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# **Module 3: Introduction to JAPE**



## About this tutorial

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- As in previous modules, this tutorial will be a hands on session with some explanation as you go
- Things for you to try yourself are in **red**
- Example JAPE code is in **blue**
- Your hands-on materials are in `module-3-jape/jape-hands-on`
- There you'll find a **corpus** directory containing documents, and a **grammar** directory containing JAPE grammar files



# Topics covered in this module

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- What is JAPE?
- Parts of the rule: LHS and RHS
- How to write simple patterns
- How to create new annotations and features
- Different operators
- Different matching styles
- Macros

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**What is JAPE and what  
is it good for?**



# What is JAPE?

- a Jolly And Pleasant Experience :-)
- Specially developed pattern matching language for GATE
- Each JAPE rule consists of
  - LHS which contains patterns to match
  - RHS which details the annotations to be created
- JAPE rules combine to create a phase
- Rule priority based on pattern length, rule status and rule ordering
- Phases combine to create a grammar

# Limitations of gazetteers

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- Gazetteer lists are designed for annotating simple, regular features
- Some flexibility is provided, but this is not enough for most tasks
  - recognising e-mail addresses using just a gazetteer would be impossible
  - but combined with other linguistic pre-processing results, we have lots of annotations and features
- POS tags, capitalisation, punctuation, lookup features, etc can all be combined to form patterns suggesting more complex information
- This is where JAPE comes in.



## JAPE example

- A typical JAPE rule might match all university names in the UK, e.g. “University of Sheffield”
- The gazetteer might contain the word “Sheffield” in the list of cities
- The rule looks for specific words such as “University of” followed by the name of a city.
- This wouldn't be enough to match all university names, but it's a start.
- Later, we'll see how we can extend this kind of rule to cover other variations.

# Simple JAPE Rule

```
Rule: University1
(
  {Token.string == "University"}
  {Token.string == "of"}
  {Lookup.minorType == city}
) :orgName
-->
:orgName.Organisation =
  {kind = "university", rule = "University1"}
```



# Parts of the rule

```
Rule: University1
```

← Rule Name

```
(  
  {Token.string == "University"}  
  {Token.string == "of"}  
  {Lookup.minorType == city}  
):orgName
```

← LHS

-->

```
:orgName.Organisation =  
  {kind = "university",  
   rule = "University1"}
```

← RHS

# LHS of the rule

Rule: University1

```
(  
  {Token.string == "University"}  
  {Token.string == "of"}  
  {Lookup.minorType == city}  
) :orgName
```

-->

- LHS is everything before the arrow
- It describes the pattern to be matched, in terms of annotations and (optionally) their features

# Matching a text string

- Everything to be matched must be specified in terms of annotations
- Each annotation is enclosed in a curly brace
- To match a string of text, use the “Token” annotation and the “string” feature

```
{Token.string == "University"}
```

- Note that case is important in the value of the string
- You can combine sequences of annotations in a pattern

```
{Token.string == "University"}  
{Token.string == "of"}  
{Lookup.minorType == city}
```

# Labels on the LHS

- For every combination of patterns that you want to create an annotation for, you need a label
- The pattern combination is enclosed in round brackets, followed by a colon and the label
- The label name can be any legal name you want: it's only used within the rule itself

```
(  
  {Token.string == "University"}  
  {Token.string == "of"}  
  {Lookup.minorType == city}  
) :orgName
```

# Operators on the LHS

Traditional Kleene and other operators can be used

- | OR
- \* zero or more occurrences
- ? zero or one occurrence
- + one or more occurrences

```
{Lookup.minorType == city} |  
{Lookup.minorType == country})
```

## Delimiting operator range

- Use round brackets to delimit the range of the operators

```
{Lookup.minorType == city} |  
  {Lookup.minorType == country}  
)+
```

One or more cities or countries in any order and combination

is not the same as

```
{Lookup.minorType == city} |  
  ({Lookup.minorType == country})+  
)
```

One city OR one or more countries



## Exercise: using operators

- Start GATE. Load ANNIE with defaults, but remove the NE transducer completely from GATE
- Load the grammar location1.jape, add it to your application, and run on the text locations.txt
- Now open the grammar location1.jape in your favourite text editor and change the kind of operator or its coverage
- Just ignore the rest of the rule and don't change it, we'll come to that later
- Save the file, then reinitialise the grammar in GATE and run the application again. View the difference.
- **WARNING:** be very careful with typos, brackets etc. when editing the grammar. Your syntax HAS TO BE CORRECT!



# JAPE RHS

```
Rule: University1
```

```
(  
  {Token.string == "University"}  
  {Token.string == "of"}  
  {Lookup.minorType == city}  
):orgName
```

```
-->
```

```
:orgName.Organisation =  
  {kind = "university", rule = "University1"}
```



# Breaking down the RHS

(...)

:orgName

annotation type

label

-->

:orgName

. Organisation

=

{kind = "university"}

feature + value

# Labels

- The label on the RHS must match a label on the LHS

```
(  
  {Token.string == "University"}  
  {Token.string == "of"}  
  {Lookup.minorType == city}  
) : orgName  
-->  
: orgName .Organization = {kind = organization}
```

- This is so we know which part of the pattern to attach the new annotation to



## Go label crazy...

- You can have as many patterns and actions as you want
- Patterns can be consecutive, nested, or both!
- Patterns cannot overlap

```
(  
  ({Token.string == "University"}) :uniKey  
  {Token.string == "of"}  
  ({Lookup.minorType == city}) :cityName  
) :orgName  
-->
```

# Multiple patterns and labels

- We can have several actions on the RHS corresponding to different labels.
- Separate the actions with a comma

```

(
  ({Token.string == "University"})
  {Token.string == "of"}
  ({Lookup.minorType == city}) : cityName
) :orgName
-->
:cityName. Location = {kind = city},
:orgName.Organization = {kind = university}
  
```

An upward-pointing red arrow indicates that the `Location` label in the second line is associated with the `{Lookup.minorType == city}` pattern in the first line.

# Patterns and actions

- A pattern does not have to have a corresponding action
- If there's no action, you don't need to label it, but you still need to bracket it
- Here, we want to add a special annotation for university towns

```
(  
  {Token.string == "University"}  
  {Token.string == "of"}  
)  
  ({Lookup.minorType == city}): cityName  
-->  
:cityName. Location = {kind = university_town}
```



# Annotations and Features

- The annotation type and features created can be anything you want (as long as they are legal names)
- They don't need to currently exist anywhere
- Features and values are optional, and you can have as many as you like
- All the following are valid:

```
:orgName.Organization = {}
```

```
:orgName.Organization = {kind=university}
```

```
:orgName.Organization =
```

```
    {kind=university, rule=University1}
```

```
:fishLabel.InterestingFishAnnotation = {scales=yes}
```



# Exercise: annotation types and features

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- Remove any existing grammars that you have loaded in GATE
- Load the grammar `university1.jape`, add it to your application, and run on the text `university.html`
- View the results
- Now open the grammar `university1.jape` in your favourite text editor and change the name of the annotation type created
- Save the file, then reinitialise the grammar in GATE and run the application again. View your new annotation..
- Try changing the name of the features, removing features, and adding new ones, and adding multiple labels
- Don't forget to reinitialise the grammar before re-running!

# Copying Feature Values to the RHS

- JAPE provides simple support for copying feature values from the LHS to the RHS

```
(  
{Lookup.majorType == location}  
) :loc  
-->  
:loc.Location = { type = :loc.Lookup.minorType }
```

- This copies the value of the Lookup minorType feature from the LHS to the new Location annotation
- Note that if more than one Lookup annotation is covered by the label, then one of them is chosen at random to copy the feature value from
- It's best not to use this facility unless you know there is only one matching annotation



## Exercise: copying Lookup features

- Open university1.jape in your text editor and create a new annotation called “UniversityTown” that matches just the city name.
- Also copy the value of the majorType of the city to a new feature of this annotation, called “kind”

*Hint: the RHS for the previous example looked like this:*

```
:loc.Location = { type = :loc.Lookup.majorType }
```

- Run this on the university1.txt document and check the results
- You should see “Sheffield” annotated like this:

Type	Set	Start	End	Id	Features
UniversityTown		36	45	49	{kind=location}

## More complex RHS

- So far we've just shown RHS syntax involving JAPE
- You can also use any Java on the RHS instead, or as well
- This is useful for doing more complex things, such as
  - Iterating through a list of annotations of unknown number
  - Checking a word has a certain suffix before creating an annotation
  - Getting information about one annotation from inside another annotation
- Complex Java on the RHS is taught in module 6 in Track 2 (Programming in GATE)

# JAPE Headers

- Each JAPE file must contain a set of headers at the top

```
Phase: University
```

```
Input: Token Lookup
```

```
Options: control = appelt
```

- These headers apply to all rules within that grammar phase
- They contain Phase name, set of Input annotations and other Options



# JAPE Phases

- A typical JAPE grammar will contain lots of different rules, divided into phases
- The set of phases is run sequentially over the document
- You might have some pre-processing, then some main annotation phases, then some cleanup phases
- Each phase needs a name, e.g. **Phase: University**
- The phase name makes up part of the Java class name for the compiled RHS actions, so it must contain alphanumeric characters and underscores only, and cannot start with a number



# Input Annotations

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- The Input Annotations list contains a list of all the annotation types you want to use for matching on the LHS of rules in that grammar phase, e.g.

## **Input: Token Lookup**

- If an annotation type is used in a rule but not mentioned in the list, a warning will be generated when the grammar is compiled in GATE
- If no input is included then all annotations are used



## Exercise: Input annotations

- Try altering the Input annotations in `university1.jape`
- Remove the `Lookup` annotation from the list. What happens when you run the grammar?
- Why?
- Add `"SpaceToken"` to the list. What happens when you run the grammar?
- What happens if you then add `SpaceToken` annotations into the rule?
- Check the Messages tab each time to see if GATE generates any warnings.



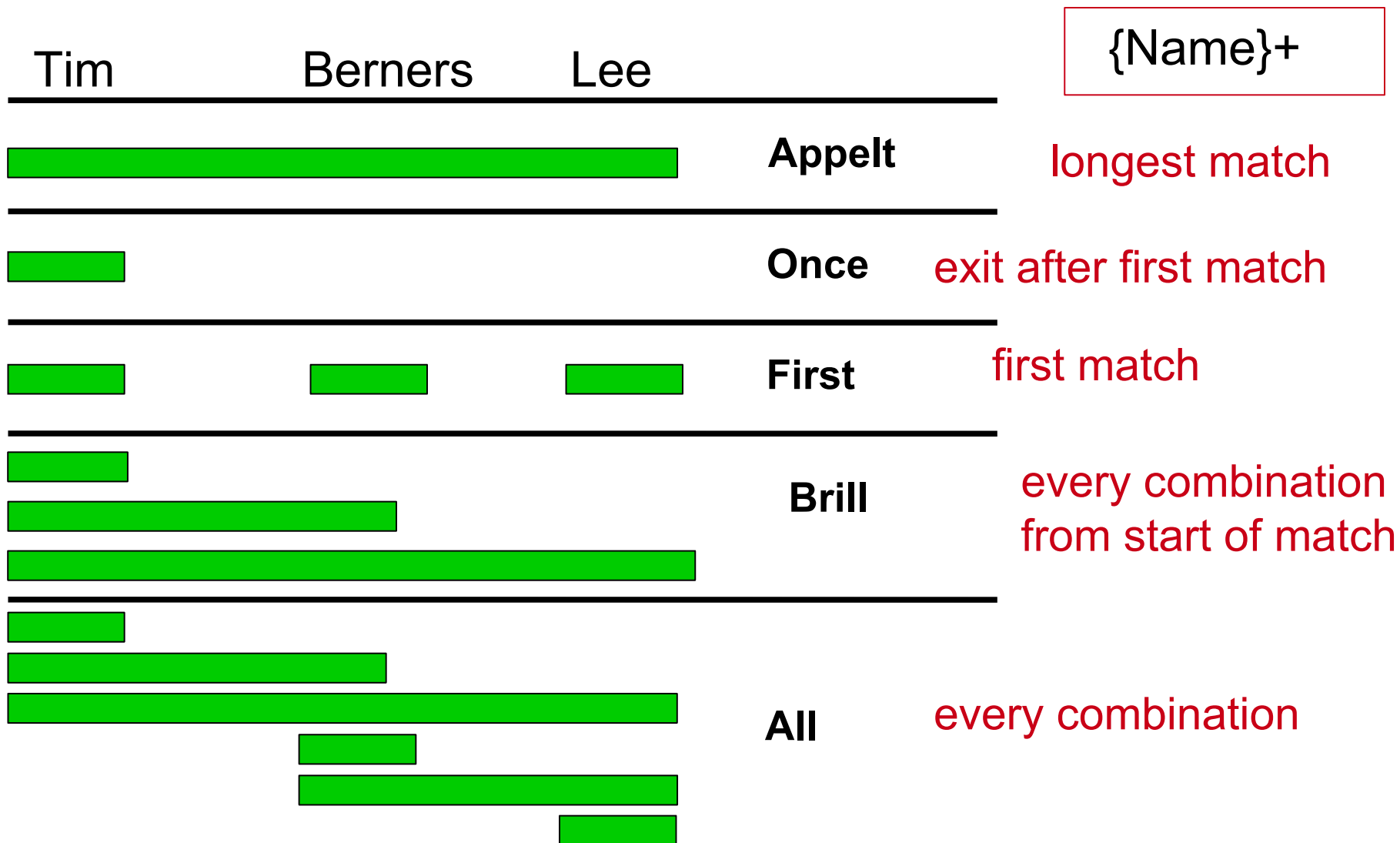
# Matching styles

## Options: control = appelt

- The matching style defines how we deal with annotations that overlap, or where multiple matches are possible for a particular sequence
- Do we want to return the longest or the shortest sequence, or define explicit priority?
- 5 different control styles possible:
  - **appelt** (longest match, plus explicit priorities)
  - **first** (shortest match fires)
  - **once** (shortest match fires, and all matching stops)
  - **brill** (fire every match that applies)
  - **all** (all possible matches, starting from each offset in turn)



# Matching styles







# Appelt style

- In the appelt style, which rule to apply is selected in the following order:
  - longest match
  - explicit priority
  - rule defined first
- Each rule has an optional priority parameter, whose value is an integer
- Higher numbers have greater priority
- If no explicit priority parameter, default value is -1
- Once a match has fired, matching continues from the next offset following the end of the match

```
Rule:    Location1
```

```
Priority: 25
```



# Priorities in appelt style

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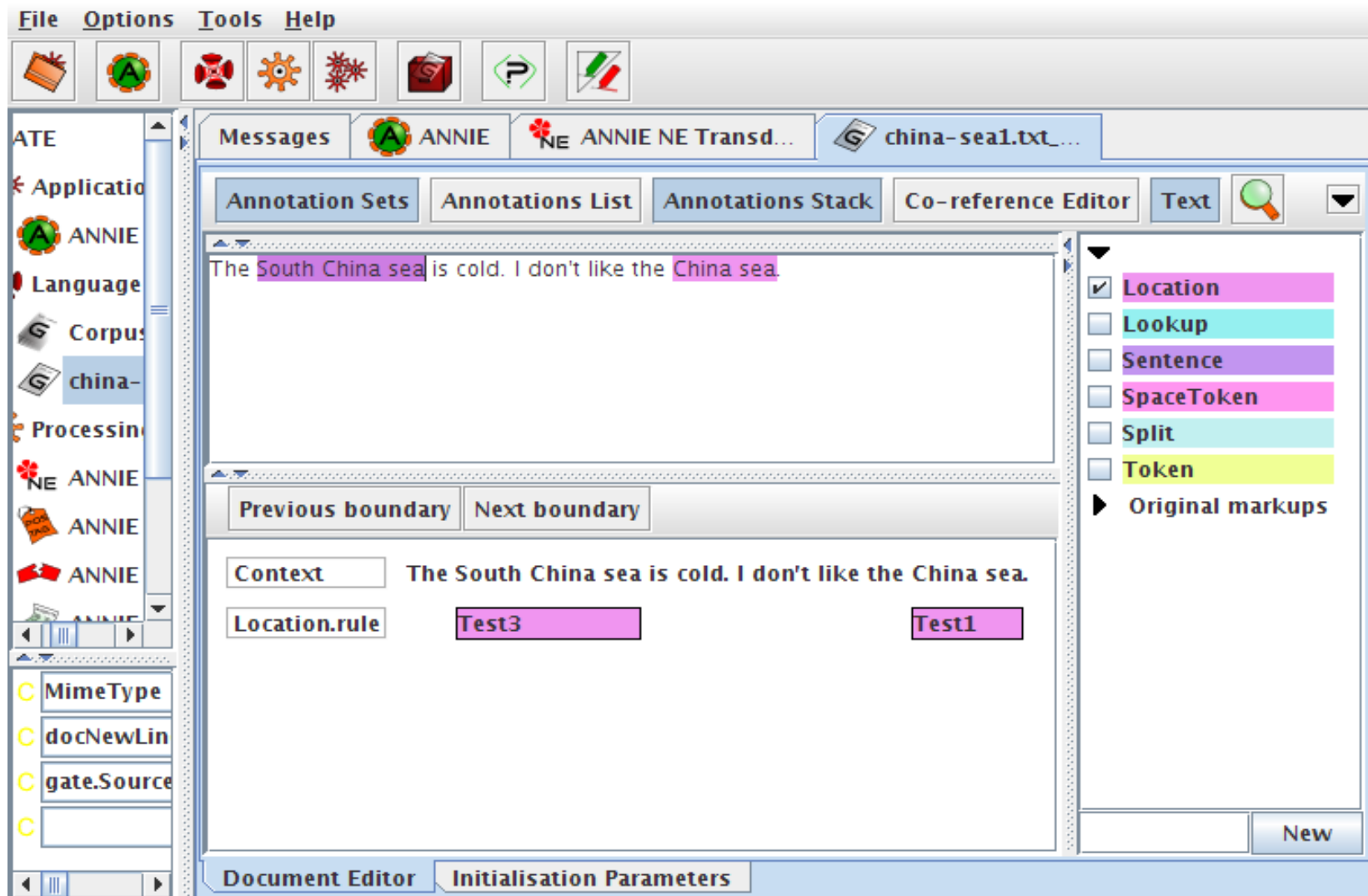
- Remove any NE transducers and any documents and corpora you have loaded in GATE
- Load the document china-sea1.txt
- Load grammar china-sea1.jape and add it to the ANNIE application
- Run the application on the corpus
- View the Location annotations
- “South China sea” is matched by rule 3, because it is the longest match
- “China sea” is matched by rule 1, because match length is the same for all 3 rules, and rule 1 has highest priority



# Annotations stack view

- For these exercises, you might wish to use the annotations stack view.
- This shows the annotations in “stack” form rather than tabular form
- In the document viewer, select “Annotation Sets” and “Annotation Stack”
- Select Location from the annotation set view
- A viewer will show the Location annotations
- Use the “previous boundary” and “next boundary” to move between the different Location annotations
- Double click “Location” in the stack viewer to add features you wish to view (e.g. “rule”)

# Viewing the annotation stack



The screenshot displays the GATE (General Architecture for Text Engineering) software interface. The main window shows the text "The South China sea is cold. I don't like the China sea." with two phrases highlighted in purple: "South China sea" and "China sea".

The interface includes a menu bar (File, Options, Tools, Help) and a toolbar with various icons. The left sidebar contains a tree view with categories like Application, Language, Corpus, Processing, and ANNIE. The top toolbar has tabs for Messages, ANNIE, ANNIE NE Transd..., and china-sea1.txt... Below this, there are tabs for Annotation Sets, Annotations List, Annotations Stack (selected), Co-reference Editor, and Text.

The main text area shows the sentence with the highlighted phrases. Below the text area, there are buttons for "Previous boundary" and "Next boundary". A "Context" field shows the full sentence: "The South China sea is cold. I don't like the China sea." Below that, a "Location.rule" field shows "Test3" and "Test1" highlighted in purple.

On the right side, there is a list of annotation types with checkboxes:

- Location (highlighted in pink)
- Lookup (highlighted in cyan)
- Sentence (highlighted in purple)
- SpaceToken (highlighted in pink)
- Split (highlighted in cyan)
- Token (highlighted in yellow)
- Original markups

At the bottom, there are tabs for "Document Editor" and "Initialisation Parameters". A "New" button is located at the bottom right.



# Difference between first and once

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- With both styles, the first match is fired
- This means they're inappropriate for rules ending in the operators + ? or \*
- The difference between the two styles is what happens after a match has been found
- With the once style, the whole grammar phase is exited and no more matches are attempted
- With the first style, matching continues from the offset following the end of the existing match

# What does “first match” mean?

- Some people think of the “first match” as the shortest, but it's not quite the same.

Phase: MatchingStyles

Input: Lookup

Options: control = first

Rule: Test1

```
(  
  {Lookup.majorType == location}  
  ({Lookup.majorType == loc_key})?  
):match
```

-->

```
:match.Location = {rule=Test1}
```

What do you think  
this grammar will do  
on your document?

Will it annotate  
“China” or “China  
sea”?



# First match

---

- Remove old grammar, load the grammar “china-sea2.jape”
- Add it to your application and run it on the china-sea document
- “China” is annotated rather than “China sea” because it is a shorter match (the optional Lookup at the end is ignored)

# Shortest match?

- Now look at this rule:

Phase: MatchingStyles

Input: Lookup

Options: control = first

Rule: Test1

```
(  
  {Lookup.majorType == location}  
  ({Lookup.majorType == loc_key})?  
):match  
-->
```

```
:match.Location = {rule=Test1}
```

What about this  
grammar rule?

Will it annotate  
“China” or “China  
sea”?



## First match (2)

- Now remove the grammar and load the grammar “china-sea3.jape”, add it to your application and run it on the china-sea document
- Were you expecting just “sea” to be annotated?
- The first Lookup is optional, BUT there is a possible match starting from the beginning of “China” before moving on to the next offsets. So this match is the one that is chosen.

# Difference between brill and all

---

- Both Brill and all match every possible combination from a given starting position
- When a match has been found, brill starts looking for the next match from the offset at the **end** of the longest match
- **All** starts looking for the next match by advancing one offset from the **beginning** of the previous match



# Offset advancing: brill and all

- Unload the grammar and load the grammar “china-sea4.jape”
- Add it to the application, and run on your china-sea document
- Use the annotation stack viewer to see the results
- You should get 4 Location annotations in total.
- Now change the matching style from brill to all in the grammar (using your text editor), reinitialise the NE transducer in GATE and run again
- See the difference using the annotation stack viewer
- You should now get 6 Location annotations

# South China Sea Results

```
{Lookup.minorType == pre}?  
{Lookup.majorType == location}  
{Lookup.majorType == loc_key}?
```

## Style

brill

all

## Annotated text

South China sea  
South China

South China sea  
South China  
China sea  
China



# LHS Macros

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- Macros provide an easy way to reuse long or complex patterns
- The macro is specified once at the beginning of the grammar, and can then be reused by simply referring to its name, in all future rules
- Macros hold for ALL subsequent grammar files
- If a new macro is given later with the same name, it will override the previous one for that grammar
- Macro names are by convention written in capitals, and can only contain alphanumeric characters and underscores
- A macro looks like the LHS of a rule but without a label

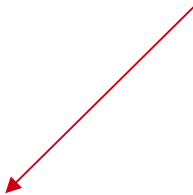
# Using a macro in a rule

Macro: NUMBER\_FULL

```
{Token.kind == number}
  ({Token.string == "," | {Token.string == "."})
  {Token.kind == number}
)*
)
```

Rule: MoneyCurrencyUnit

```
(
  (NUMBER_FULL) ?
  ({Lookup.majorType == currency_unit})
)
```



:number -->

```
:number.Money = {kind = "number", rule =
"MoneyCurrencyUnit"}
```

# Multi-constraint statements

- You can have more than one constraint on a pattern
- Just separate the constraints with a comma
- Make sure that all constraints are enclosed within a single curly brace

```
{Lookup.majorType == loc_key,  
  Lookup.minorType == post}
```

Is not the same as

```
{Lookup.majorType == loc_key}  
{Lookup.minorType == post}
```



# Negative constraints on annotations (!)

- You can use the ! operator to indicate negation
- Negative constraints are generally used in combination with positive ones to constrain the locations at which the positive constraint can match.

**Rule: PossibleName**

```
(  
  {Token.orth == "upperInitial", !Lookup}  
) : name  
-->  
: name.PossibleName = {}
```

- Matches any uppercase-initial Token, where there is no Lookup annotation starting at the same location





# Negative constraints on features (!=)

- The previous example showed a negative constraint on an annotation `{ !Lookup }`
- You can also constrain the features of an annotation
- `{Lookup.majorType != stop}` would match any Lookup except those with majorType “stop” (stopwords)
- Be careful about the difference between this and `{ !Lookup.majorType == stop }`
- This matches ANY annotation except a Lookup whose majorType is “stop”, rather than any Lookup where the majorType is not “stop”



# Comparison operators

---

- So far, we have compared features with the equality operators `==` and `!=`
- We can also use the comparison operators `>`, `>=`, `<` and `<=`
- `{Token.length > 3}` matches a Token annotation whose length is an integer greater than 3

# Regular expression operators

- You can also use `=~` and `==~` to match regular expressions
- `{Token.string ==~ "[Dd]ogs"}` matches a Token whose string feature value is (exactly) either “dogs” or “Dogs”
- `{Token.string =~ "[Dd]ogs"}` is the same but matches a Token whose string feature CONTAINS either “dogs” or “Dogs” within it
- Similarly, you can use `!~` and `!=~`
- In the first example, it would match a Token whose string feature is NOT either “dogs” or “Dogs”
- In the second example, it would match a Token whose string feature does NOT contain either “dogs” or “Dogs” within it



# Contextual operators

- The contextual operators “contains” and “within” match annotations within the context of other annotations
- {Organization contains Person} matches if an Organization annotation completely contains a Person annotation.
- {Person within Organization} matches if a Person annotation lies completely within an Organization annotation
- The difference between the two is that the first annotation specified is the one matched
- In the first example, Organization is matched
- In the second example, Person is matched



# Combining operators

- You can combine operators of different types, e.g.
- `{Person within {Lookup.majorType == organization}}`
- `{!Person within {Lookup.majorType == organization}}`
- `{Person within {Lookup.majorType != organization}}`
- `{Person contains {!Lookup}, Person within {Organization}}`
- But be sure you know what you're doing, as it can get quite complicated!



# Summary

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- This module has looked at some basic operations within JAPE.
- The best way to learn is to keep practising. Try things out and see what happens.
- It's usually best to build up JAPE rules in simple steps.
- Trying to do too much in a single rule will get you confused.
- Pay close attention to syntax and to things like making sure case is respected and that you have no typos in your rules.
- Remember you can use in your JAPE rules any annotations that you have previously used in your pipeline.
- You can also use any Java you want in your rules.
- Come back next time for the programming track to learn more about that!

# China Sea Results (1)

{Lookup.majorType == location} ({Lookup.majorType == loc\_key})?

Style	Annotated text	No of annotations
first	China	2
once	China	1
appelt	China sea	2
brill	China sea China	2 2
all	China sea China	2 2

## China Sea Results (2)

{Lookup.majorType == location}? {Lookup.majorType == loc\_key}

Style	Annotated text	No of annotations
first	China sea	2
once	China sea	1
appelt	China sea	2
brill	China sea	2
all	China sea China	2 2