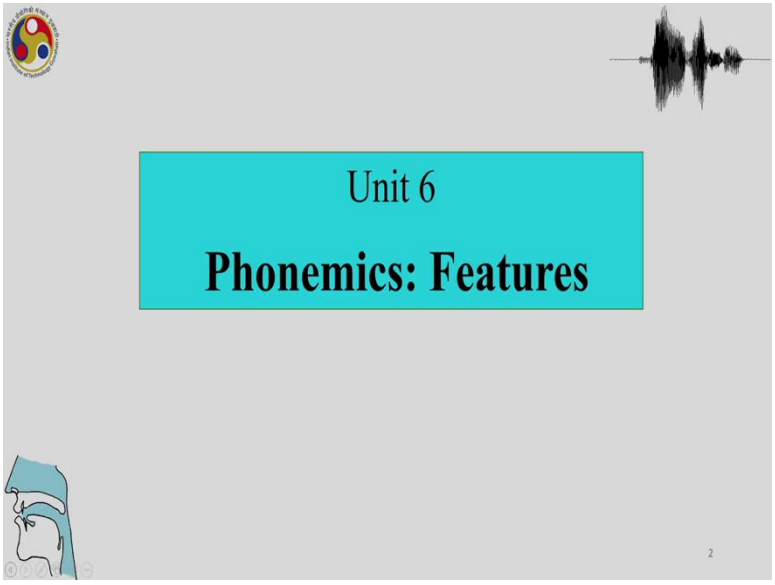
Phonetics and Phonology: A broad overview
Professor Shakuntala Mahanta
Department of Humanities and Social Sciences
Indian Institute of Technology Guwahati
Lecture 19
Distinctive Features and natural classes

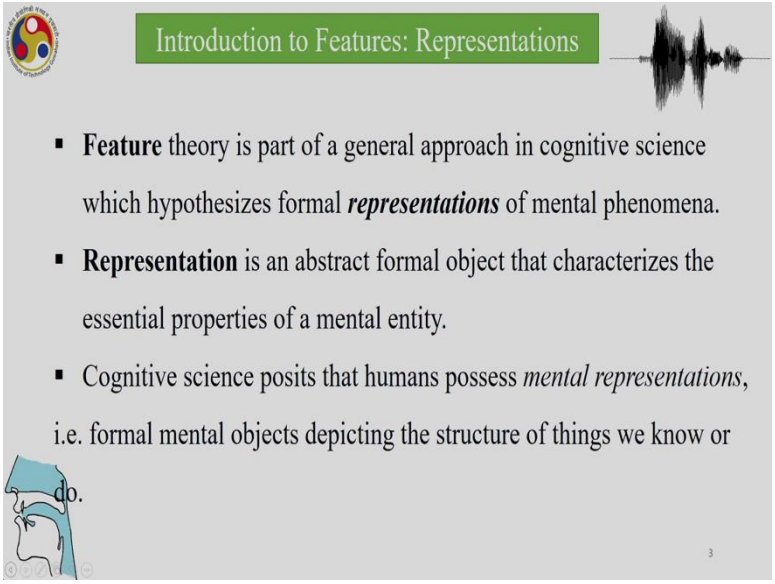
Welcome to this NPTEL Massive Online Open Course. And this course is on Phonetics and Phonology a broad overview; we have been looking at Phonology.

(Refer Slide Time: 00:42)



And we have looked at Phonemics in the last class. And in this lecture, we will look at Features in more detail. So, we have talked about distinctive Features in our various lectures when we are talking about Phonology, about formalizing the properties of phonemes etcetera, we are talking about Features. So, today you will see how Features are used and what are the components of a Feature theory.

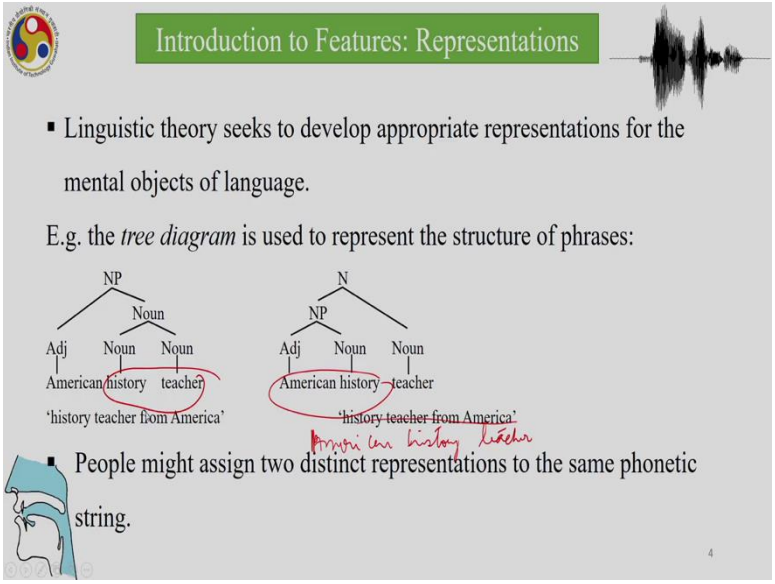
(Refer Slide Time: 01:16)



So, Feature theory is part of a general approach in cognitive science, which hypothesizes formal representations of mental phenomena. So, a representation is considered to be an abstract object that characterizes the properties of a mental entity. And cognitive science posits that humans possess mental representations, that is formal mental objects depicting the structure of things we know or do.

And one of the things we know we have knowledge of as humans is the knowledge of language. Knowledge and the knowledge of language is sought to be represented in terms of Features. And what do the Features represent? The components of sounds, formalizing the components of sounds.

(Refer Slide Time: 02:11)

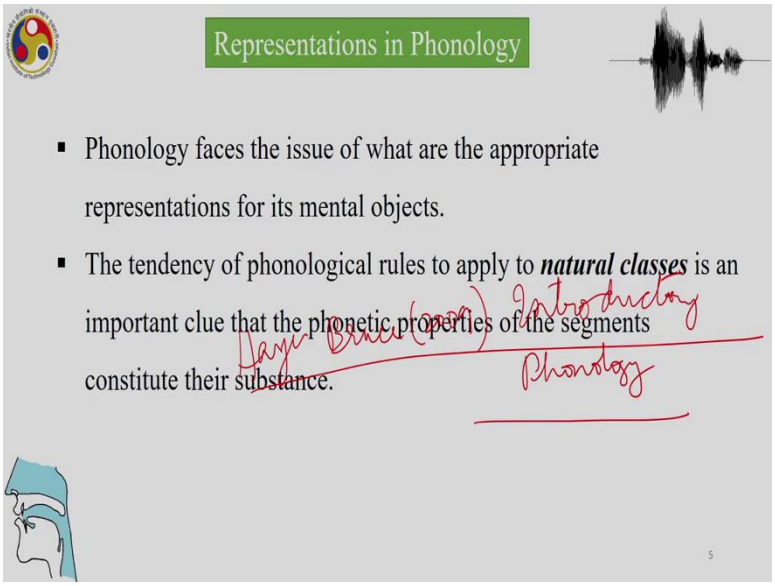


And as we have just been explaining, linguistic theory seeks to develop appropriate representations for the mental objects of language. And this diagram, there is a tree diagram to represent phrases, those of you who are acquainted with linguistics would know that how do we represent a noun phrase, or we represent structures, phrases, clauses, we use tree diagrams to show where the nodes of the different parts of a phrase or clause, that the higher nodes, the low nodes, and how the parts are linked.

This is shown with the help of tree diagrams, which show that if there is one phrase 'American history teacher', it can have to potentially have two meanings were in one representation, you will see that it means history teacher from America, or one could mean teacher which teaches your American history and an American history teacher.

And this would mean an American history teacher where American history forms one node, and then we have another one, which shows that this part, this noun phrase, history teacher is qualified by American, which shows that the history teacher is from America. And this is a representation showing the different nodes. And again, as we are talking about representations, this is a way of representing those structures, and two distinct representations to the same phonetic string.

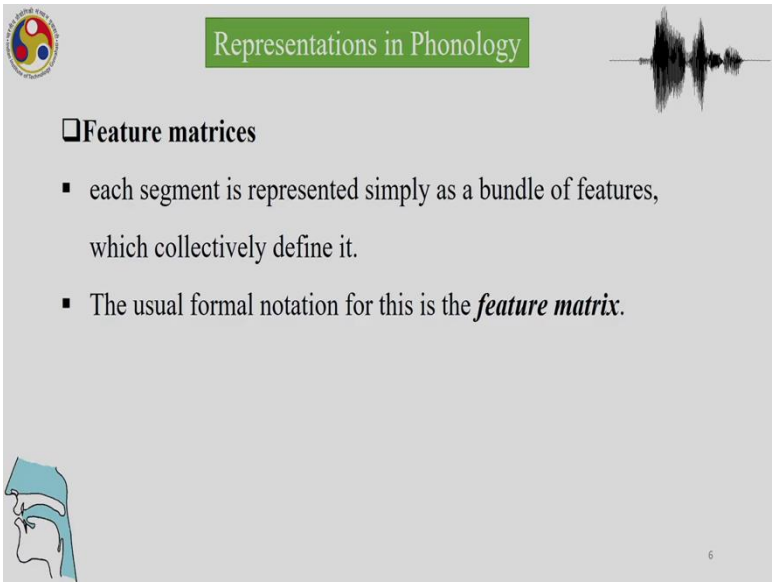
(Refer Slide Time: 03:54)



And now, we talk about representations in Phonology. Phonology faces the issue of what are the appropriate representations for its mental objects. Before we go on further, many of this lecture is based on Hayes Bruce 2009, Introductory Phonology. And for more details about the concepts, the ideas that we are talking about, you can follow this book, which is available for purchase. So, the tendency of phonological rules to apply to natural classes is an important clue that phonetic properties of the segments constitute their substance.

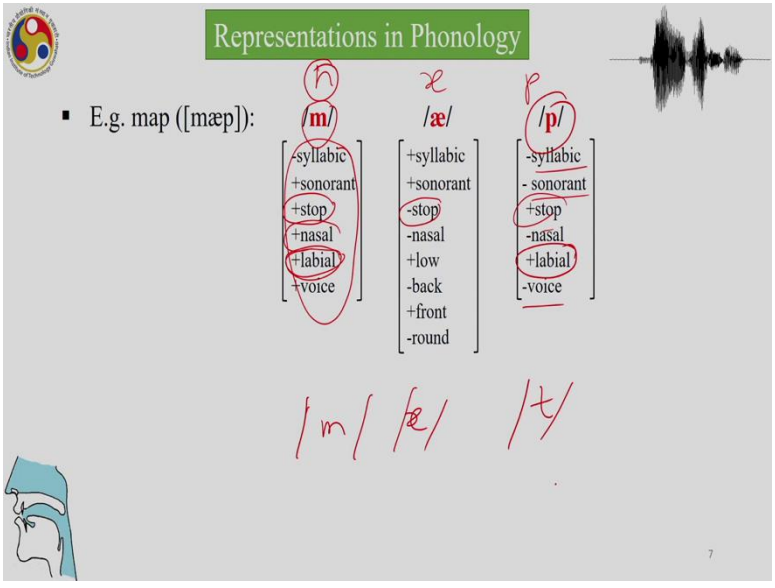
So, one important aspect of phonological rule application is that they apply to groups of sounds and that is repeated in language and the groups are also seen to know very much, so the differences are not large when phonological rules apply in one language, and when we look at another language where the rule is applying the classes match, and that is where the idea of natural classes spring from. And that is an important clue that phonetic properties of segments constitute their substance.

(Refer Slide Time: 05:23)



So, Feature matrices, so we talked about Feature matrices when we talked about Jakobson and Halle Features a representation of Features, so that was the initial conceptualization of the idea of Feature matrices, which is a seen a lot of development over the years in Phonology. And each segment is represented simply as a bundle of Features, which collectively define it. And usual formal notation for this is the feature matrix.

(Refer Slide Time: 05:52)



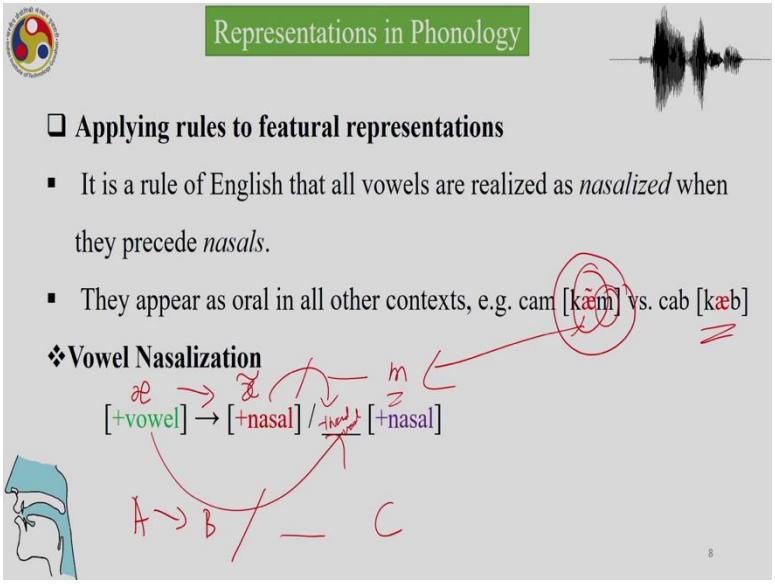
This is how we would differ the English word map, or if this English word map was for instance, nap, or if this English word was mat, how would these representations change? Now this phonemena is supposed to have these abstract representations, it is minus syllabic, we will

come to what is the sonorant? So, all these categories like stop, whether is it possible to say plus top or minus top or the other categories extra, we will talk about those things shortly.

And plus nasal, and plus labial, so ma is a labial on nasal so it is plus label. Hence, if we have another word say nap, how is this going to change obviously, the property of label is going to change because n is an alveolar continent, and everything else remaining the same. Similarly, if it is, this word changes from map to mat, for instance, then what changes would entail here.

So, we have similarly labial to represent everything else, it is minus syllabic, it is minus sonorant, it is stop, it is minus nasal, it is minus voice, all things remaining the same, because there is a change from pa to ta, the labial category is going to change and this is going to be different, we will see what alveolar consonants are termed in terms of Features. But those are the things that would be different if there are changes from one word to another word.

(Refer Slide Time: 07:46)



Now, applying rules to featural representations, it is a rule of English that all vowels are realized as nasalized when they preceed nasals, and they appear as oral in all other contexts, example, cam vs cab. So here, this is nasalized and here, this is not nasalized. So, there is a rule of nasalization in English, that of our will become nasal, when there is a following plus nasal. And this is talking about this particular context, where there is a following plus nasal consonant, which is made this change to the vowel which will occur here.

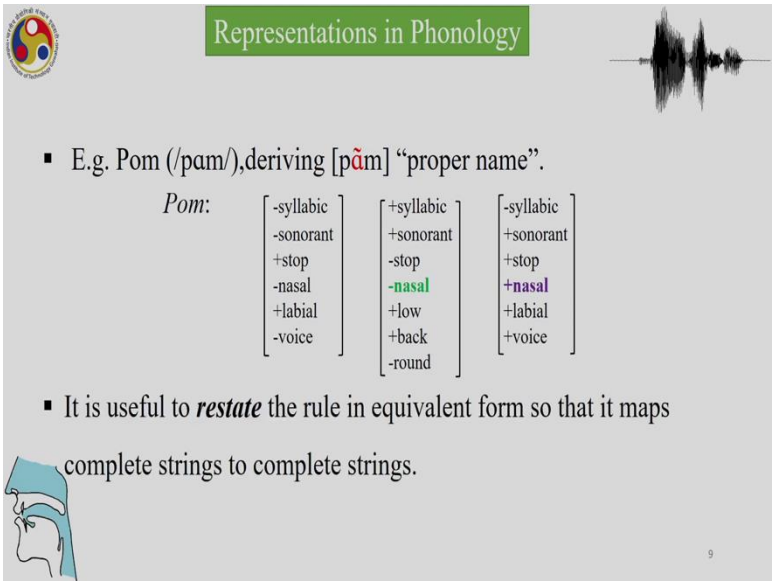
So, this vowel will become a plus nasal vowel. As we know about a rule-writing from our initial lectures before this, we know that when there is a following plus nasal, consonant or this

is how rules are written, A goes to B in the environment, where there is a nasal. So, what changes, a vowel changes to nasal when there is a plus nasal consonant. And this is the context for the application of vowel nasalization rule in English.

And what are we trying to say here? Note that we are not saying that A becomes A in the context where there is m, we are not saying that. We are not saying that this particular vowel becomes the nasalized version of this vowel in the context where there is a following nasal consonant m, we are not giving those specific cities of that word. Instead, we are saying that the vowel becomes nasal when there is a following nasal consonant.

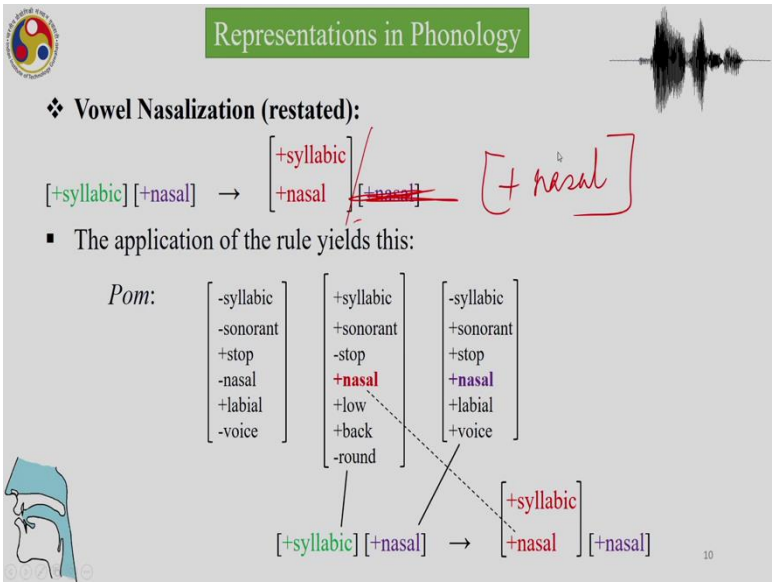
So, we have made a generalization based on, of course, we know from English that this nasalization happens across all vowels whenever there are following nasal consonants, But for that representation, now, we are saying that the vowel becomes nasal, when there is a following plus nasal constant and we are not saying A goes to A, in the context where there is a following m, because it is not just restricted to this vowel in this the presence of this nasal, this happens to all vowels in the presence of all nasal consonants, and that is what Feature writing helps us to do to capture generalizations.

(Refer Slide Time: 10:25)



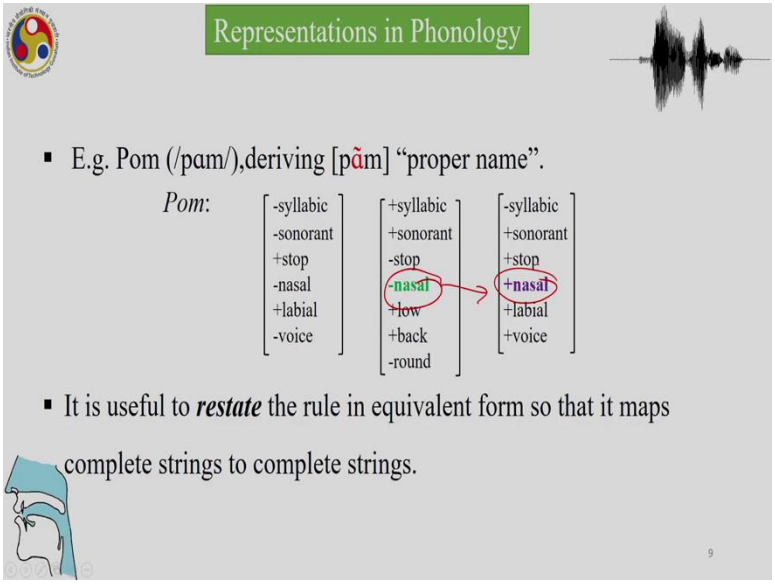
So, now suppose we have pam deriving, pam a proper name. So, it is useful to restate the rule in equivalent form, so that it maps complete strings to complete strings. So, the strings are here, whereas we have shown the generalization with just vowels becomes nasal. Here, we are showing further changes minus syllabic, minus plus sonorant, plus stop, minus nasal that is capturing all the essential featural properties of the vowels and the consonant.

(Refer Slide Time: 10:59)



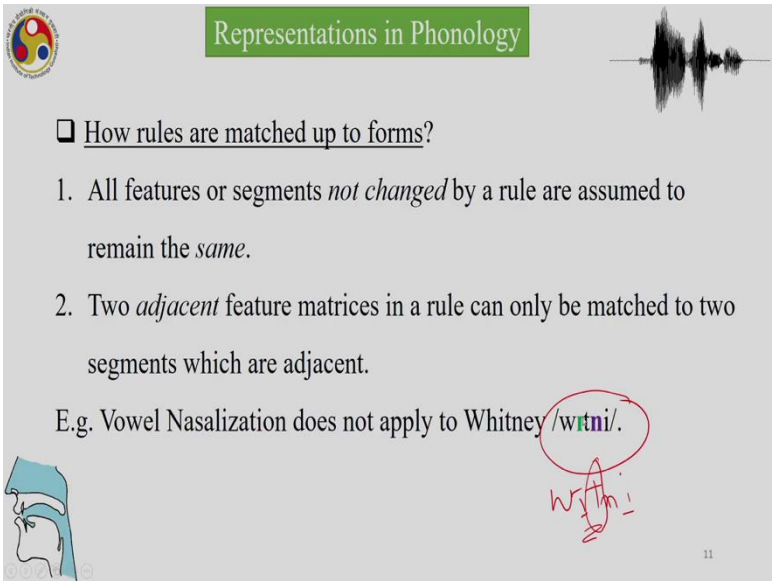
So, now, this particular generalization, which we captured here, as vowel nasalization can be restated as we form with more generalization so plus syllabic, plus nasal goes to plus syllabic plus nasal in the context, where there is a nasal following plus nasal. So, in the context where there is a following plus nasal. So, the application of this rule yields now that this plus syllabic, minus nasal goes to plus syllabic, plus nasal in the environment where there is a plus nasal. Now, all that it does, is that it changes the minus nasal to plus nasal.

(Refer Slide Time: 11:52)



So, this particular minus nasal changes to this particular plus nasal.

(Refer Slide Time: 11:58)

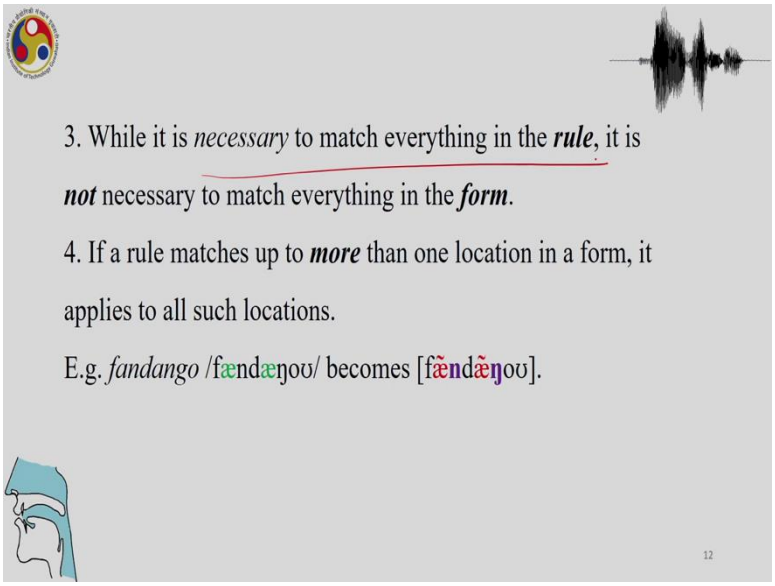


So, how are rules matched up to forms? All Features or segments are not changed by a rule are assumed to remain the same. Two adjacent feature matrices in a rule can only be matched to two segments, which are adjacent. So, what are we trying to match up when we are writing rules? And as we sit here, all features or segments are not changed by rule. So, a rule is simple by its very definition, a rule cannot be very complicated, otherwise, it will not capture the essence of knowledgeable process.

So, two adjacent feature matrices in a rule can only be matched to two segments which are adjacent. And it cannot be more than that, because phonological processes are such that they are not extremely unnatural, or unless there is a few unnatural rules in Phonology, but they are mostly, they are very, very natural rules. And they apply in very specific contexts.

So, there can be mostly viewed from the point of view of a phonological analysis and when the features are apparent to the person who is studying the features in greater detail. So, vowel nasalization does not apply to a Whitney, for instance, why does not it apply to Whitney because it is obvious because the context is not there anymore. What happens to the context? The context is absent because of the intervening consonant between the E, this E, and the following n.

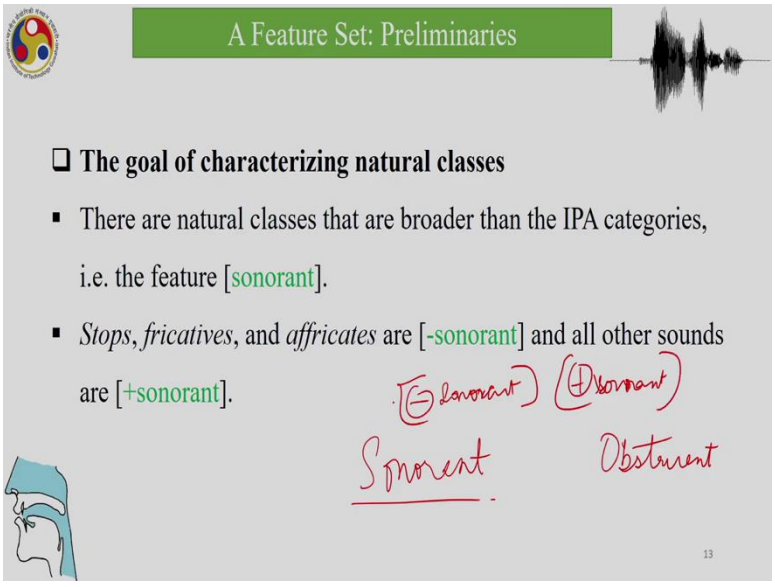
(Refer Slide Time: 13:34)



So, while it is necessary to match everything in the rule, it is not necessary to match everything in the form. So, if a rule matches up to more than one location, in a form, it applies to all such locations. So, meaning that all under rule requires is the matching of the context. So, if your input provides you more context, then the rule will keep on applying.

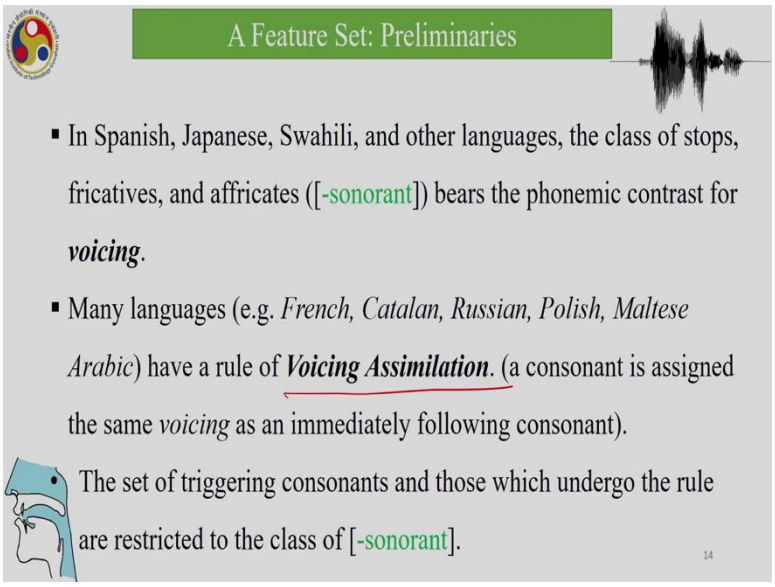
And so, it does not say anything about the form, it does not say that apply this rule to only one context in the output form and do not apply to the other form. So, that is why the rule is necessary to match everything in the rule. So, if fandango becomes fandango, so our rule of nasalization applies to both this and this well.

(Refer Slide Time: 14:30)



Now, what do we need for a feature set? So, the goal of characterizing natural classes. There are natural classes that are broader than the IPA categories, that is a feature sonorant and stops, fricatives, affricates are minus sonorant, and all other sounds are plus sonorant. So, one broad category is that of sonorant and minus sonorant are called obstruent. And generally, they can also be expressed as minus sonorant versus plus sonorant. So, as we can see, now that we are using these two feature values of plus and minus.

(Refer Slide Time: 15:20)

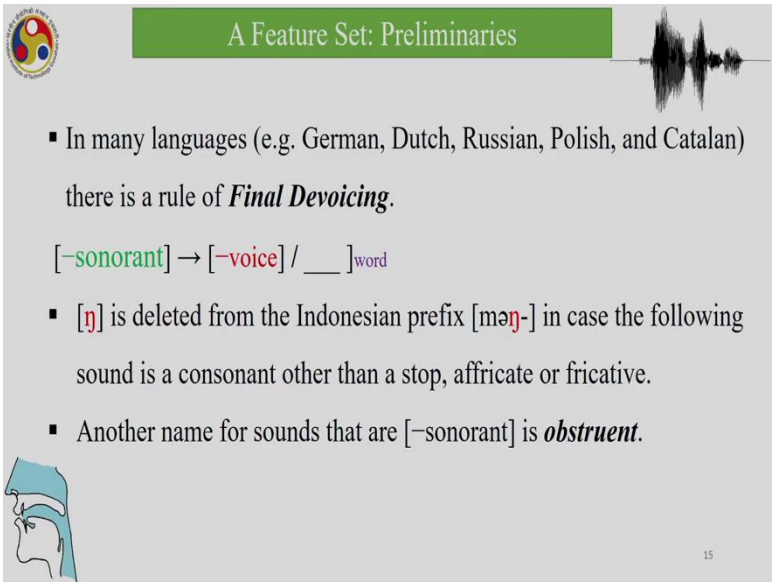


So, in a lot of languages of the world, the class of stops, fricatives, affricates, bear the phonemic contrast for voicing. So, voicing is very often seen in the languages of the world. And a lot of languages are contrast voicing in of strings in minus sonorant. And, of course, and there are sometimes also limitations on the application of certain rules of voicing.

So, many languages such as French, Catalan, Russian, Polish, Maltese have a rule of voicing assimilation, that is a consonant is a sign the same voicing as an immediately following consonant. So, these are the restrictions on sometimes, even though there is voice in contrast, there can be also along with the contrast, there can be also phonological rules applying.

And specifically, with relation to voicing, and they may be contrast, they may be also voicing assimilation, which means two obstruents must have the same value for voicing. So, in Spanish, Japanese, Swahili, other languages, the fricatives and affricates bear the phonemic contrast for voicing.

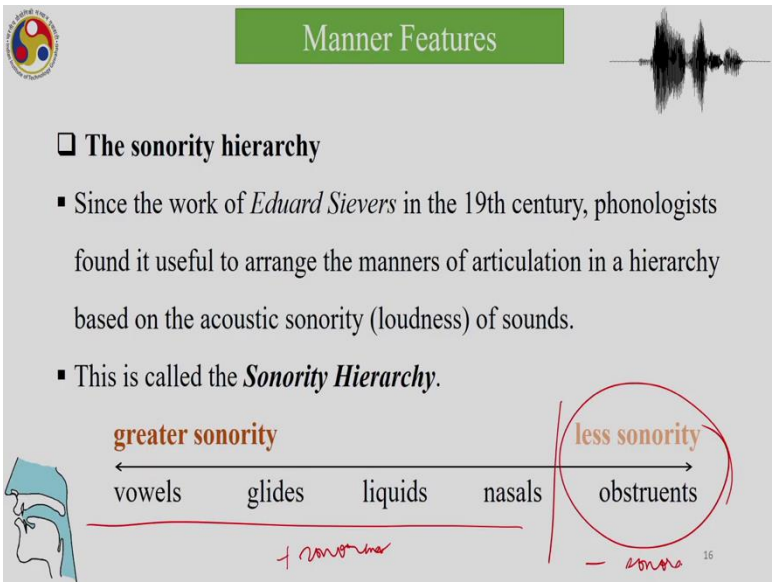
(Refer Slide Time: 16:40)



So, apart from voicing assimilation, there can be other things like Final Devoicing. So, what is Final Devoicing? Final Devoicing is nothing else that other than the fact that obstruents become voiceless in the word-final position. So, whereas in the language in the voicing contrast, in all other positions, in the final position, there will be Final Devoicing.

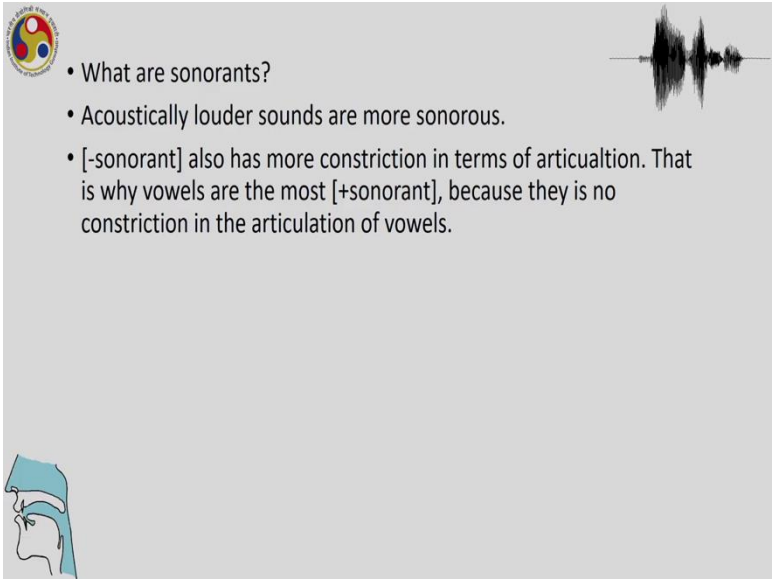
And then there are instances where noise deleted from the Indonesian prefix, man, in case the following sound is a consonant other than a stop, affricate, or fricative. Another name for sounds that are minus sonorant is obstruent, as we have just already said.

(Refer Slide Time: 17:18)



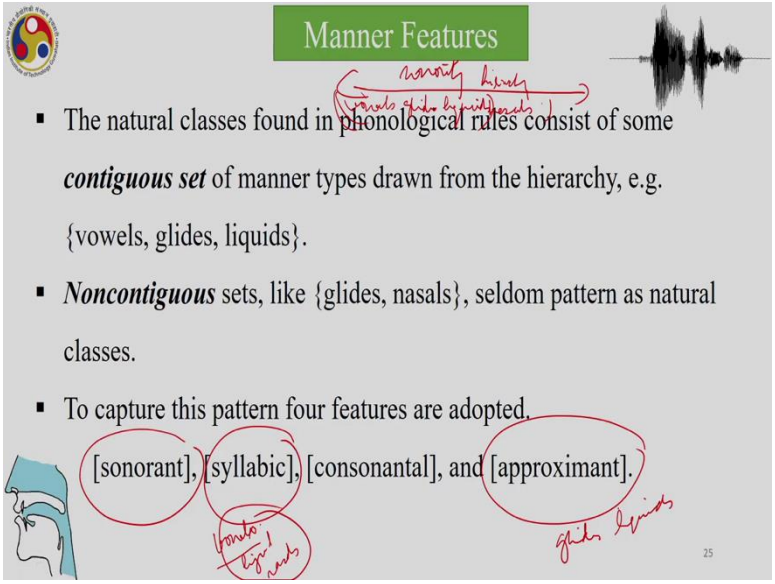
And the sonority hierarchy, since the work of Eduard Sievers in the 19th century, phonologists found it useful to arrange the manner of articulation in a hierarchy based on the acoustics sonority of sounds. So, neurons are loud sounds, so that is what we understand by the sonority, this is called the sonority hierarchy. So, what is the sonority hierarchy? We have vowels, glides, liquids, nasals which are of greatest sonority, and then obstruents, which are the least sonorous. So, as a result, these are plus sonorant and so, this minus sonorant.

(Refer Slide Time: 18:07)



So, something that you may want to keep in mind while knowing about sonorant is that minus sonorant, they have more constriction in terms of articulation. That is why vowels are the most sonorant and because there is no constriction in the articulation of vowels.

(Refer Slide Time: 18:23)

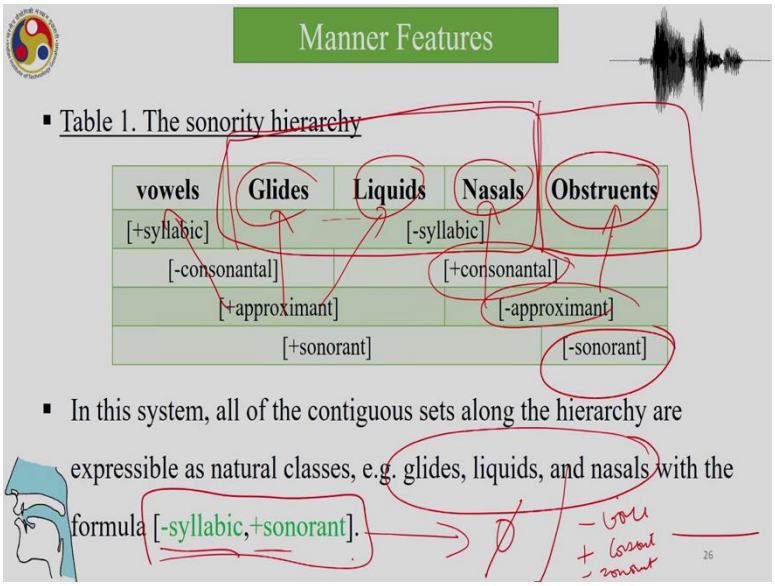


So, we will come to all these sounds, let us look at some other natural classes. Based on manner features, we have vowels, glides, liquids and sometimes like non-contiguous sets like glides, nasals, they seldom pattern as natural classes and this is in terms of our sonority hierarchy. So, we know that we have a sonority hierarchy, where we have vowels, glides, liquids, and vowels, glides, and liquids most of the time pattern together and others like glides and liquids do not form one group, one natural class together.

So, these are the Manner Features and to capture this pattern four features are adopted we have sonorant, syllabic, consonantal, and approximant. So, now for sonorant now we know the sonority hierarchy, we have our glides, liquids, nasals, and but even among these groups, we have the ones which are syllabic.

So, vowels, and liquids, and nasals can be syllabic. Whereas, glides are not syllabic and we have among consonantal glides pattern with the other continents and then we have approximants where we have glides, liquids which patterns together. So, we have different groups based on their other features apart from sonority.

(Refer Slide Time: 20:09)



So, this is a table that we can see here. So, let us start with obstruents, which are minus sonorant. And among the others, now we have minus sonorant. And we have a break right here, where we have all these as minus sonorant and all these is plus sonorant, and obstruents is minus sonorant. Now, we move one step forward, and then we include, we have nasals and obstruents, which are now minus approximants, we have nasals, and obstruents.

And then we have among plus approximants, we have glides, vowels. And then, now we move a bit further to the left and then we include liquids, nasals, obstruents, now they are consonantal, whereas among minus consonantal, we have vowels and glides. Importantly, we have glides, liquids, nasals, and obstruents in minus syllabic natural class.

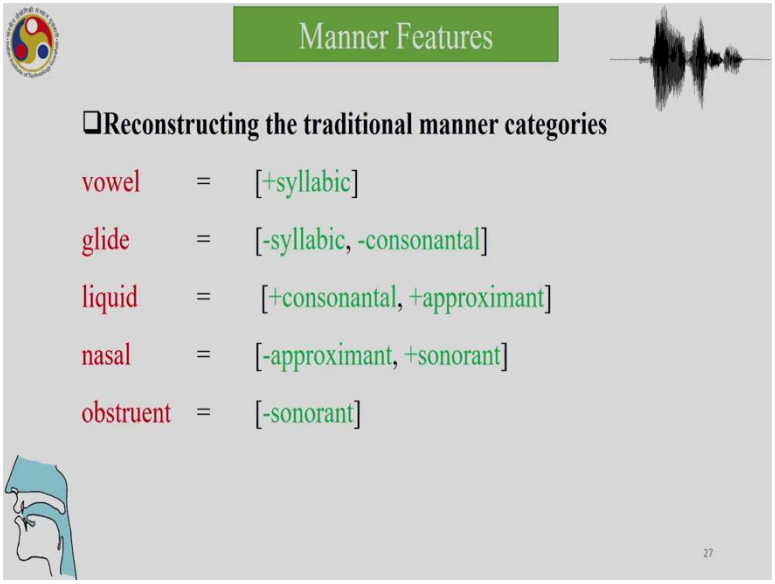
So, in this system, all of the contiguous sets along the hierarchy are expressible as natural classes, example glides, liquids, and nasals with the formula minus syllabic plus sonorant. And hence, whenever we have a process, which targets glides, liquids, nasals we will use this set, this natural class to express, this group so we can say minus syllabic plus sonorant goes to for instance, this rule may or may not exist in language.

But I have just for the sake of illustration if we say in a language suppose liquids, glides, and nasals, delete in the context where there is a proceeding minus voice plus consonantal minus sonorant, let us say. So, suppose, there is a language in which minus syllabic plus sonorant, delete in the context where there is a proceeding minus voice plus consonant and minus.

Whereas, so there may be a language where glides, liquids, and nasals, delete if there is a preceding voiceless obstruents, then this is the natural class that we will use to express that rule, that in this language glides, liquids, and nasals, delete. And then, we will use the category of minus syllabic plus sonorant.

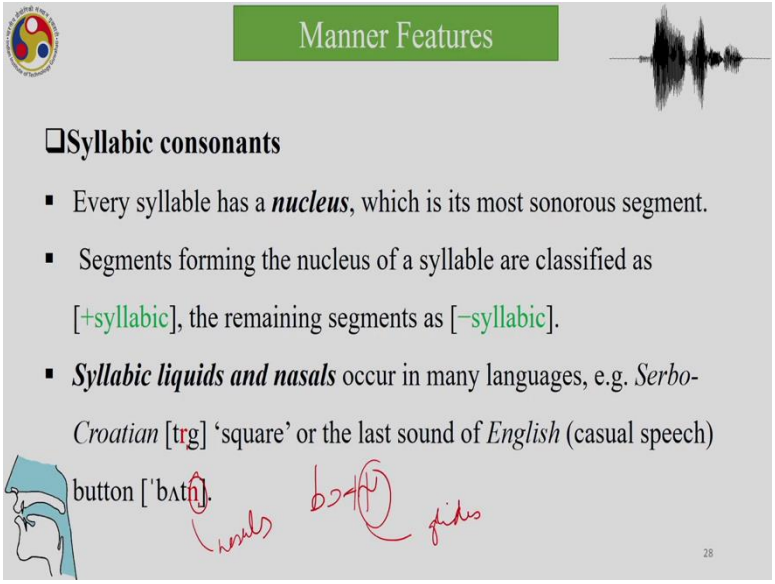
And note that when we say minus syllabic plus sonorant, we are leaving out obstruents. So, when we say minus syllabic plus sonorant, we are leaving out obstruents, which are minus sonorant. And to express a rule which involves these three to the exclusion of obstruents we have to say, along with minus syllabic plus sonorant.

(Refer Slide Time: 23:35)



So, the vowels are plus syllabic, glides are minus syllabic and minus consonantal, and liquids are plus consonantal plus approximant, nasals minus approximant plus sonorant, and obstruents are minus sonorant.

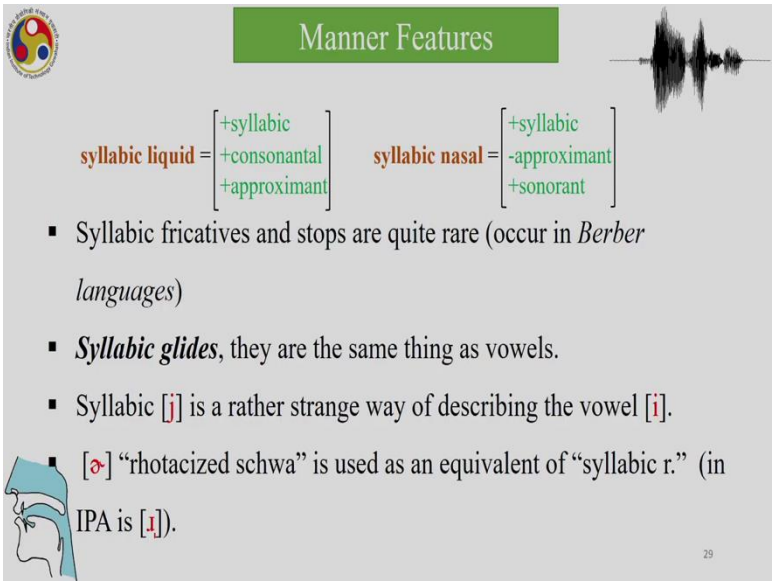
(Refer Slide Time: 23:47)



And every syllable has a nucleus, which is its most sonorous segment, and segments forming the nucleus of a syllable are classified as plus syllabic, the remaining segments as minus syllabic. And syllabic, liquids, and nasals occur in many languages, example Serbo-Croatian square or the last sound of English for instance, like button or English bottle which is velarized or a button which is this nasal release and this velarized l.

So, these are all syllabic, this is syllabic nasal, this is a syllabic. So, we have glides, liquids, and nasals. Among glides, liquids, and nasals in English we have nasals which are syllabic and we have glides which are syllabic.

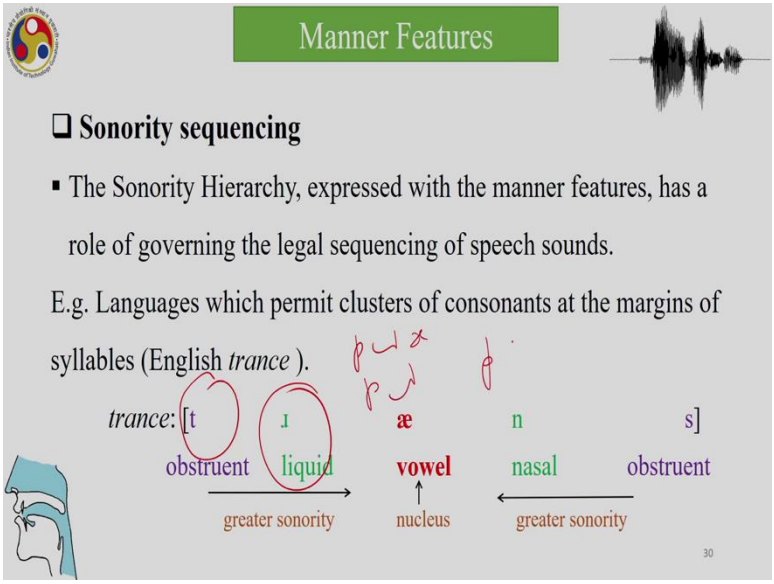
(Refer Slide Time: 24:45)



So, among Manner Features we have syllabic liquids, which can be expressed as plus syllabic plus consonantal plus approximant and syllabic nasal, which can be expressed as plus syllabic minus approximant plus sonorant. And syllabic fricatives and stops are quite rare, but occur in some languages like Berber.

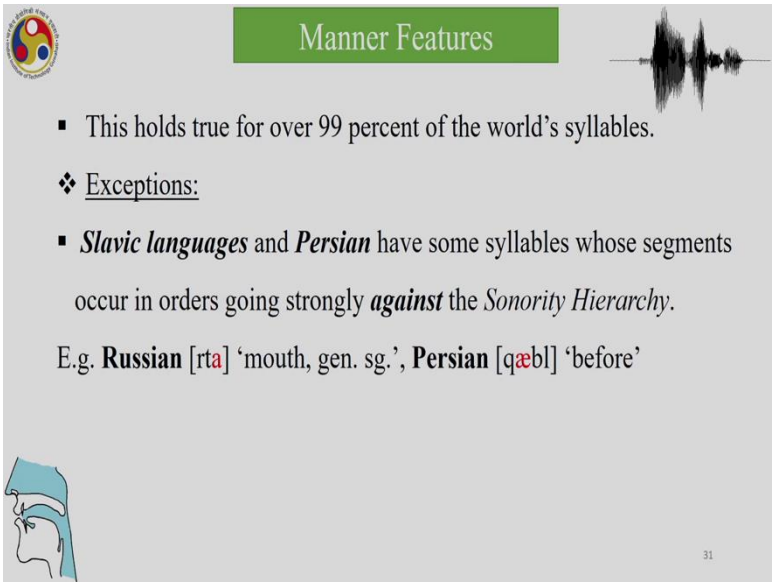
And syllabic glides, they are the same thing as vowel. Syllabic j is a rather strange way of describing the vowel i. And the rhoticized schwa, so we have not talked about rhotic so much, but vowels can be rhoticized is using equivalent of syllabic r, in the case of IPA International Phonetic Alphabet symbol, it is inverted r.

(Refer Slide Time: 25:30)



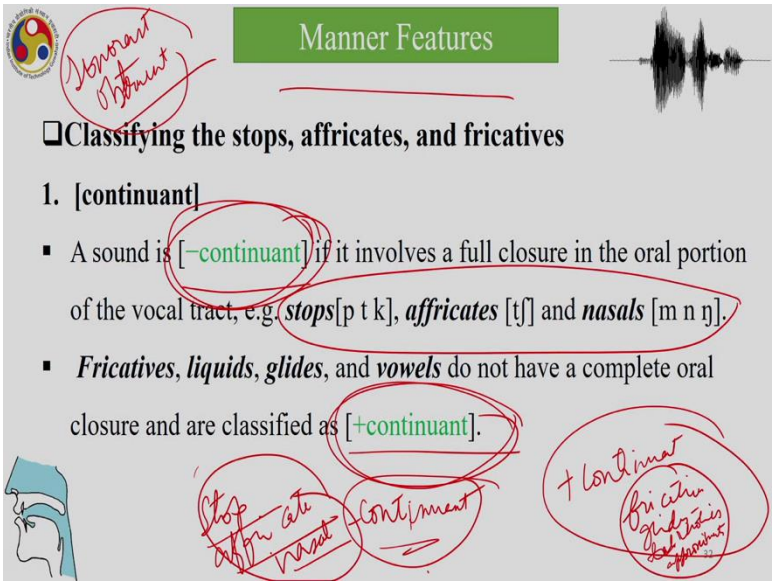
So, sonority sequencing, the sonority hierarchy expressed with the manner features, has a role of governing the legal sequencing of speech sounds. And languages which permit clusters of consonants at the margins of syllables is, so we have examples like trance. So, more sonorant consonant is, it is going to appear towards the right side of an obstruents in the onset position, so in trance or our prank or prey, or play etcetera, at the margins of syllables. So, you have sonority hierarchy plays a role in syllabification as well. And we will discuss more about this when we discuss syllables.

(Refer Slide Time: 26:24)



And this holds true for over 99 percent of the world's syllables. Exceptions are Slavic languages. Persian has some syllables, whose segments occur in orders going against the sonority hierarchy and Russian and these are some Russian and Persian examples.

(Refer Slide Time: 26:40)



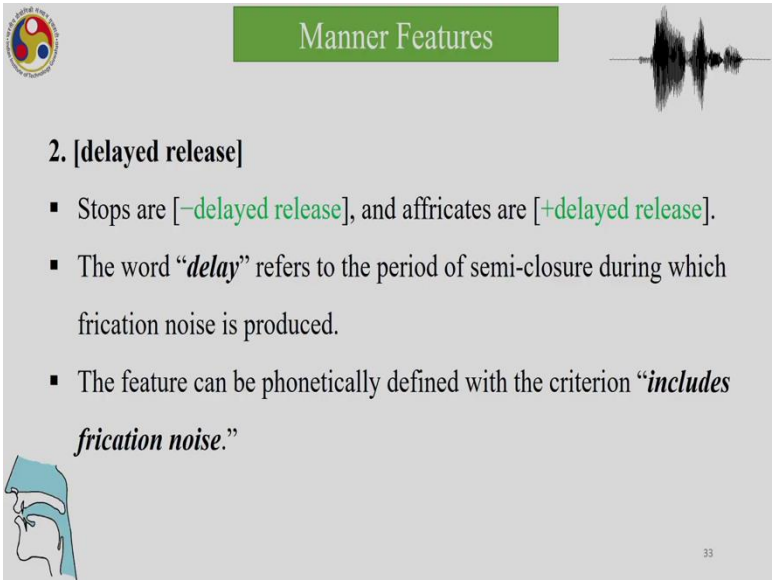
Classifying the stops, affricates, and fricatives. Now when talking about Manner Features, we have talked about sonorant extensively. Now, we talk about stops, affricates, and fricatives. So, the sound is a minus continuant if it involves a full closure in the oral position of the vocal tract. So, minus continuant and plus continuant. So, far, we have talked about sonorant, obstruent. Now, we are talking about minus continuant and plus continuant.

So, that is one class we have talked about before natural class, this is a major natural class in describing languages of the world. So, what does minus sonorant mean? If a sound involves full closure in the oral position of the vocal tract, then we have a minus continuant. So, if it has vowels, liquids, glides, etcetera, do not have complete closure and are called plus continuant. So, now stops, we can see that stop affricate, nasal belong to one category called minus continuant.

And we have plus continuant which includes everything from fricatives to vowels. So, if you recall the sonority hierarchy, you will remember that we have glides, we have rhotic, we have laterals, we have all other approximants. Now, excluding the nasals, so nasal because of the release, which is of a stop release, does it the kind of release are these three types of consonants.

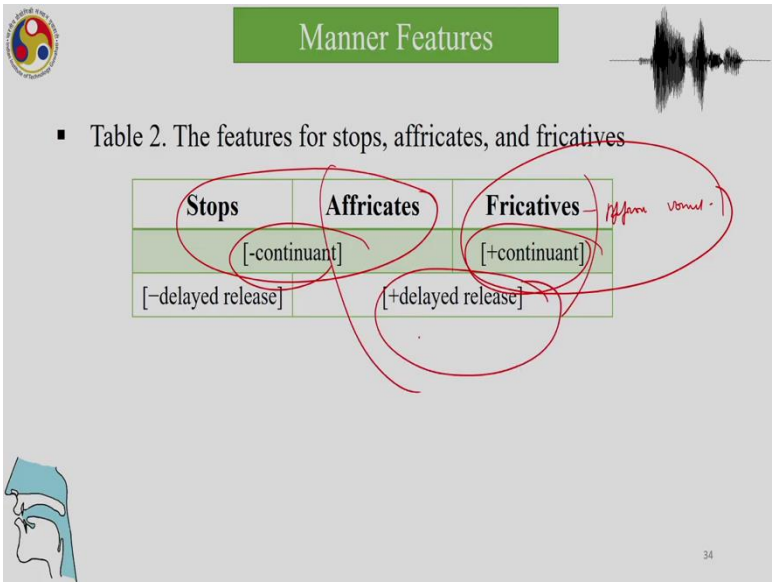
Have you recalled your manner of articulation classes? Where we talked about complete closure, you will remember that this complete closure is important in classifying these two groups one is just continuing group, which is the way the release happens, which is to continuity in the release, we have everything from fricatives, liquids, glides, vowels fall into a group called plus continuant. And the other group which has different sort of closure and release, like stops, fricatives, nasal they form another group.

(Refer Slide Time: 29:14)



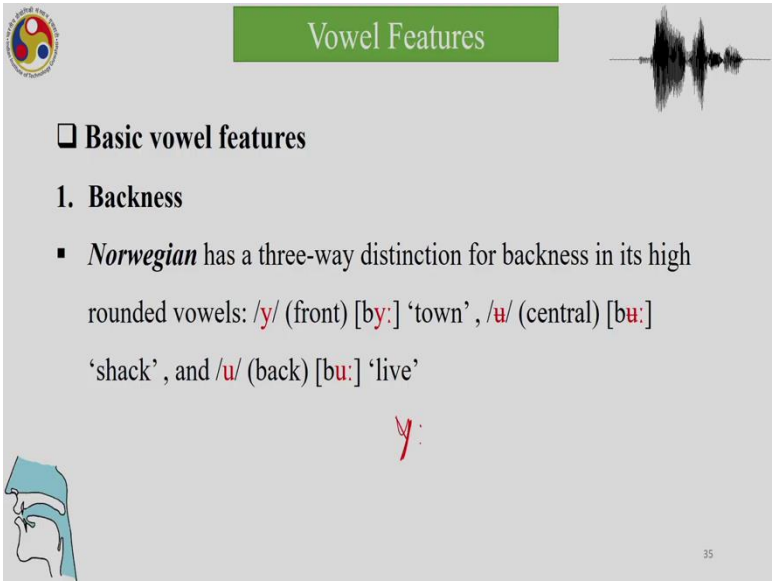
Among stops and fricatives, we have stops are considered delayed, minus delayed-release, affricates are considered plus delayed-release, because of the difference. The word delay refers to the period of semi-closure during which vacation noise is produced. The feature can be phonetically defined with the criterion includes furcation noise.

(Refer Slide Time: 29:35)



So again, fricatives are not minus continuant they are plus continuant. There are features for stops, affricates, and fricatives. Now, I can see that we have a big group of continuants, where it includes everything, all the approximants, and vowels as well. And in this group of plus continuing in the minus continuing group, we have stops and affricates, but affricates are clubbed with fricatives when it comes to release.

(Refer Slide Time: 30:13)

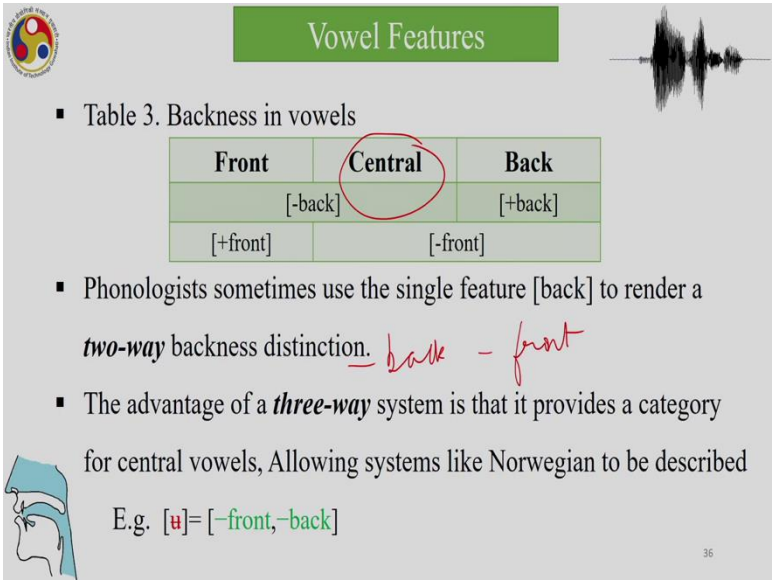


So, let us talk a bit about Vowel Features. Backness, we have looked at Vowel Features and vowels, articulation of vowels. When you talked about articulatory phonetics looked at vowels and looked at acoustic phonetics, talking about the Phonology of vowels. So, they are also

represented with features. And mostly, we have front back distinctions or high low or rounded unrounded distinctions, as we have already understood about vowels.

And these are also seen in representations used for vowels. And Norwegian, which is a three-way distinction for backness in its high rounded vowels are represented. So, this is represented with this symbol, which looks a bit like a y, and which is although it is high and rounded, and front, so this is y and then the central u and then the back u.

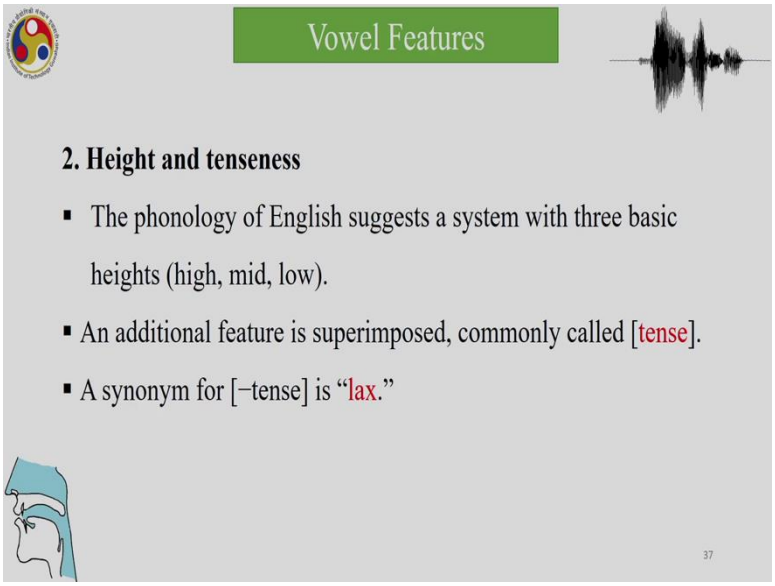
(Refer Slide Time: 31:13)



So, this is the way that we represent those, the stations that we have front, central, and back, front and central are minus back and back is plus back and front and central could also be considered, minus front. So, central vowels are minus back, as well as minus front. Whereas front vowels are minus back, and back vowels are plus back, and front vowels are plus front, minus vowels are minus front.

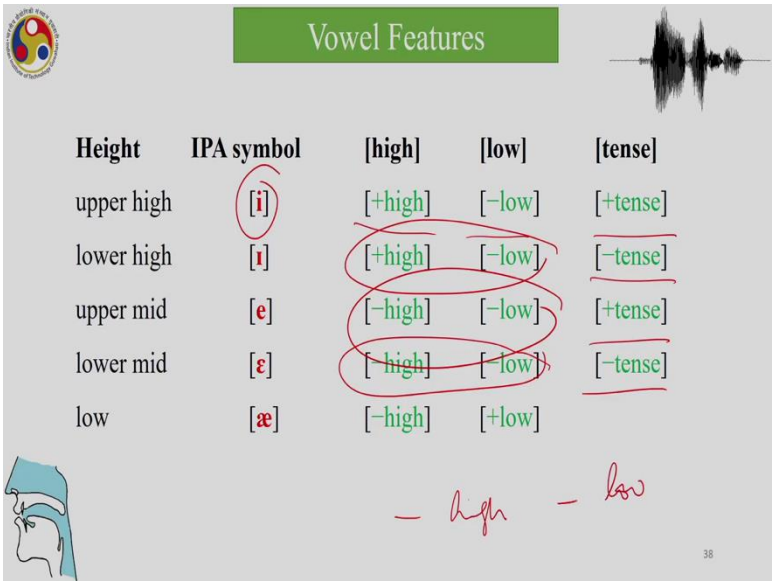
So, for languages which do not have central vowels, you would mostly represent them with back feature. So, Phonologists sometimes use the single feature back to render two-way backness distinction, and the advantage of a three-way system is that it provides a category for central vowels.

(Refer Slide Time: 32:04)



Height and tenseness, and the Phonology of English suggest a system with three basic heights, high, mid, and low. And an additional feature is superimposed, commonly called tense. A synonym for minus tense is lax.

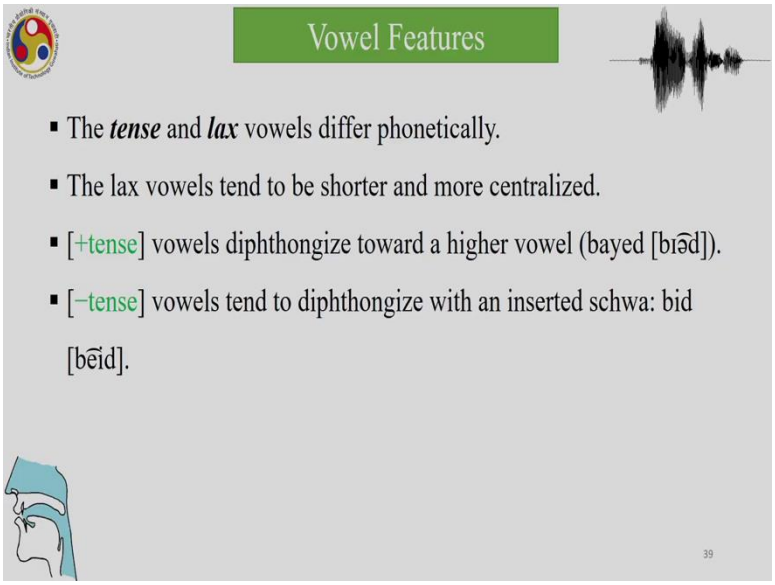
(Refer Slide Time: 32:17)



And these are the symbols for the high vowels. So, these are the representations, it is minus high, minus low, plus tense. And as you can see, minus tense, and plus tense, so the way, the way that we are representing lax vowels here, and plus high vowels, and plus low for low vowels, and mid vowels are represented as minus high and minus low, and low or high, so plus

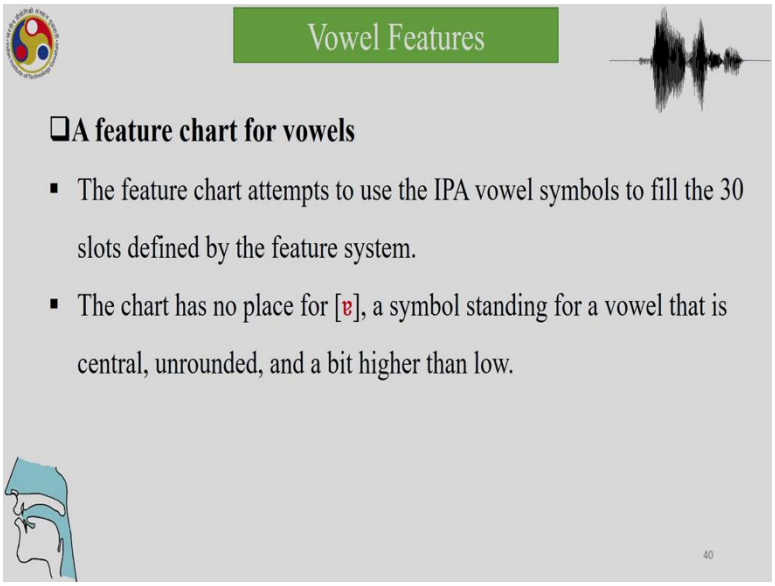
high, minus low, and if it is lower-mid, then again, we have some mid vowels are minus high, minus low, whereas high vowels are plus high, low vowels are plus low.

(Refer Slide Time: 33:01)



The tense and lax vowels differ phonetically and lax vowels tend to be shorter and more centralized, plus tense vowels diphthongize towards a higher vowel, and minus tense vowels tend to diphthongize with an inserted schwa.

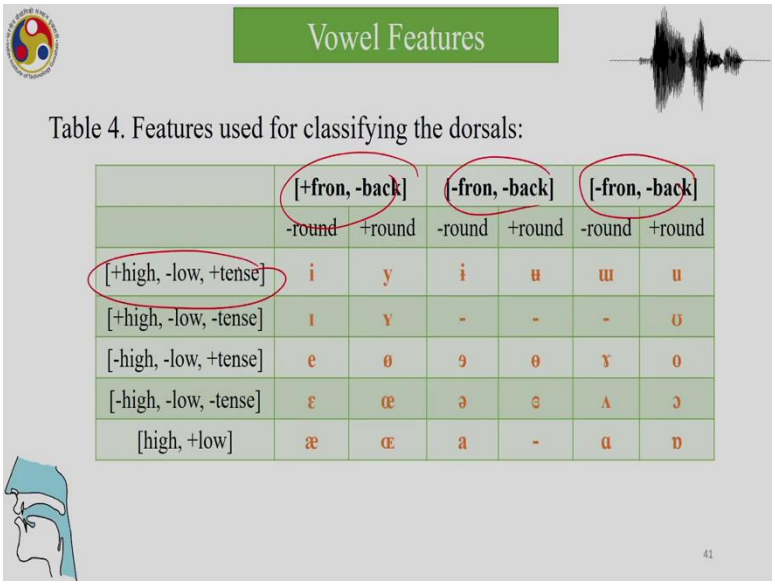
(Refer Slide Time: 33:18)



A feature chart for vowels. The Feature chart attempts to use the International Phonetic Alphabet vowel symbols to fill the 30 slots defined by the feature system and the chart has no

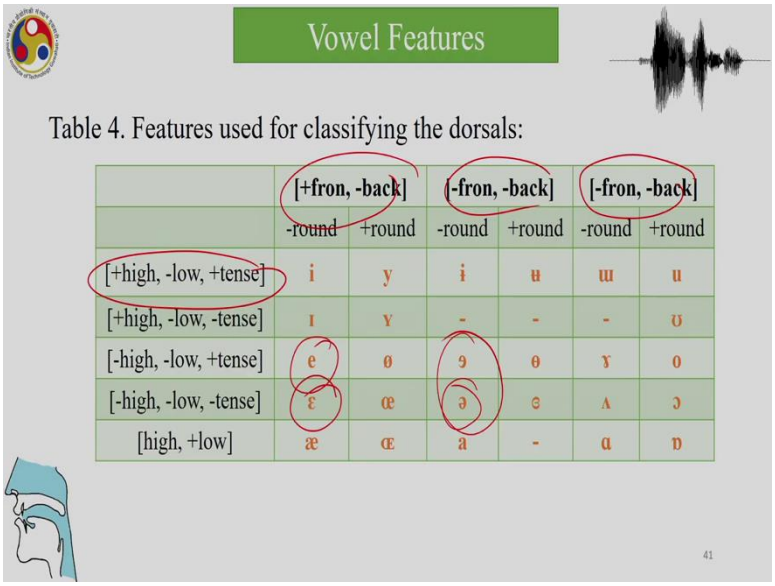
place for the inverted a symbol standing for a vowel that is central, unrounded, and a bit higher than low.

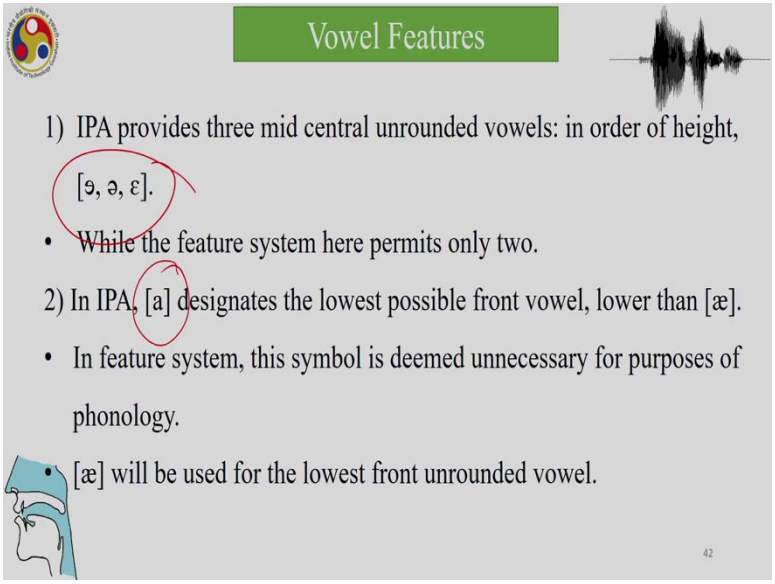
(Refer Slide Time: 33:34)



So, this is the way you will represent them and the categories are these front back, and high low, and tense.

(Refer Slide Time: 33:48)



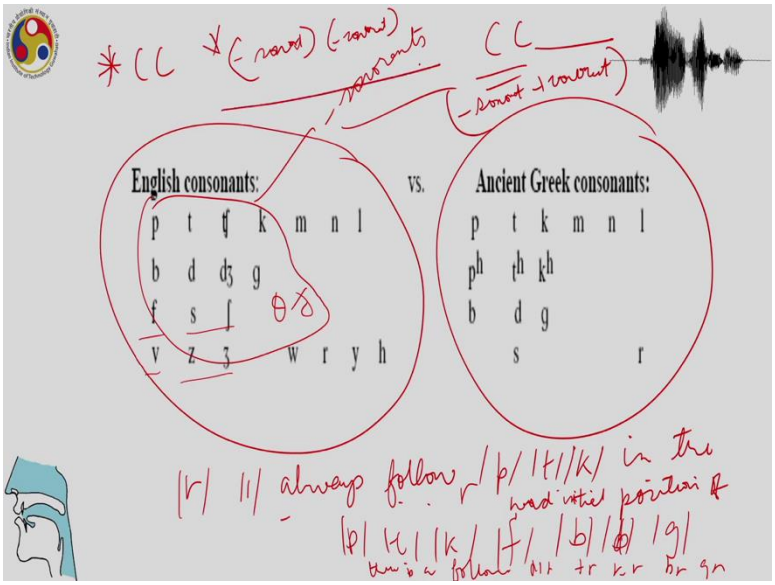


So, International Phonetic Alphabet provides three mid-central vowels in order of height, while the features system here only permits two. So, in terms of the mid-central unrounded vowels and one is plus tense and the other is minus tense. This is the schwa which is minus high, minus low, minus tense, the other minus round mid vowel is plus tense.

And then, we have a here which is different from this vowel and a here which is different from these workers. These are plus front and minus front vowels, and these are minus front and minus back vowels. So, because of the use of the plus and minus values, there is more economy in the system. However, the International Phonetic Alphabet designates a to be the lowest possible front vowel.

In feature system, this system is deemed unnecessary for purpose of phonology, a is used to be the lowest front unrounded vowel.

(Refer Slide Time: 35:00)



Now, we discuss a bit more of the feature's system with this example, from the MIT course on features. So, this is the set of English consonants, and this is the set of ancient Greek consonants. And the question that we have in front of us is, how do you represent these two systems? Now, they are pretty much similar in the sense that they have. So, the English system is quite reduced, it does not show all the, for instance, we do not have a few consonants here.

So, for instance, s, sh is there, z, z is there, f, v is there, but th is missing, th is missing from this English consonant set. So, it should appear, th and th missing, some are missing, but irrespective of that, now, if we have a system like this, and suppose also we have to express a few things about these two languages, suppose we have to say that in English, the two approximants r, l always follow p, t, k in the word-initial position of a word.

Suppose this is something we want to express in the word-initial position, always p, t, k in English always has a following r and l in consonant clusters. And what we want to express a that r and l never proceeds, p and p, t, k. Supposedly want to express the same thing about ancient Greek consonants, the example is, is that just to show that across different languages is things may be the same and may be repeated.

So, if we want to express the same thing about ancient Greek, what we have to do is if we did not have a feature system, we would have to say that in English, whenever we have p, t, k or f

or even b, d, g there is a following r, so we get pr, tr, kr, or br, or gr in English and we do not get r, p, r, t. So, what we are talking about is the cumbersome or is that, that it is not just cumbersome.

It does not capture a very intuitive generalization, the generalization is that in English or in consonant inventors as remote as ancient Greek also, we will have the same system that what is it that if you think about p, t, k, or b, d, g, or even f, s, which are fricatives. What group of continents do they constitute? They constitute your minus sonorant. So, how will you express something like this, that in English or an ancient Greek p, t, k, b, d, g or s, f always has following r, l, the r, l never precede them in a word-initial position?

To express that all we need to say that in English or in ancient Greek sonorant always have an immediately following position, when they are proceeding minus sonorant in the context when we have if there is a C C in a word-initial position, and if this is minus sonorant, then this is plus sonorant. Essentially or if you recall that we talked about rules and constraints in the last class, we can express this as also as a constraint, we can say that in English and in ancient Greek avoid consonant clusters, which are both minus sonorant.

So, minus sonorant clusters are not possible in English and ancient Greek. So, that is how we use features, it helps us, it shows these abstract generalizations which is as native speakers' knowledge of a language which can be expressed succinctly and in very simple terms, if we use what we have the tools offered by natural classes, and also helps us to not just understand also helps us to formalize the rules that appear in language after language and these are repeated with this same group of consonants and also vowels.

Thank you for listening to this talk on Features and we will continue with Phonology in the next lecture.