



MINISTRY OF DEFENCE

INTERNATIONAL TECHNOLOGY ALLIANCE IN NETWORK & INFORMATION SCIENCES

Extraction and Use of Domain Semantics from NL sentences using ITA Controlled English

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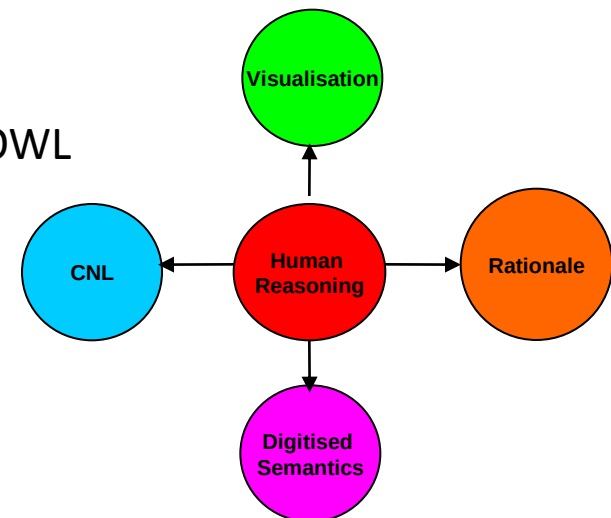
ITA Research Objectives

- Extract facts in Controlled English from Natural Language documents
- Facilitate configuration of NL processing tools in Controlled English
- Provide rationale for linguistic and analytic processing

We are not tasked with creating fundamental breakthroughs in the theory of NL processing

What do we mean by Controlled English?

- *Controlled English is a Controlled Natural language, being a subset of English that is both human readable and machine interpretable*
- Based upon **Conceptual Models** defined by the users:
 - types of things, and their relationships
 - the **written language** used to express facts about things and relations
 - **logical rules** allowing query and inference on sets of facts
- CE is one component to support reasoning
 - Support for different **problem solving strategies**
 - Conversion to other **digitised semantic languages**, eg OWL
 - Use of **rationale** to express flow of reasoning
 - **Visualisation** techniques for showing CE facts



Models, Facts, Assumptions

Meta Model	Concept, Entity Concept, Relation Concept, Conceptual Model	belongs to, has as domain
Semiotics Model	Thing, Meaning, Symbol	stands for, expresses
General Model	Agent, Spatial Entity, Temporal Entity, Situation, Container	has as agent role, is contained in
Linguistic Model	Sentence, Phrase, Noun, Word, Word Sense, Predicate, Linguistic Frame	has as dependent, is parsed from, expresses
Analysts Domain Model	Place, Person, Village, Communication, IED, Facility,	is located in, monitors

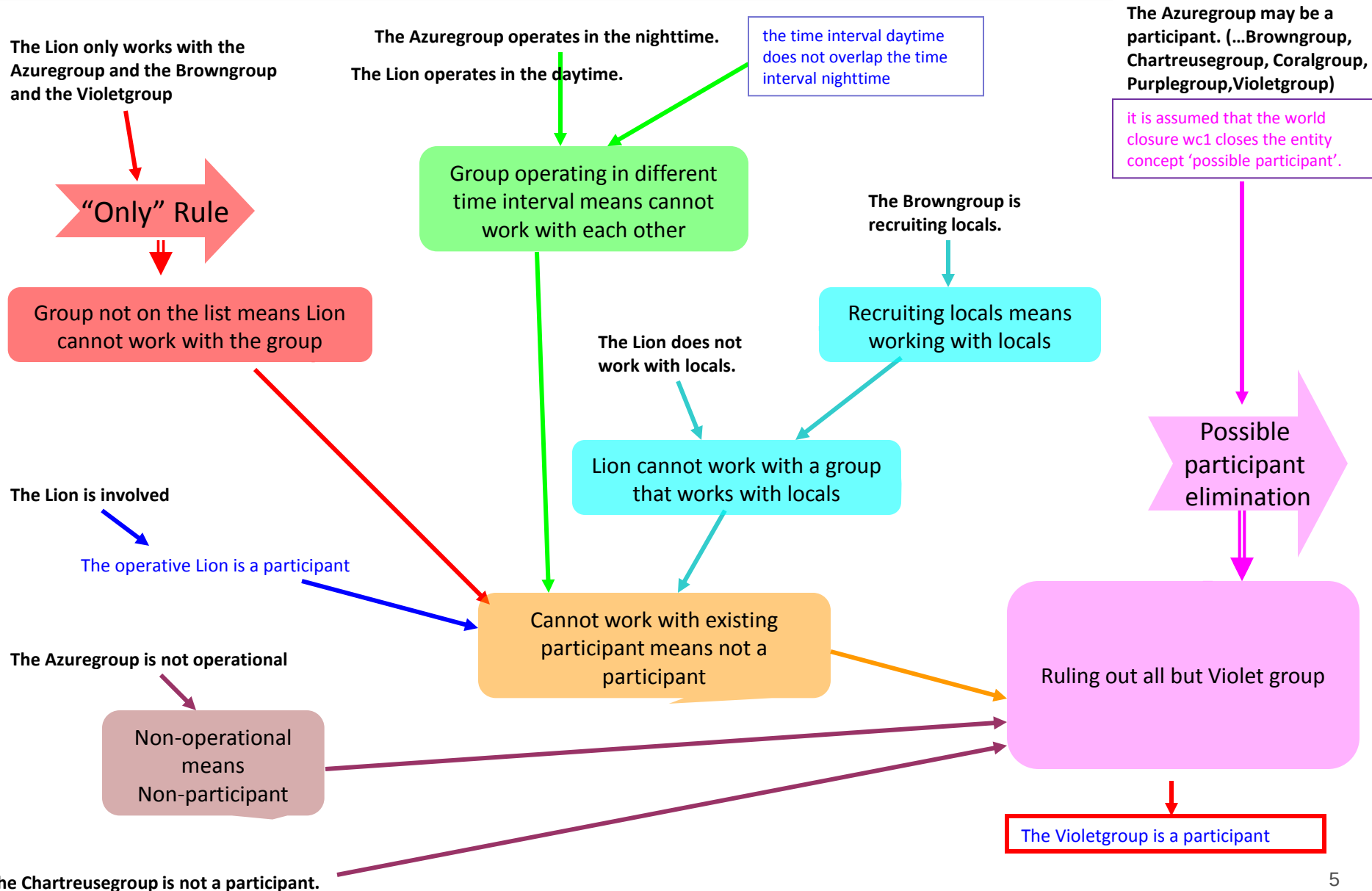
there is a possible participant named Azuregroup that operates in the time interval daytime.

the agent Lion cannot work with the group Browngroup.

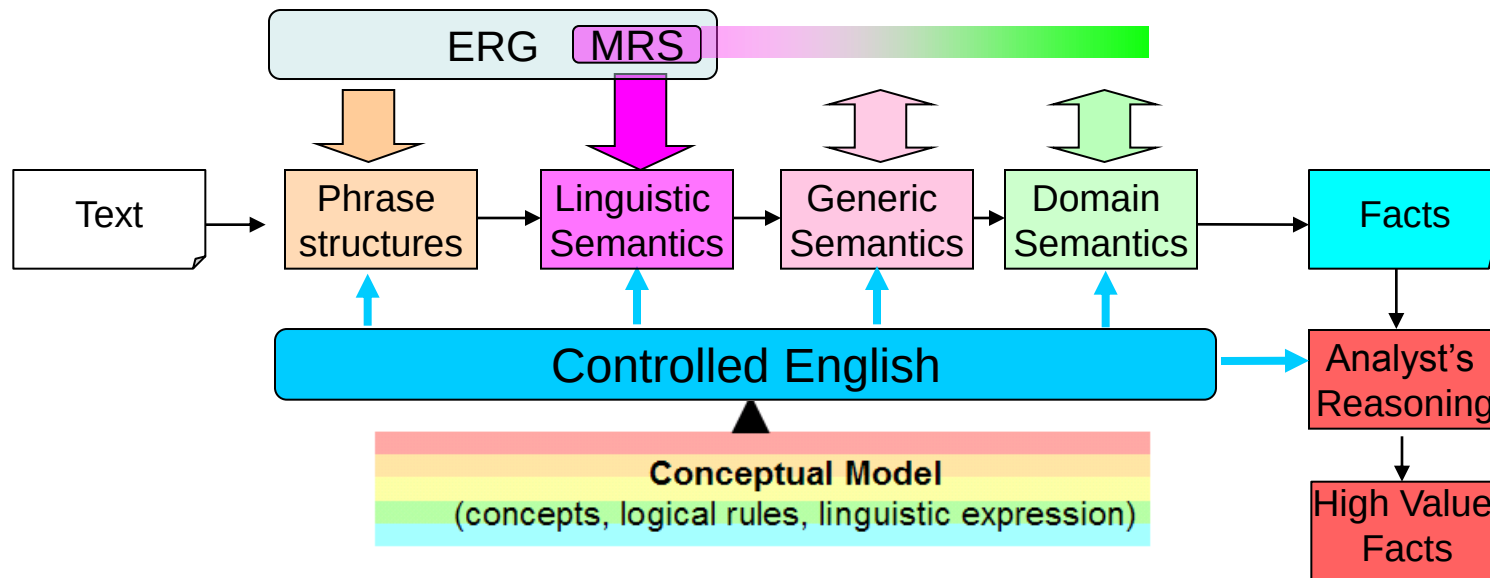
if (the agent A cannot work with the agent B)
then (the agent B cannot work with the agent A).

it is assumed that the attack a1 involves the group Browngroup.

The goal!



Integrating CE and the ERG



- English Resource Grammar (ERG) to provide detailed syntactic structures
- Minimal Recursion Semantics (MRS) to express Linguistic Semantics
- Generic semantics to represent the world in terms of situations and roles
- Domain semantics to
 - express facts in the user's concepts
 - to extract high value facts from extracted facts
- Research into
 - the integration of domain semantics and linguistic processing
 - how linguistic knowledge can be represented in Controlled English

Mini-Demonstration

Linguistic information

MRS

"John chases the cat"

```
[ LTOP: h1
  INDEX: e3 [ e SF: PROP TENSE: PRES MOOD: INDICATIVE PROG: - PERF: -
  ]
  RELS: <
    [ proper_q_rel<0:4>
      LBL: h4
      ARG0: x7 [ x PERS: 3 NUM: SG GEND: M IND: + ]
      RSTR: h6
      BODY: h5 ]
    [ named_rel<0:4>
      LBL: h8
      ARG0: x7
      CARG: "John" ]
    [ "_chase_v_1_rel"<5:11>
      LBL: h2
      ARG0: e3
      ARG1: x7
      ARG2: x9 [ x PERS: 3 NUM: SG IND: + ] ]
    [ _the_q_rel<12:15>
      LBL: h10
      ARG0: x9
      RSTR: h12
      BODY: h11 ]
    [ "_cat_n_1_rel"<16:19>
      LBL: h13
      ARG0: x9 ] >
  HCONS: < h1 qeq h2 h6 qeq h8 h12 qeq h13 > ]
```

MRS in CE

the mrs elementary predication #ep0 is an instance of the mrs predicate 'proper_q_rel' and has the thing x7 as zeroth argument.

the mrs elementary predication #ep1 is an instance of the mrs predicate 'named_rel' and has the thing x7 as zeroth argument and has 'John' as c argument.

the mrs elementary predication #ep2 is an instance of the mrs predicate '_chase_v_1_rel' and has the situation e3 as zeroth argument and has the thing x7 as first argument and has the thing x9 as second argument.

the mrs elementary predication #ep3 is an instance of the mrs predicate '_the_q_rel' and has the thing x9 as zeroth argument.

the mrs elementary predication #ep4 is an instance of the mrs predicate '_cat_n_1_rel' and has the thing x9 as zeroth argument.

But just because its in a form of English, it doesn't mean its easy to understand the concepts

MRS in Controlled English

the mrs elementary predication #ep0 is an instance of the mrs predicate 'proper_q_rel'
and has the thing x7 as zeroth argument.

the mrs elementary predication #ep1 is an instance of the mrs predicate 'named_rel'
and has the thing x7 as zeroth argument
and has 'John' as c argument.

the mrs elementary predication #ep2 is an instance of the mrs predicate '_chase_v_1_rel'
and has the situation e3 as zeroth argument
and has the thing x7 as first argument
and has the thing x9 as second argument.

Predicate Logic:
chase(e3,x7,x9)

the mrs elementary predication #ep3 is an instance of the mrs predicate '_the_q_rel'
and has the thing x9 as zeroth argument.

Predicate Logic:
cat(x9)

the mrs elementary predication #ep4 is an instance of the mrs predicate '_cat_n_1_rel'
and has the thing x9 as zeroth argument.

-- MRS extra features

the situation e3 has the category 'SF:PROP' as feature and has the tense category 'PRES' as feature and has the mood category indicative as feature and has the category 'PROG:-' as feature and has the category 'PERF:-' as feature.

the thing x7 has the person category third as feature and has the number category singular as feature and has the gender category male as feature and has the category 'IND:+' as feature.

the thing x9 has the person category third as feature and has the number category singular as feature and has the category 'IND:+' as feature.

-- Scope information

the mrs elementary predication #ep0_563 equals modulo quantifiers the mrs elementary predication #ep1_563.

the mrs elementary predication #ep3_563 equals modulo quantifiers the mrs elementary predication #ep4_563.

But just
because its in a
form of English,
it doesn't mean
its easy to
understand the
concepts

MRS shown in tabular form

John chases the cat.

MRS elementary predications
+ arguments

the ep #ep0 proper q_rel				
	has as <u>zeroth</u> argument			x7
the ep #ep1 named_rel				
	has as <u>zeroth</u> argument			x7
	has as c argument	John		
the ep #ep2 _chase_v_1_rel				
	has as <u>zeroth</u> argument	the situation e3		
	has as first argument			x7
	has as second argument			x9
the ep #ep3 _the q_rel				
	has as <u>zeroth</u> argument			x9
the ep #ep4 _cat_n_1_rel				
	has as <u>zeroth</u> argument			x9

things

Its still CE in
tabular form!

Semantics are linguistically “nuanced”

The person John chases the cat.

“Apposition” is a linguistic phenomenon

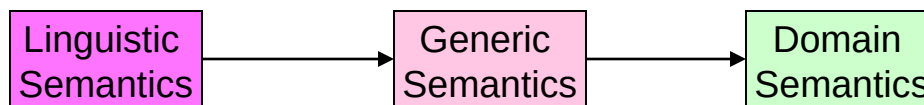
Probably wouldn’t include “apposition” in your formalisation of this sentence!

- May look logical but still related to the language structure

the ep #ep0 appos_rel								
	has as zeroth argument			the situation e4				
	has as first argument						x6	
	has as second argument					x5		
the ep #ep1 the_q_rel								
	has as zeroth argument						x6	
the ep #ep2 person_n_1_rel								
	has as zeroth argument						x6	
the ep #ep3 proper_q_rel								
	has as zeroth argument					x5		
the ep #ep4 named_rel								
	has as zeroth argument					x5		
	has as c argument	John						
the ep #ep5 chase_v_1_rel								
	has as zeroth argument		the situation e3					
	has as first argument						x6	
	has as second argument					x15		
the ep #ep6 the_q_rel								
	has as zeroth argument					x15		
the ep #ep7 cat_n_1_rel								
	has as zeroth argument					x15		

The role of Generic Semantics

- We want to abstract away as much of the linguistic details as possible
- We aim to map to “generic semantics”
 - Situations, roles, containers
- But we still need the extracted facts in terms of the domain concepts
 - People, cats, agents, “works with”, etc
- So we must map from “generic semantics” to domain semantics



separation is not
always clearcut

Mapping to generic semantics - 1

nouns like “cat” express types of things and words like “the” express specific individuals of that class

“... the cat”

the ep #ep3 the q_rel					
	has as <u>zeroth</u> argument				x9
the ep #ep4 cat_n_1_rel					
	has as <u>zeroth</u> argument				x9

Linguistic terminology

there is a definite quantifier named q1 that is on the thing x9.

the mrs predicate ‘_cat_n_1_rel’ expresses the entity concept ‘feline’.

Mapping between word (sense) and domain concept

conceptualise a ~ feline ~ F
that is an animal.

the thing x9 is a feline.

Mapping to generic semantics - 2

“verbs like “chase” express situations or states of affairs together with actors that play roles in that situation”

the ep #ep2 _chase_v_1_rel				
	has as <u>zeroth</u> argument		the situation e3	
	has as first argument			x7
	has as second argument			x9

the mrs predicate ‘_chase_v_1_rel’ expresses the situation concept ‘chase situation’.

there is a chase situation named s1.

Mapping between word (sense) and domain concept

conceptualise a ~ chase situation ~ S that is a situation.

the mrs predicate ‘_chase_v_1_rel’ has 'second argument' as second role source

the chase situation s1 has the thing x7 as first role and has the thing x9 as second role.

How to find the second role

Mapping into domain semantics

“situations can be seen as relationships between the actors”

there is a chase situation s1 that has the person John21 as first role and has the feline x9 as second role.

We know John is a person, based on matching a set of reference entities

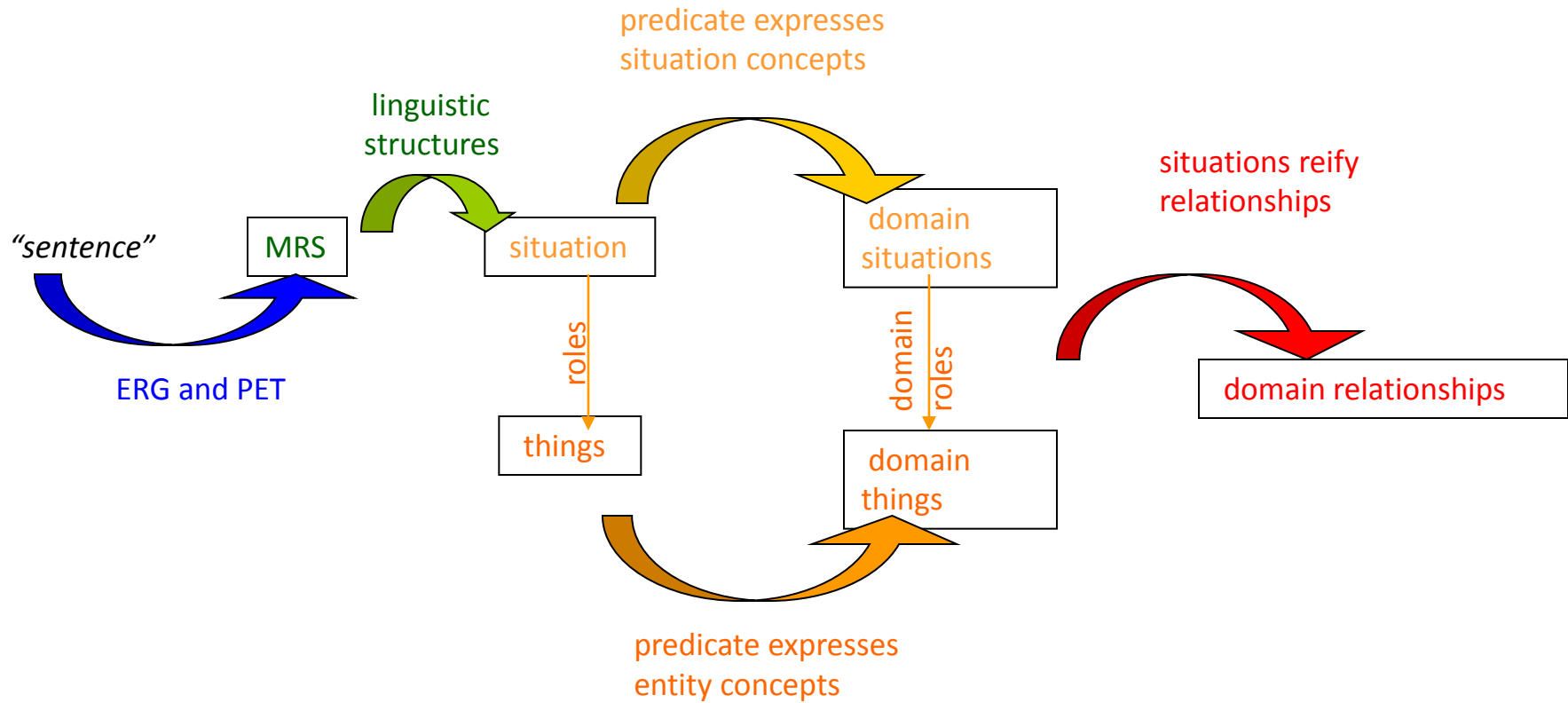
the entity concept 'chase situation' reifies the relation concept 'chases'

Mapping between domain situation and domain relationships

conceptualise
the volitional agent A ~ chases ~ the thing B.

the person John21 chases the feline x9

Processing an NL sentence



"ERG system"

"CE system"

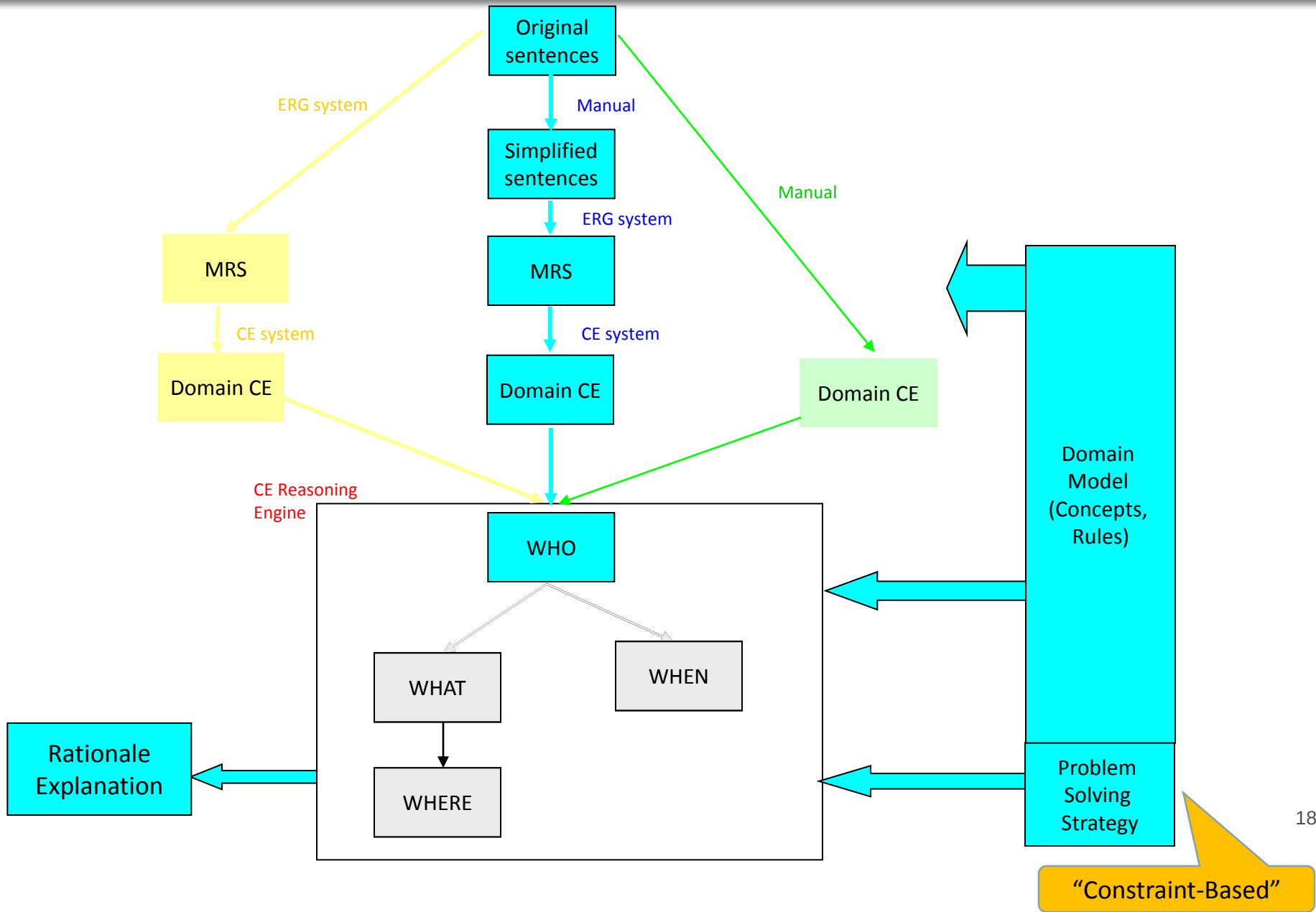
ELICIT identification task

- 1 The Lion is involved
- 2 Word has it that an unprotected target is preferred to ensure the likelihood of success (can assume is true)
- 3 The Lion doesn't operate in Chiland
- 4 The Lion attacks in daylight
- 5 The Azure, Brown, Coral, Violet, or Chartreuse groups may be planning an attack
- 6 The Azure and Violet groups use only their own operatives, never employing locals
- 7 The Chartreuse group is not involved
- 8 The Lion is known to work only with the Azure, Brown, or Violet groups
- 9 The Purple or Gold group may be involved
- 10 All of the members of the Azure group are now in custody
- 11 Reports from the Coral group indicate a reorganization
- 12 There is a lot of activity involving the Violet group
- 13 The Brown group is recruiting locals - intentions unknown
- 14 The Lion will not risk working with locals
- 15 The Jackal has been seen in Tauland
- 16 Members of the Purple group have been visiting Omegaland
- 17 The Chartreuse group has close ties with local media
- 18 The Azure group has a history of attacking embassies
- 19 The Purple and Gold groups have blood ties
- 20 The Brown group has been known to use IED's
- 21 Only the Coral and Violet groups have a capacity to hit protected targets
- 22 All high value targets belonging to Tauland and Epsilonland are well protected
- 23 The attackers are focusing on a high visibility target
- 24 Caches of explosives have recently been found in Epsilonland, Chiland, and Psiland
- 25 Financial institutions in Tauland, Chiland, and Omegaland were recently attacked there is evidence of more attacks
- 26 Reports that uniforms were stolen in Tauland, Epsilonland and Psiland
- 27 Bloggers are discussing the role of financial institutions in oppressing the Coral, Violet and Chartreuse groups
- 28 Members of the Violet and Chartreuse groups were active in planning protests at a recent financial summit
- 29 Security forces are providing highly visible, around the clock protection to all visiting dignitaries in the region
- 30 Dignitaries in Epsilonland employ private guards
- 31 Tau, Epsilon, Chi, Psi and Omega-lands are providing visible, around the clock protection to their own dignitaries at home
- 32 A new train station is being built in the capital of country Tauland
- 33 Tauland's embassy in Epsilonland has a flat roof
- 34 Until recently most of the dignitaries in Tauland rode in Mercedes
- 35 Dignitaries in Chiland have motorcycle escorts
- 36 Epsilonland's embassy in Tauland has two helicopter pads
- 37 The Azure, Brown, Coral, and Violet groups have the capacity to operate in Tau, Epsilon, Chi, Psi and Omega-lands
- 38 Locals in Tauland, Epsilonland and Omegaland are being recruited
- 39 Countries Chiland, Psiland and Omegaland are taking steps to protect their embassies abroad
- 40 The Brown group members have entered Tauland and Epsilonland
- 41 Reports from Tauland, Chiland and Psiland indicate surveillance ongoing at coalition embassies
- 42 The target is a coalition member embassy, visiting dignitary, or financial institution (Tau, Epsilon, Chi, Psi or Omega-lands)
- 43 No traces of members from the Coral group have been found in countries Psiland or Omegaland
- 44 Chiland is in the process of deploying troops to protect the embassies of coalition partners
- 45 The Azure, Brown, and Coral groups want to attack the interests of Tauland, Epsilonland or Chiland
- 46 The Coral and Violet group operatives have entered Psiland
- 47 All high value targets of Omegaland are well protected
- 48 There has been an increase in messages intercepted in Psiland
- 49 The Lion was born in Tauland
- 50 There is no new information about Brown group operations in Chiland
- 51 Epsilonland is mountainous
- 52 Tauland is land locked
- 53 The attack will be at 11:00
- 54 The Azure and Brown groups prefer to attack at night
- 55 The Tauland embassy in Epsilonland is hosting a international conference on the 10th
- 56 The Chartreuse, Purple and Gold groups are known to attack at any time of the day
- 57 Attacking buildings when there are many people present increases casualties
- 58 The Coral, Chartreuse and Purple groups are capable of attacking year round
- 59 The Lion is planning something in April on the anniversary of his father's death
- 60 There are fewer attacks in the dead of winter (January thru March)
- 61 The Violet and Chartreuse groups want to attack the interests of Chiland, Psiland and Omegaland
- 62 The Violet group is planning something big on the 5th
- 63 The Violet group prefers to operate in daylight
- 64 The lion was born in June
- 65 The Coral group prefers to attack at night
- 66 The Purple group prefers to attack in daylight
- 67 The Brown group needs time to regroup
- 68 The Azure group does not attack on its holy days

WHO is attacking, WHAT is being attacked, WHEN, WHERE?

Ambiguities, eg
"Dignitaries in Epsilonland employ private guards" what does "in" mean?

Approach to solving the ELICIT task



Examples of domain rules

[non_operational]

if

(there is an agent named A that
is a non-operational agent)

then

(the agent A is a non-participant).

[cannot_work_with]

if

(the agent A cannot work with the agent B) and
(the agent B works with the agent C)

then

(the agent A cannot work with the agent C).

[sem_participant]

if

(there is a situation named elicitsituation) and
(there is a participant named P)

then

(the situation elicitsituation involves the participant P).

[no_time_overlap]

if

(the operative A operates in the time interval TA) and
(the group B operates in the time interval TB) and
(the time interval TA does not overlap the time interval TB)

then

(the operative A cannot work with the group B).

[visiting_dignitary]

if

(there is a dignitary named D that
is an official of the country HOME C and
is located in the country HOST C) and
(the country HOME C # the country HOST C)

then

(the dignitary D is visiting the country HOST C).

Generating Facts and Rules

Original	Simplified	CE
<i>The Lion is involved</i>	The Lion is a participant	there is a participant named Lion.
<i>The Lion attacks in daylight</i>	The Lion operates in the daytime.	the operative 'Lion' operates in the time interval daytime.
<i>The Azure, Brown, Coral, Violet, or Chartreuse groups may be planning an attack.</i>	The Azuregroup may be a participant. The Browngroup may be a participant. ...	there is a possible participant named Azuregroup. there is a possible participant named Browngroup
<i>The Chartreuse group is not involved</i>	The Chartreusement is not a participant.	there is a non-participant named Chartreusement.
<i>All of the members of the Azure group are now in custody</i>	The Azuregroup is not operational	there is a non-operational agent named Azuregroup.
<i>The Brown group is recruiting locals - intentions unknown</i>	The Browngroup is recruiting locals.	the group 'Browngroup' recruits the local agent 'a local agent'.
<i>The Lion will not risk working with locals</i>	The Lion does not work with locals.	the operative 'Lion' cannot work with the local agent 'a local agent'.
<i>The Azure and Brown groups prefer to attack at night</i>	The Azuregroup operates in the nighttime. The Browngroup operates in the nighttime.	the group 'Azuregroup' operates in the time interval nighttime. the group 'Browngroup' operates in the time interval nighttime.

Original	Simplified	CE
<i>The Lion is known to work only with the Azure, Brown, or Violet groups</i>	The Lion only works with the Azuregroup and Browngroup and Violetgroup.	if (there is a agent named Lion) and (the agent A is different to the agent Azuregroup) and (the agent A is different to the agent Browngroup) and (the agent A is different to the agent Violetgroup) then (the agent Lion cannot work with the agent A).

"The Lion is a participant" - rules

the ep #ep0 _the_q_rel				
	has as zeroth argument		x7	
the ep #ep1 _named_rel				
	has as zeroth argument		x7	
	has as c argument		Lion	
the ep #ep2 _be_v_id_rel				
	has as zeroth argument		the situation e3	
	has as first argument		x7	
	has as second argument			x9
the ep #ep3 _a_q_rel				
	has as zeroth argument			x9
the ep #ep4 _participant_n_1_rel				
	has as zeroth argument			x9

[mrs_normal_situation]

if
 (there is an mrs elementary predication named P that
 has the situation S as zeroth domain argument) and
 (it is false that the mrs elementary predication P
 is a marked elementary predication)
 then
 (the situation S is a normal situation).

Identify a
normal
situation

the mrs predicate '_participant_n_1_rel' expresses
the entity concept 'participant'.

if
 (the mrs elementary predication P
 has the thing T as first argument) and
 (there is an mrs elementary predication NP that
 is an instance of the mrs predicate 'named_rel' and
 has the thing T as first argument and
 has the value C as c argument) and
 (there is a reference entity named REF that
 has the value C as common name)
 then
 (the mrs elementary predication P
 has the reference entity REF as first domain argument).

the agent Lion has 'Lion' as
common name and
is a reference entity.

Match
arguments
to reference
entities

the mrs elementary predication #ep2 has the agent Lion
as first domain argument

if (the mrs elementary predication EP
 is an instance of the mrs predicate '_be_v_id_rel' and
 has the normal situation S as zeroth domain argument and
 has the thing SUBJ as first domain argument and
 has the thing PRED as second domain argument) and
 (the mrs elementary predication EP1
 is an instance of the mrs predicate '_a_q_rel' and
 has the thing PRED as zeroth domain argument) and
 (the mrs elementary predication EP2
 is an instance of the mrs predicate CATEGORY and
 has the thing PRED as zeroth domain argument) and
 (the mrs predicate CATEGORY expresses the entity concept EC)
 then
 (the thing SUBJ realises the entity concept EC).

Handle the
"be a XXX"

the agent Lion realises the entity concept participant.

there is a participant named Lion.

"The Lion is a participant" - abstract

the ep #ep0 _the_q_rel				
	has as zeroth argument	x7		
the ep #ep1 named_rel				
	has as zeroth argument	x7		
	has as c argument	Lion		
the ep #ep2 _be_v_id_rel				
	has as zeroth argument		the situation e3	
	has as first argument	x7		
	has as second argument			x9
the ep #ep3 _a_q_rel				
	has as zeroth argument			x9
the ep #ep4 _participant_n_1_rel				
	has as zeroth argument			x9

Match arguments to reference entities

the agent Lion has 'Lion' as common name and is a reference entity.

the mrs elementary predication #ep2 has the agent Lion as first domain argument

Identify a normal situation

the situation e3 is a normal situation.

Handle the "be a XXX"

the mrs predicate '_participant_n_1_rel' expresses the entity concept 'participant'.

the agent Lion realises the entity concept participant.

there is a participant named Lion.

"The Azuregroup may be a participant" -abstract

"The Azuregroup may be a participant"

MRS output

the ep #ep0 the_q_rel						
	has as zeroth argument					x7
the ep #ep1 named_rel						
	has as zeroth argument					x7
	has as c argument	Azuregroup				
the ep #ep3 be_v_id_rel						
	has as zeroth argument			the situation e12		
	has as first argument					x7
	has as second argument					x11
	is modalised by	#ep2 may_v_modal_rel				
the ep #ep4 a_q_rel						
	has as zeroth argument					x11
the ep #ep5 participant_n_1_rel						
	has as zeroth argument					x11

Identify a modal situation

the situation e12 is a modal situation.

the entity concept 'participant' is modal to the entity concept 'possible participant'.

the mrs predicate '_participant_n_1_rel' expresses the entity concept 'participant'.

the group Azuregroup has "Azuregroup" as common name and is a reference entity.

Match arguments to reference entities

the mrs elementary predication #ep3 has the group Azuregroup as first domain argument.

Handle the modal version of the concept

The group Azuregroup is a possible participant.

Extracting Rules

“sentences using “only” seem to express rules”

The Lion only works with the Azuregroup.

the operating situation #1 has the agent Lion as first role
and has the agent Azuregroup as second role

the operating situation #1 is a
constrained situation

if
(the operating situation S is a constrained situation and
has the agent T1 as first role and
has the agent T2 as second role)

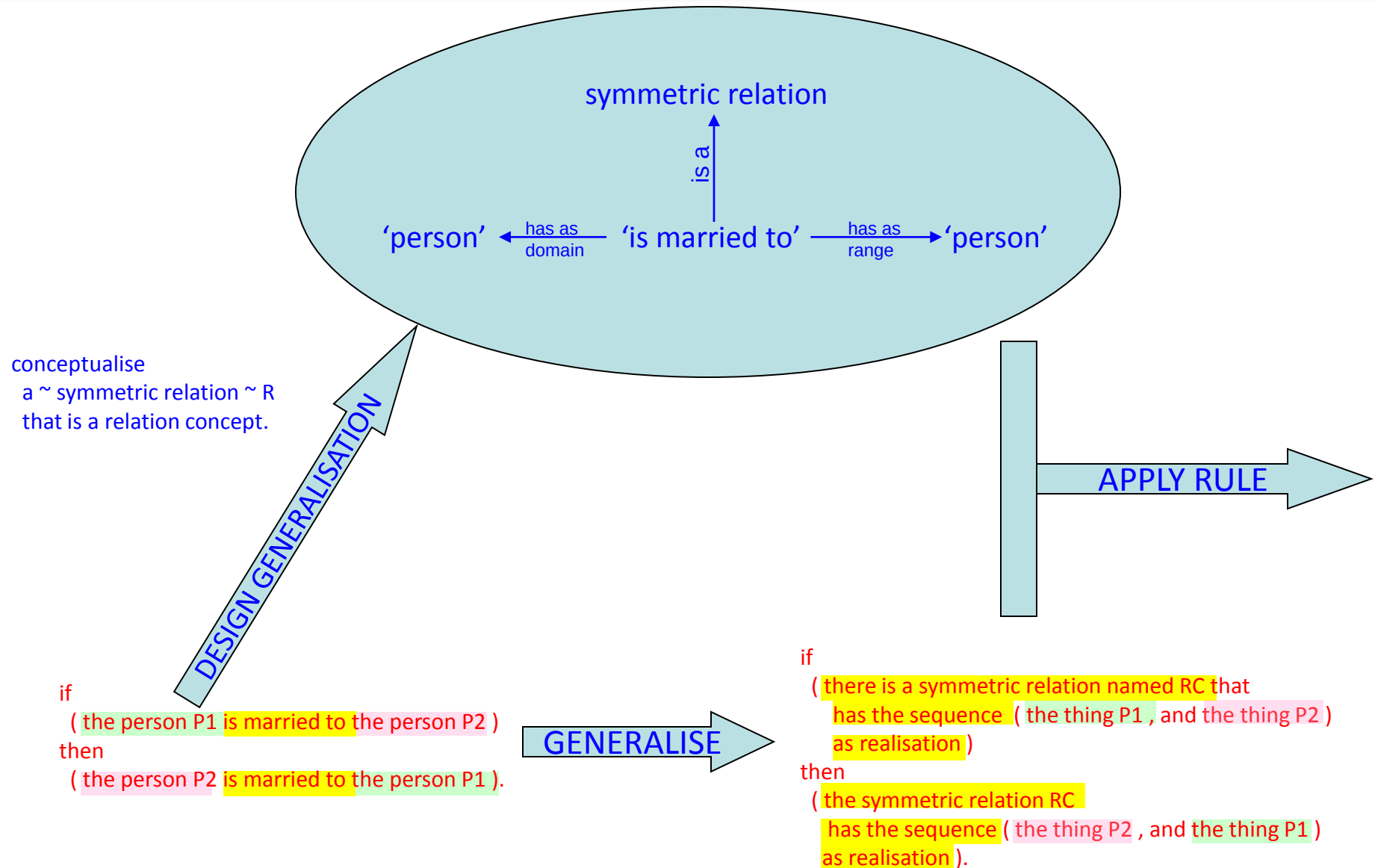
then
(there is a logical inference named LI that
has the statement that
(the agent “A” is different to the agent T2)
as premise and
has the statement that
(the agent T1 cannot work with the agent “A”)
as conclusion
).

This rule writes rules!

Linguistic analysis

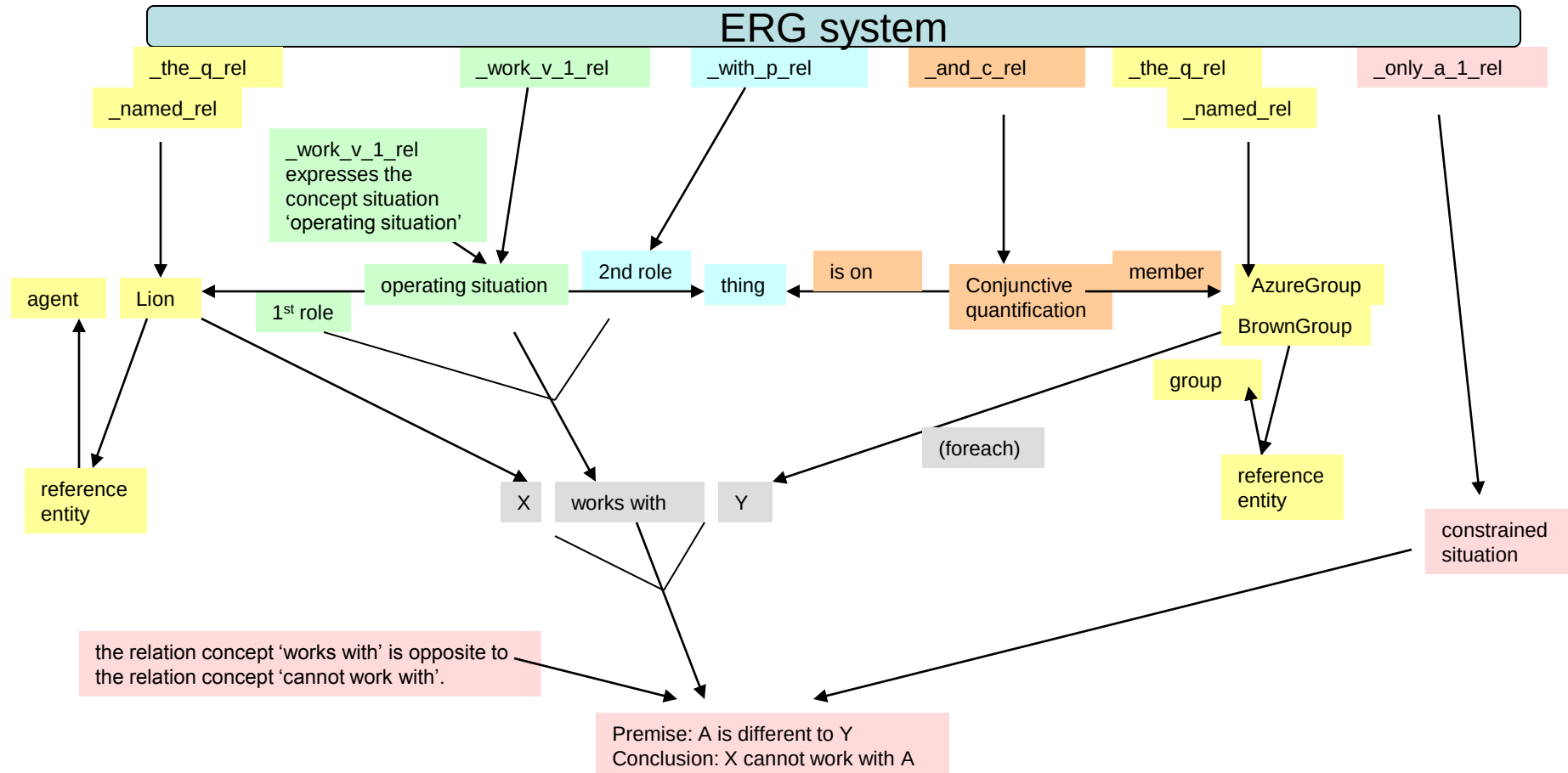
if
(the agent A is different to the agent Azuregroup)
then
(the agent Lion cannot work with the agent A).

Generalising rules with meta-logic



“only” information flow

The Lion only worked with the Azuregroup and the Browngroup.



- WHO

the attack situation elicitsituation

involves the operative Lion and

involves the group VioletGroup.

Summary of Reasoning

The Lion only works with the Azuregroup and the Browngroup and the Violetgroup

The Azuregroup operates in the nighttime.
The Lion operates in the daytime.

the time interval daytime
does not overlap the time
interval nighttime

The Azuregroup may be a participant. (...Browngroup, Chartreusegroup, Coralgroup, Purplegroup, Violetgroup)

it is assumed that the world closure wc1 closes the entity concept 'possible participant'.

"Only" Rule

Group operating in different time interval means cannot work with each other

The Browngroup is recruiting locals.

Group not on the list means Lion cannot work with the group

Recruiting locals means working with locals

The Lion does not work with locals.

Lion cannot work with a group that works with locals

The Lion is involved

The operative Lion is a participant

Possible participant elimination

The Azuregroup is not operational

Non-operational means
Non-participant

Cannot work with existing participant means not a participant

Ruling out all but Violet group

The Violetgroup is a participant

The Chartreusegroup is not a participant.

Summary of Reasoning

The Lion only works with the Azuregroup and the Browngroup and the Violetgroup

The Azuregroup operates in the nighttime.
The Lion operates in the daytime.

the time interval daytime does not overlap the time interval nighttime

The Azuregroup may be a participant.
(...Browngroup, Chartreusegroup, Coralgroup, Purplegroup, Violetgroup)

it is assumed that the world closure wc1 closes the entity concept 'possible participant'.

The Browngroup is recruiting locals.

The Lion does not work with locals.

if
(there is a non-participant named 'Azuregroup') and
(there is a non-participant named 'Browngroup') and
(there is a non-participant named 'Chartreusegroup') and
(there is a non-participant named 'Coralgroup') and
(there is a non-participant named 'Goldgroup') and
(there is a non-participant named 'Purplegroup') and
(there is a possible participant named 'Violetgroup') and
(the world closure wc1 closes the entity concept 'possible participant')

then
(there is a participant named 'Violetgroup').

Lion is a agent	
Azuregroup is a agent	
Browngroup is a agent	
Chartreusegroup is a agent	
Violetgroup is a agent	
Lion cannot work with Chartreusegroup	only_e3_542
Lion cannot work with Coralgroup	only_e3_542
Lion cannot work with Goldgroup	only_e3_542
Lion cannot work with Purplegroup	only_e3_542

Azuregroup operates in nighttime	
Lion operates in daytime	
daytime does not overlap nighttime	
Lion cannot work with Azuregroup	no_time_overlap
Lion cannot work with Browngroup	no_time_overlap
Lion cannot work with Coralgroup	no_time_overlap

Browngroup recruits a local agent	
Browngroup works with a local agent	recruiting_locals_1

Browngroup works with a local agent	
a local agent works with Browngroup	works_with_symmetry

Lion cannot work with a local agent	
a local agent works with Browngroup	
Lion cannot work with Browngroup	cannot_work_with

Lion is a participant	
Lion cannot work with Azuregroup	
Azuregroup is a non-participant	group_non_involvement
Browngroup is a non-participant	group_non_involvement
Coralgroup is a non-participant	group_non_involvement
Goldgroup is a non-participant	group_non_involvement
Purplegroup is a non-participant	group_non_involvement

The Azuregroup is not operational

Azuregroup is a non-operational agent	
Azuregroup is a non-participant	non_operational
Browngroup is a non-participant	non_operational
Coralgroup is a non-participant	non_operational

The Chartreusegroup is not a participant.

Chartreusegroup is a non-participant	
--------------------------------------	--

Violetgroup is a possible participant	
Chartreusegroup is a non-participant	
wc1 is a world closure	
wc1 closes possible participant	ass321
Purplegroup is a non-participant	
Goldgroup is a non-participant	
Coralgroup is a non-participant	
Browngroup is a non-participant	
Azuregroup is a non-participant	
Violetgroup is a participant	wc1_cp_Violetgroup

Some linguistic questions

- “The Coralgroup is a non participant” seems to describe a negative situation
 - is that a situation or isn’t it?
- “The Lion only works with the Azuregroup” seems to describe a rule (of habitual behaviour)
 - How does the rule relate to the basic propositional content?
- “The daytime” has a strange semantics
 - is it a thing, a class of things?
 - why cant you say “a daytime”
- Do the following refer to the same thing?
 - *The Browngroup is recruiting locals.*
 - *The Lion does not work with locals.*
 - Yes and No!
 - Yes: they mean the same generic idea of “locals”
 - Therefore the Browngroup and the Lion cant work together
 - No: in general, one set of “locals” may not be the same as another set.

These questions, and others, lead to theoretical discussions!

Using CE we can describe the possible approaches

Handling Ambiguity?

- Word Sense Disambiguation
 - Assume a word sense.
 - Infer consequences and use domain knowledge to rule out impossible situations
 - Would like to use Wordnet, Verbnet, Wikipedia?
- Sentence interpretations
 - Record any “simplifying assumptions” when translating sentences
 - Track through the rationale to show user
- Uncertainty in NL expressions, eg “*is thought to*”
 - Convert the basic sentence to propositions
 - Label the specific expressions with assumptions
 - Track through rationale and show users

Main focus for
future work

Resolving the “tank” ambiguity

the engineer drove the tank

Truth box assuming water tank

Universal truth box

Truth box assuming military tank

it is assumed that the mrs
predicate ‘_tank_n_1_rel’
expresses the concept ‘water
tank’.

the mrs predicate
‘_drive_v_1_rel’ expresses the
concept ‘drive situation’.

it is assumed that the mrs
predicate ‘_tank_n_1_rel’ expresses
the concept ‘military tank’.

the drive situation e3 has the
thing x9 as second role

META (range of “drives”
+ reification of “drive
situation”)

the thing x9 is a water tank.

the thing x9 is a vehicle

the thing x9 is a military tank.

Inconsistent

This assumption is wrong

This is an extension to NLP
“selectional restriction”

Some Scientific questions

- How do we avoid the “1-rule-per-sentence” trap?
 - Systematic handling of all linguistic phenomena via the MRS test suite
 - Generalise as much as possible
 - Build intermediate structures, eg compounds, sets
 - Use meta-modelling to turn specific rules to general rules
- How do we make the reasoning more intelligible
 - Design reasoning in small steps using “stepping stone” concepts
 - Provide more abstract “reasoning engines” with CE sentences to configure
 - Be able to explain all of the logical inferences
 - Present the reasoning in a coherent order
 - Storytelling?

David's Question

- I seem to be doing a lot of work in turning MRS into domain semantics.
 - Is this really necessary?

Thank You!