in this case we have:

$$\text{If } x \text{ is } M \qquad P(a) = a - (ыи, ой, ий) + (ом, ем)$$

$$\text{If } x \text{ is } W \qquad P(a) = a - (ая, яя) + (ой, ей)$$

$$\text{If } x \text{ is } N \qquad P(a) = a - (ое, ее) + (ом, ем)$$

For adjectives in the plural form, the following general formula can be used:

$$\Sigma P(a) = A - \Omega + (ых, их)$$

*Each word that is placed in the Russian case system undergoes changes, and by examining these changes, we can identify patterns that make language learning easier and more systematic. To begin with, it is important to note that the **Nominative** case (падеж) is always the cornerstone for nouns, and the changes associated with other cases are based on it. Additionally, many irregularities in these functions can be observed by examining the **Nominative** case. It is crucial to mention that this review does not include exceptions that manifest themselves in the masculine form.*

*One of these irregularities appears in the plural state, culminating in **Genitive** system, where the most notable irregularities are found among the cases. In many languages that lack a case system, the endings of words can exhibit various forms and irregularities. In contrast, in the Russian language, it is the endings of each word that reveal its gender, number, role, and case in the sentence. In the previous discussion, we explained that in the different functions of the last word, it is the last word that changes. In plural forms, the ending is particularly important.*

*We denote the word ending affecting the plurality with the capital Greek letter **Ω** (omega), while the singular word ending is represented by the lowercase Greek letter **ω**. Additionally, we introduce another part of the word structure: the prefix before the letter before word ending, which we denote with the capital Greek letter **Ψ** (psi).*

To outline the overall structure of a word, we present it as follows:

$$x = \alpha ... \Psi\omega \qquad X = \alpha ... \Psi\Omega$$

*Here, **α** represents the root of the word, **Ψ** signifies the pre ending letter, and **Ω/ω** represents the ending of the word.*

*The foundation of changes for nouns and adjectives in their various functions is based on the singular form and its plural form in the **Nominative** case. Thus, we can express this as:*

$$E(x) = x \quad , \Sigma E(x) = X$$

*Where **x** is the singular form of the word in the **Nominative** case, and **X** is the plural form of the same word in the **Nominative** case.*

To categorize irregularities, we apply the same two principles mentioned earlier:

1. ***Modeling***
2. ***Classification***

The first function is the **Nominative** *function, in which each word remains equal to itself in both singular and plural forms, without alteration. However, the plural form in the plural case represents a function of the singular state, which can be expressed in the following general form:*

$$\Sigma E(x) = x + ы,\ и$$

For example, the word " студент" is written in the plural form as " студенты", so we have:

$$\Sigma E(студент) = студент + ы$$

However, these two cases are not the only plural states in the **Nominative** *case, and the bottom of the word can be changed to "а" or "я", so the general formula for the changes can be written as follows:*

$$\Sigma E(x) = x + ы,\ и,\ а,\ я$$

Of course, this includes exceptions that will not be mentioned in the section.

Now let's look at the changes of nouns in the plural form without considering the exceptions:

$$\Sigma E(M):\ \begin{array}{ll} if\ \omega = 0 & \Sigma E(x) = x + ы,\ и \\ if\ \omega = й & \Sigma E(x) = x - й + и \\ if\ \omega = ь & \Sigma E(x) = x - ь + и \end{array}$$

Here it can be seen that if the root of the word is zero, there are two situations, the reason is that if the root of one of the letters is: "Г, К, Х, Ж, Ч, Ш, Щ", then these letters cannot be used "ы", and in the plural case, "и" should be used at the end of the word, so we have:

$$if\ \Psi = к,г,х,ч,ж,ш,щ:\qquad \Sigma E(x) = x + и$$

And for the feminine plurals, we have:

$$\Sigma E(W): \begin{cases} \text{if } \omega = а & \Sigma E(x) = x - а + \text{ ы, и} \\ \text{if } \omega = я & \Sigma E(x) = x - я + и \\ \text{if } \omega = ь & \Sigma E(x) = x - ь + и \end{cases}$$

*In the case where the sai for the omegas "a" is equal to the "**stressed letters**" , we use "и" for the plural form.*

For neutral plural nouns we have:

$$\Sigma E(N): \begin{cases} \text{if } \omega = о & \Sigma E(x) = x - о + а \\ \text{if } \omega = е & \Sigma E(x) = x - е + я \\ \text{if } \omega = мя & \Sigma E(x) = x - мя + мени \end{cases}$$

***Genitive** case is the most complex function among these cases, which has the most variations.*

*Now let's look at the changes in **Genitive** case.*

For the masculine singular, we have:

$$R(M): \begin{cases} \text{if } \omega = 0 & R(x) = x + а \\ \text{if } \omega = й & R(x) = x - й + я \\ \text{if } \omega = ь & R(x) = x - ь + я \end{cases}$$

Regarding the feminine gender, it should be noted that like all changes in the nouns of the Russian language, the pronunciation of each word affects its structure:

$$\text{if } \Psi = к,г,х,ч,ж,ш,щ \quad : R(x) = x - а + и$$

The last word becomes "и", otherwise we have:

$$R(W): \begin{cases} \text{if } \omega = а & R(x) = x - а + \text{ и, ы} \\ \text{if } \omega = я & R(x) = x - я + и \\ \text{if } \omega = ь & R(x) = x - ь + и \end{cases}$$

The neutral gender also changes in all cases, whether in the singular or plural, in the same way as the masculine gender:

$$R(N):\quad \begin{array}{ll} if\ \omega = о & R(x) = x - о + а \\ if\ \omega = е & R(x) = x - е + я \\ if\ \omega = мя & R(x) = x - мя + мени \end{array}$$

The plural functionis using the plural form of nouns, but what is meant by the bottom of the word is in the singular, so note that the first omega is the bottom of the word in the singular and the second omega is the bottom of the word in the plural form:

$$R(M):\quad \begin{array}{ll} if\ \omega = 0 & \Sigma R(x) = X - \Omega + ей \\ (\Psi = ж,ч,ш,щ,ь) & \\ if\ \omega = 0 & \Sigma R(x) = X - \Omega + ев \\ (\Psi = ц) & \\ if\ \omega = 0 & \Sigma R(x) = X - \Omega + ов \\ if\ \omega = й & \Sigma R(x) = X - \Omega + ев \end{array}$$

For the plural form of feminine nouns we have:

$$R(W):\quad \begin{array}{ll} if\ \ \omega = а & \Sigma R(x) = x - а \\ if\ \omega = я & \Sigma R(x) = x - я + ь \\ if\ \omega = ия & \Sigma R(x) = x - ия + ий \\ if\ \omega = ь & \Sigma R(x) = x - ь + ей \end{array}$$

It should be noted that in the case where the ending of the word is equal to "a", there are cases in which two consonant letters are put together, such as the following pattern:

... CCa

In this case, after deleting "a", the two consonant letters are put together, for solving pronunciation problem between those two letters, one of the two letters placed with "o" or "e":

$$... CC+a = C+ o, e + C$$

For the plural form, neutral nouns we have:

$$R(N): \begin{cases} \text{if } \omega = о & \Sigma R(x) = x - о \\ \text{if } \omega = е & \Sigma R(x) = x - е + ей \\ \text{if } \omega = ие & \Sigma R(x) = x - ие + ий \end{cases}$$

In neutral nouns, the same rule for the plural of feminine nouns is repeated when the last two letters are silent, so we have:

$$... CC+ о = C+ о, е + C$$

Now, let's examine the changes in masculine singular nouns in the ***Dative*** *case:*

$$D(M): \begin{cases} \text{if } \omega = 0 & D(x) = x + у \\ \text{if } \omega = й & D(x) = x - й + ю \\ \text{if } \omega = ь & D(x) = x - ь + ю \end{cases}$$

For feminine singular nouns, we have:

$$D(W): \begin{cases} \text{if } \omega = а & D(x) = x - а + е \\ \text{if } \omega = я & D(x) = x - я + е \\ \text{if } \omega = ия & D(x) = x - ия + ии \\ \text{if } \omega = ь & D(x) = x - ь + и \end{cases}$$

For singular, neutral nouns we also have:

$$D(N): \begin{cases} \text{if } \omega = о & D(x) = x - о + у \\ \text{if } \omega = е & D(x) = x - е + ю \\ \text{if } \omega = мя & D(x) = x - мя + мени \end{cases}$$

Now let's look at the plural state of nouns in the ***Datvie*** *case, which is much simpler than it seems, and we examine this state independently of the genus, so we have that:*

$$\text{if } \omega = 0 \qquad \Sigma D(x) = x + ам$$

$$\text{if } \omega = а \qquad \Sigma D(x) = x - а + ам$$

$$\text{if } \omega = о \qquad \Sigma D(x) = x - о + ам$$

For other amounts of omegas, we have:

$$\Sigma D(x) = X - \Omega + ям$$

*It should also be noted that, as mentioned previously, exceptions primarily occur in the masculine plural forms. Some nouns that end in **я** in the plural form also end in **ям** in the plural case of the **Dative** case. These exceptions will be addressed in future discussions.*

*Now that we have examined the **Nominative** case and the **Genitive** case , it is important to understand that the **Accusative** case functions as a combination of these two cases. The changes in the **Accusative** case depend on whether the noun is animate (living) or inanimate (non-living). Notably, it is only the singular feminine form that takes on a unique ending.*

For non-living masculine nouns, we can express the changes in the singular as follows:

$$\text{if } x = NL \qquad V(x) \sim E(x)$$

For living males in the singular, we have:

$$\text{if } x = L \qquad V(x) \sim R(x)$$

For singular feminine nouns, whether living or non-living, we have:

$$V(W):\quad \begin{array}{ll} \text{if } \omega = a & V(x) = x - a + y \\ \text{if } \omega = я & V(x) = x - я + ю \\ \text{if } \omega = ь & V(x) = x \end{array}$$

In neutral nouns, we have the same equivalence with the subject antidote:

$$V(x) \sim E(x)$$

*For the plural case, in all genera, if it is non-living, the same currency is the **Nominative** function, and if it is alive, the same currency is the **Genitive** function:*

$$\text{if } x = NL \qquad \Sigma V(x) \sim \Sigma E(x)$$

$$\text{if } x = L \qquad \Sigma V(x) \sim \Sigma R(x)$$

The next function is the ***Instrumental*** *function, which we are going to examine for the masculine singular:*

$$T(M):\quad \begin{array}{ll} \text{if } \omega = 0 & T(x) = x - \Omega + ом \\ \text{if } \omega = 0 & T(x) = x - \omega + ем \\ (\Psi = ж,ц,ч,ш,щ) & \\ \text{if } \omega = й & T(x) = x - \Omega + ем \\ \text{if } \omega = ь & T(x) = x - \Omega + ем \end{array}$$

For the feminine singular, we have:

$$T(W):\quad \begin{array}{ll} \text{if } \omega = а & T(x) = x - а + ой \\ \text{if } \omega = а & T(x) = x - а + ей \\ (\Psi = ж,ц,ч,ш,щ) & \\ \text{if } \omega = я & T(x) = x - я + ей \\ \text{if } \omega = ия & T(x) = x - ия + ей \\ \text{if } \omega = ь & T(x) = x - ь + ью \end{array}$$

For the singular neutral nouns, it is much simpler, just add the letter "м" to the end of them:

$$T(N) = x + м$$

And if the end of the noun ends in "мя", we have it as follows:

$$\text{if } \omega = мя \qquad T(x) = x - мя + менем$$

For the plural nouns, we have the following:

$$\begin{array}{ll} \text{if } \omega = 0 & \Sigma T(x) = x + ами \\ \text{if } \omega = а & \Sigma T(x) = x - а + ами \\ \text{if } \omega = о & \Sigma T(x) = x - о + ами \end{array}$$

For other amounts of "omegas, we have":

$$\Sigma T(x) = X - \Omega + ями$$

The last case is also known as ***Prepositional*** *function, which except for some masculine singular nouns that change to "у", other nouns take the same undertone as "е":*

$$P(M) = x - \omega + е$$

For nouns, we also have a singular feminine:

$$P(W): \begin{array}{ll} if\ \omega = а & P(x) = x - а + е \\ if\ \omega = я & P(x) = x - я + е \\ if\ \omega = ия & P(x) = x - ия + ии \\ if\ \omega = ь & P(x) = x - ь + и \end{array}$$

For singular nouns, we have neutral gender:

$$P(N): \begin{array}{ll} if\ \omega = о & P(x) = x - о + е \\ if\ \omega = е & P(x) = x \\ if\ \omega = ие & P(x) = x - ие + ии \\ if\ \omega = мя & P(x) = x - мя + мени \end{array}$$

For the plural mode, the following general rule applies regardless of gender:

$$\begin{array}{ll} if\ \omega = 0 & \Sigma P(x) = x + а\ \ х \\ if\ \omega = а & \Sigma P(x) = x - а + ах \\ if\ \omega = о & \Sigma P(x) = x - о + ах \end{array}$$

For other amounts of omegas, we have:

$$\Sigma P(x) = X - \Omega + ях$$