



SNS COLLEGE OF ENGINEERING

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**Approved by AICTE, Recognized by UGC & Affiliated to Anna
University, Chennai**

**Department of Artificial Intelligence and Data
Science**

**Course Name – Introduction to Artificial
Intelligence**

II Year / III Semester

Unit 2 Representing Knowledge using Rules



Predicate Calculus

- Introduction through an example (*Zohar Manna, 1974*):
 - Problem: A, B and C belong to the Himalayan club. Every member in the club is either a mountain climber or a skier or both. A likes whatever B dislikes and dislikes whatever B likes. A likes rain and snow. No mountain climber likes rain. Every skier likes snow. *Is there a member who is a mountain climber and not a skier?*
- Given knowledge has:
 - Facts
 - Rules



Predicate Calculus: Example contd.

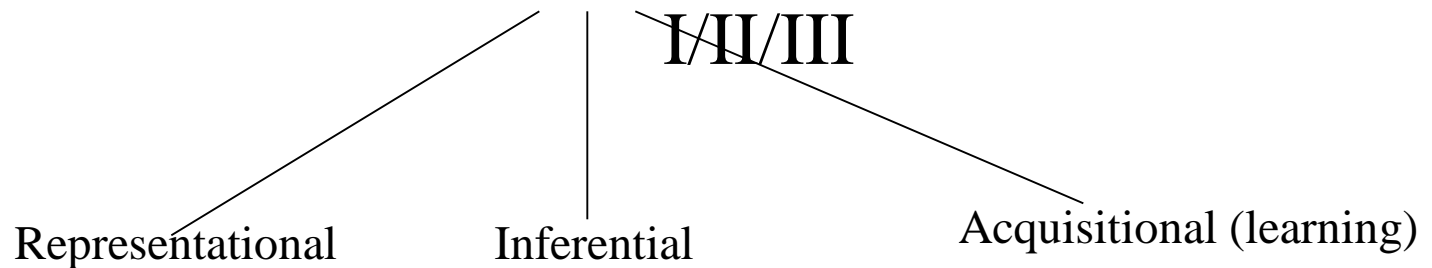
- Let mc denote mountain climber and sk denotes skier. Knowledge representation in the given problem is as follows:
 1. $member(A)$
 2. $member(B)$
 3. $member(C)$
 4. $\forall x[member(x) \rightarrow (mc(x) \vee sk(x))]$
 5. $\forall x[mc(x) \rightarrow \sim like(x, rain)]$
 6. $\forall x[sk(x) \rightarrow like(x, snow)]$
 7. $\forall x[like(B, x) \rightarrow \sim like(A, x)]$
 8. $\forall x[\sim like(B, x) \rightarrow like(A, x)]$
 9. $like(A, rain)$
 10. $like(A, snow)$
 11. Question: $\exists x[member(x) \wedge mc(x) \wedge \sim sk(x)]$
- We have to infer the 11th expression from the given 10.
- Done through Resolution Refutation.



Knowledge representation

■ Requirements:

- Adequacy (I) (also called completeness)
- Correctness (II)
- Efficiency (III)





Representation

Should be able to represent everything in scope (expressive power)

Correct

Efficient

Knowledge

Structured (Eg: tables)

Semi-structured (Eg: Xml database)

Unstructured (Eg: Plain text)



- Examine tables as a knowledge representation scheme
- How do tables fair in terms of
 - Adequacy
 - Inference
 - Acquisition ?



Student name	Height	Weight	BMI
Ram	5.6	76	xyz
Shyam	6.2	63	pqr
John	5.1	56	abc

- Consider the question “Which student is the tallest?”
- Without a procedure to calculate max, the question cannot be answered. (Needs Inferencing)



Other knowledge representation schemes

1. Propositional calculus
 2. Predicate calculus
 3. Semantic net
 4. Frames
-
- Predicate calculus is considered as the epitome of KR in terms of adequacy and inferencing

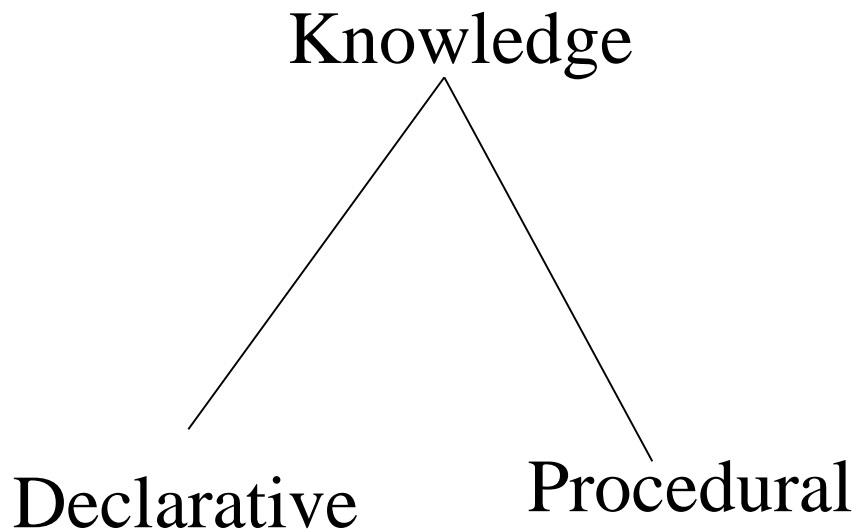


Inferencing in PC

Resolution

Forward
chaining

Backward
chaining



- Declarative knowledge deals with factoid questions (what is the capital of India? Who won the Wimbledon in 2005? Etc.)
- Procedural knowledge deals with “How”
- Procedural knowledge can be embedded in declarative knowledge



Example: Employee knowledge base

Employee record

Emp id : 1124

Age : 27

Salary : 10L / annum

Tax : Procedure to calculate tax from basic salary,
Loans, medical factors, and # of children



Universal Networking Language

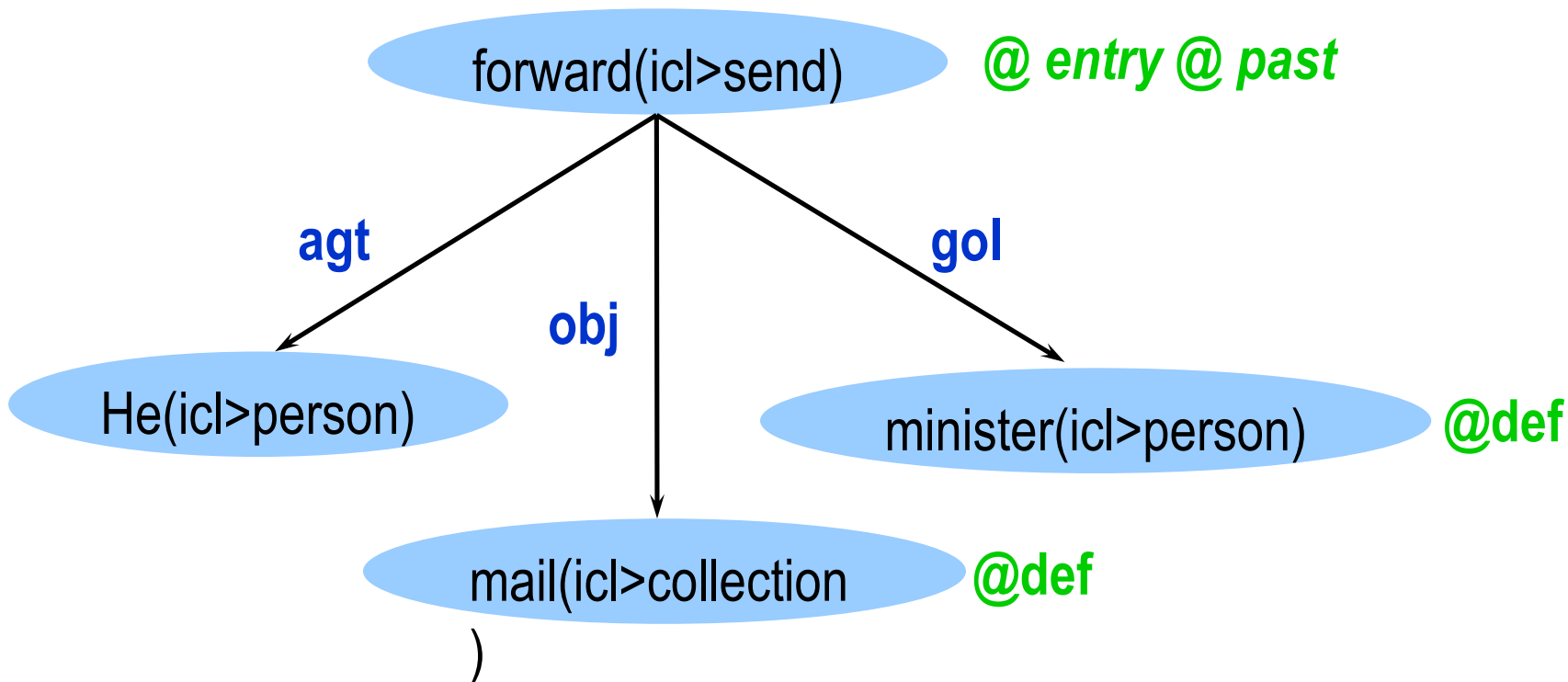


- Universal Words (UWs)
- Relations
- Attributes
- Knowledge Base



UNL Graph

He forwarded the mail to the minister.





UNL Expression

agt (forward(icl>send). **@ entry @ past,**
he(icl>person))

obj (forward(icl>send). **@ entry @ past,**
minister(icl>person))

gol (forward(icl>send). **@ entry @ past,**
mail(icl>collection). **@def**)



Universal Word (UW)

- What is a Universal Word (UW)?
- What are the features of a UW?
- How to create UWs?



What is a Universal Word (UW)?

- Words of UNL
- Constitute the UNL vocabulary, the syntactic-semantic units to form UNL expressions
- A UW represents a concept
 - Basic UW (an English word/compound word/phrase with no restrictions or Constraint List)
 - Restricted UW (with a Constraint List)
- Examples:
 - “crane(icl>device)”
 - “crane(icl>bird)”



The Features of a UW

- Every concept existing in any language must correspond to a UW
- The constraint list should be as small as necessary to disambiguate the headword
- Every UW should be defined in the UNL Knowledge-Base



Restricted UWs

- Examples
 - He will hold office until the spring of next year.
 - The spring was broken.
- Restricted UWs, which are Headwords with a constraint list, for example:
 - “spring(icl>season)”
 - “spring(icl>device)”
 - “spring(icl>jump)”
 - “spring(icl>fountain)”



How to create UWs?

- Pick up a concept
 - the concept of “***crane***”
as “***a device for lifting heavy loads***”
or
as “***a long-legged bird that wade in water in search of food***”
- Choose an English word for the concept.
 - In the case for “***crane***”, since it is a word of English, the corresponding word should be ‘***crane***’
- Choose a constraint list for the word.
 - [] ‘***crane(icl>device)***’
 - [] ‘***crane(icl>bird)***’



UNL Relations

- Constitute the syntax of UNL
- Express how concepts(UWs) constitute a sentence
- Represented as strings of 3 characters or less
- A set of 41 relations specified in UNL (e.g., *agt, aoj, ben, gol, obj, plc, src, tim,...*)
- Refer to a semantic role between two lexical items in a sentence
 - E.g., *John has composed this poem.*

AGT / AOJ / OBJ

- AGT (Agent)

Definition: *Agt defines a thing which initiates an action*

- AOJ (Thing with attribute)

Definition: *Aoj defines a thing which is in a state or has an attribute*

- OBJ (Affected thing)

Definition: *Obj defines a thing in focus which is directly affected by an event or state*



Examples

- John broke the window.
agt (break.@entry.@past, John)
- This flower is beautiful.
aoj (beautiful.@entry, flower)
- He blamed John for the accident.
obj (blame.@entry.@past, John)



BEN

- BEN (Beneficiary)

Definition: *Ben defines a not directly related beneficiary or victim of an event or state*

- Can I do anything for you?

ben (do.@entry.@interrogation.@politeness, you)

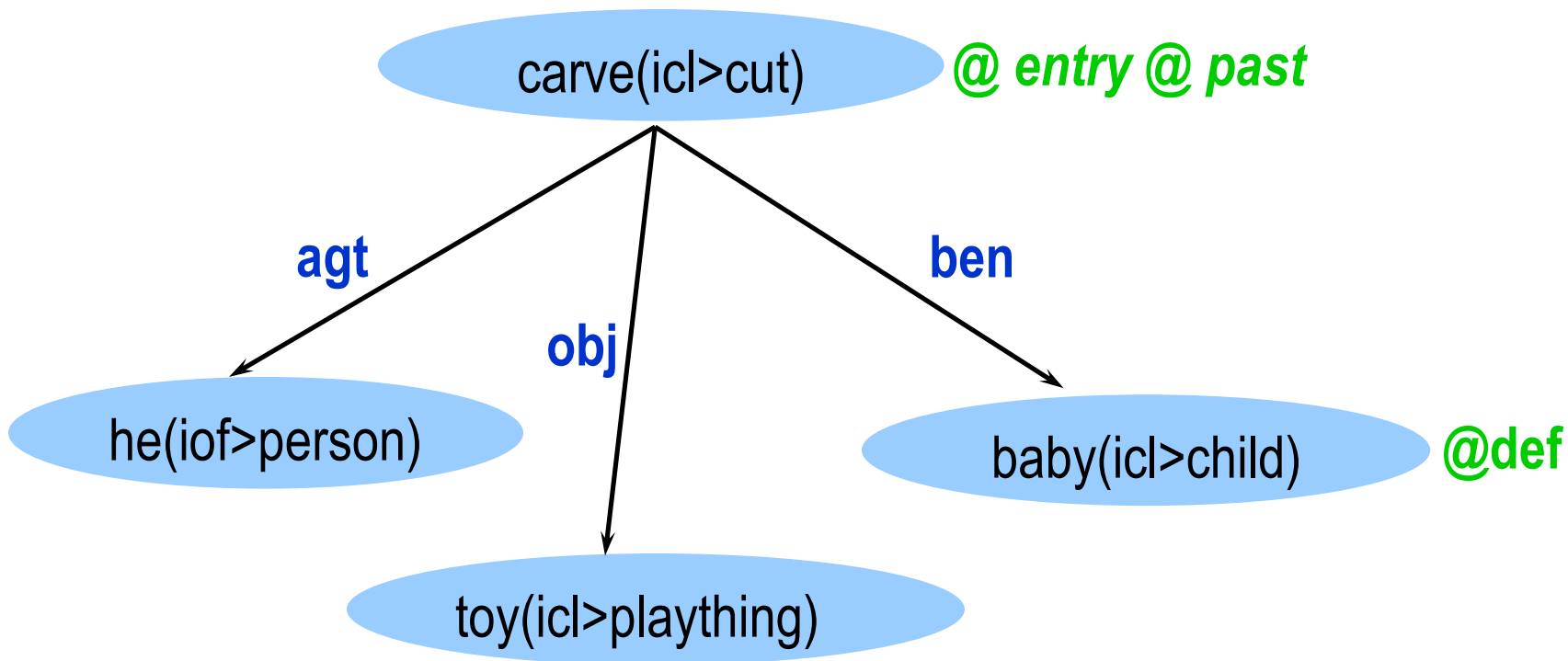
obj (do.@entry.@interrogation.@politeness, anything)

agt (do.@entry.@interrogation.@politeness, I)



BEN : UNL Graph

He carved a toy for the baby.





GOL / SRC

- GOL (Goal : final state)

Definition: *Gol defines the final state of an object or the thing finally associated with an object of an event*

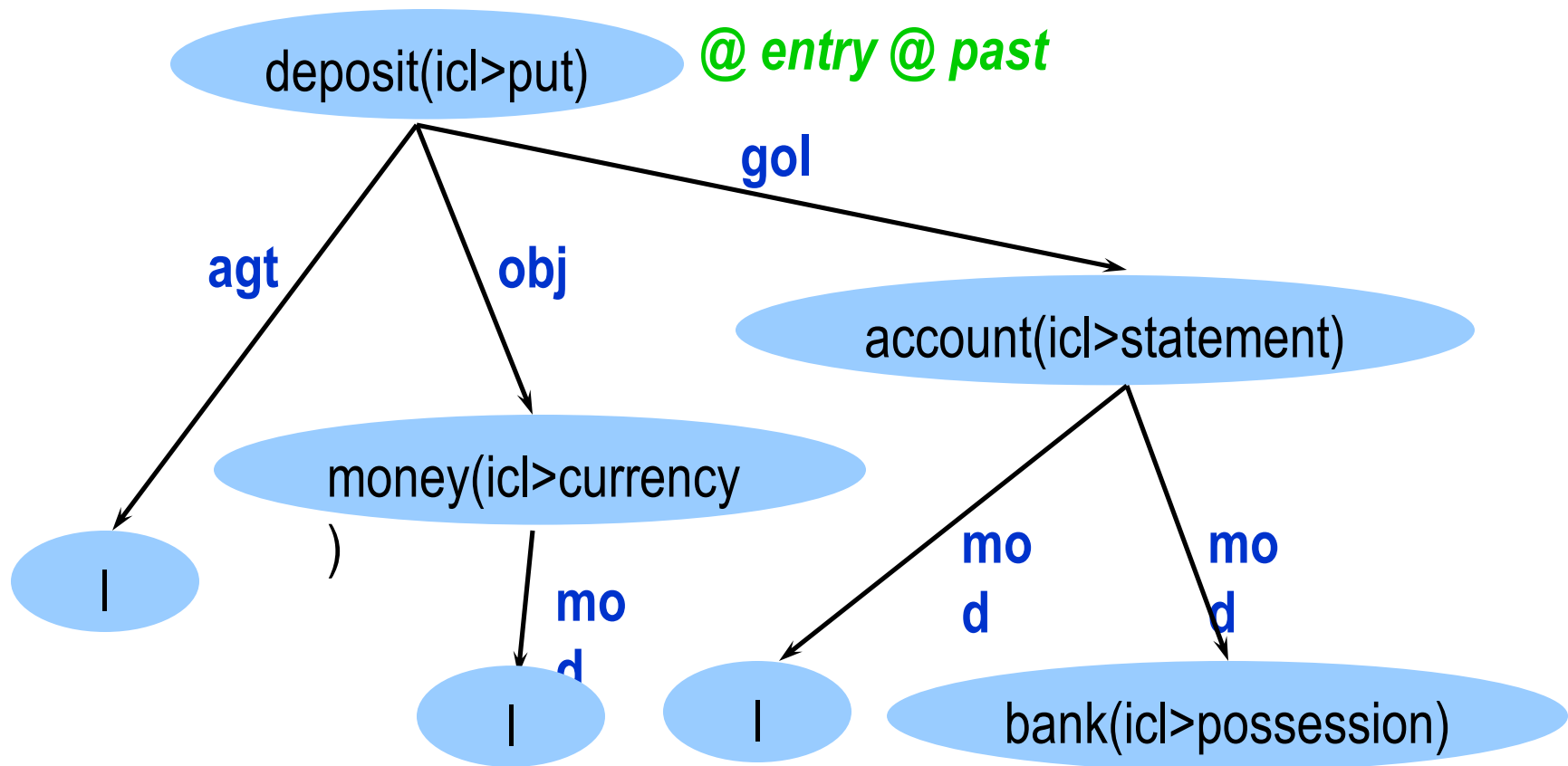
- SRC (Source : initial state)

Definition: *Src defines the initial state of object or the thing initially associated with object of an event*



GOL

- I deposited my money in my bank account.

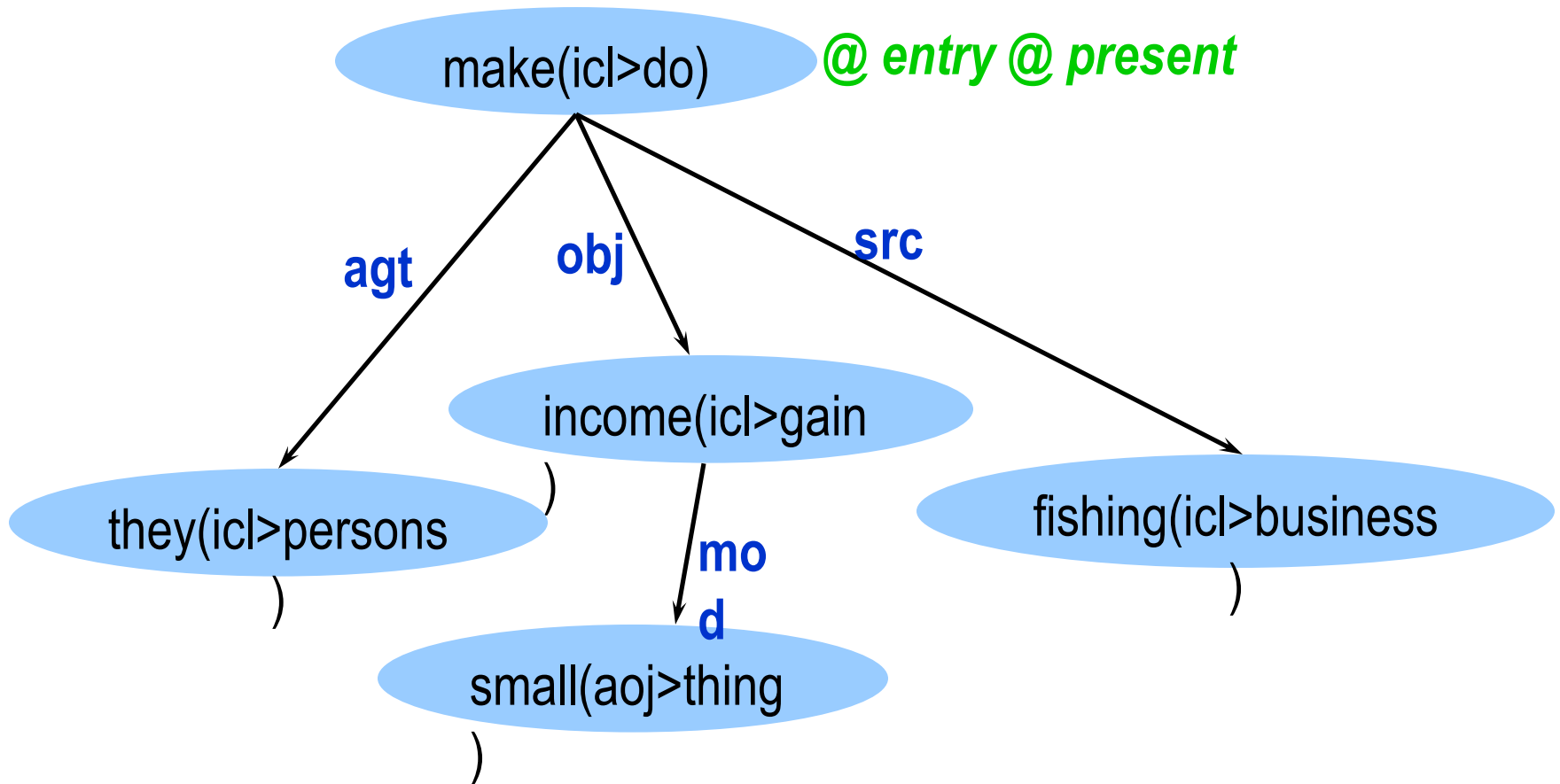




SRC



They make a small income from fishing.





PUR

- PUR (Purpose or objective)

Definition: Pur defines the purpose or objectives of the agent of an event or the purpose of a thing exist

- *This budget is for food.*

pur (food.@entry, budget)
mod (budget, this)



- RSN (Reason)

Definition: *Rsn defines a reason why an event or a state happens*

- *They selected him for his honesty.*

agt(select(icl>choose).@entry, they)

obj(select(icl>choose) .@entry, he)

rsn (select(icl>choose).@entry, honesty)



TIM

- TIM (Time)

Definition: Tim defines the time an event occurs or a state is true

- *I wake up at noon.*

agt (wake up.@entry, I)

tim (wake up.@entry, noon(icl>time))



TMF

- TMF (Initial time)

Definition: Tmf defines a time an event starts

- *The meeting started from morning.*

obj (start. @entry. @past, meeting. @def)

tmf (start. @entry. @past, morning(icl>time))



TMT

- TMT (Final time)

Definition: Tmt defines a time an event ends

- The meeting continued till evening.

obj (continue. @entry. @past, meeting. @def)

tmt (continue. @entry. @past, evening(icl>time))



PLC

- PLC (Place)

Definition: *Plc defines the place an event occurs or a state is true or a thing exists*

- *He is very famous in India.*

aoj (famous.@entry, he)

man (famous.@entry, very)

plc (famous.@entry, India)



PLF

- PLF (Initial place)

Definition: *Plf defines the place an event begins or a state becomes true*

- *Participants come from the whole world.*

agt (come.@entry, participant.@pl)

plf (come.@entry, world)

mod (world, whole)



PLT

- PLT (Final place)

Definition: *Plt defines the place an event ends or a state becomes false*

- *We will go to Delhi.*

agt (go.@entry.@future, we)

plt (go.@entry.@future, Delhi)



INS

- INS (Instrument)

Definition: *Ins defines the instrument to carry out an event*

- I solved it with computer

agt (solve.@entry.@past, I)

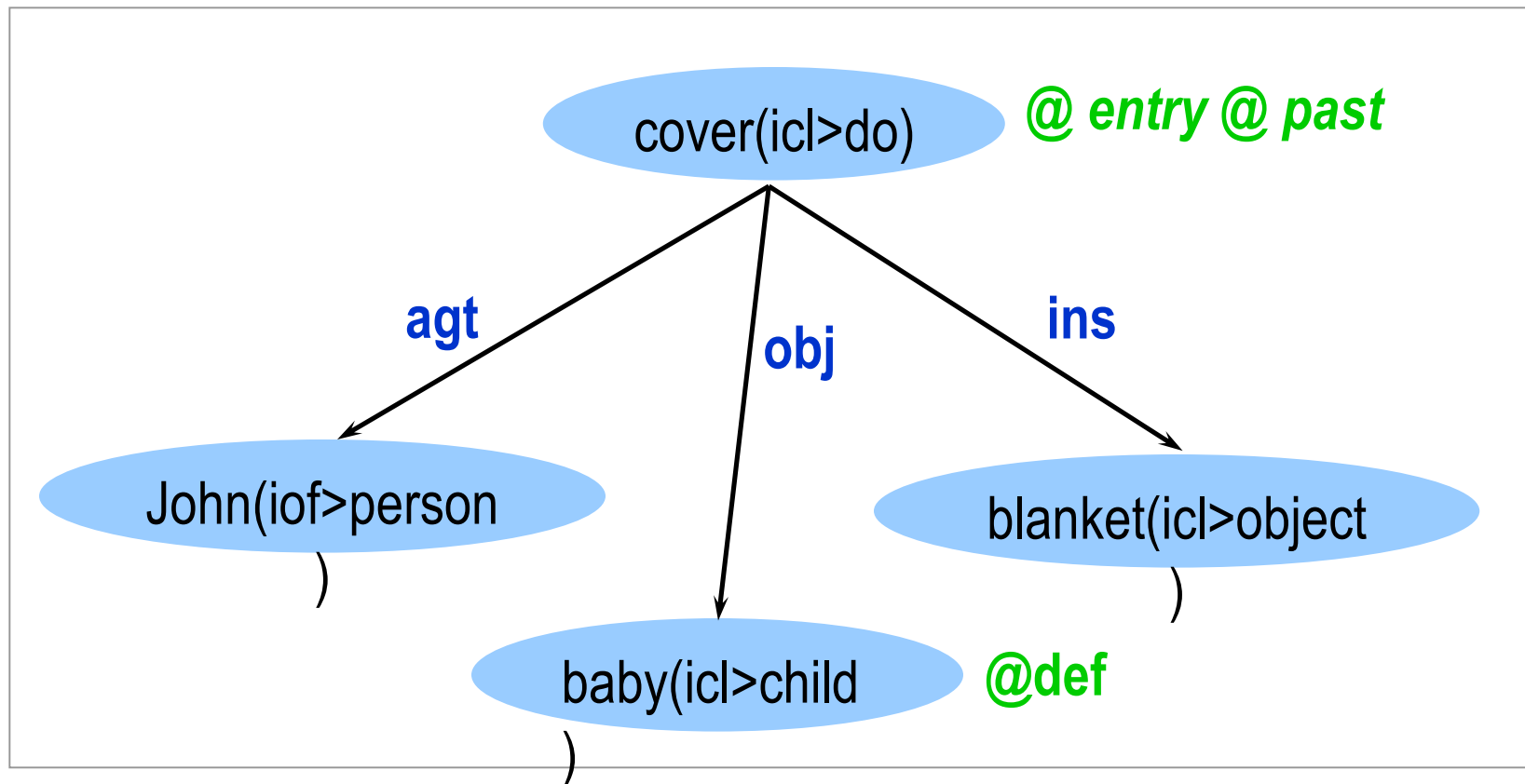
ins (solve.@entry.@past, computer)

obj (solve.@entry.@past, it)



INS : UNL Graph

John covered the baby with a blanket.





Attributes

- Constitute syntax of UNL
- Play the role of bridging the conceptual world and the real world in the UNL expressions
- Show how and when the speaker views what is said and with what intention, feeling, and so on
- Seven types:
 - Time with respect to the speaker
 - Aspects
 - Speaker's view of reference
 - Speaker's emphasis, focus, topic, etc.
 - Convention
 - Speaker's attitudes
 - Speaker's feelings and viewpoints



Tense: @past

He went there yesterday

- The past tense is normally expressed by *@past*

{unl}

agt(go.@entry.@past, he)

...

{/unl}



Aspects: @progress

It's raining hard.

{unl}

man (rain.@entry.@present.@**progress**,
hard)

{/unl}



Speaker's view of reference

- **@def** (Specific concept (already referred))

The house on the corner is for sale.

- **@indef** (Non-specific class)

There is a book on the desk

- **@not** is always attached to the UW which is negated.

He didn't come.

agt (come.@entry.@past.@not, he)



Speaker's emphasis

- **@emphasis**

John his name is.

mod (name, he)

aoj (John.@emphasis.@entry, name)

- **@entry** denotes the entry point or main UW of an UNL expression



UNL Knowledge Base (UNLKB)

- What is the UNL Knowledge Base?
- Linguistic Background
- How to define the UWs in the UNL Knowledge-Base?



What is the UNL Knowledge Base?

- A semantic network comprising every directed binary relation between UWs
- Categorized according to the role of a concept to other concepts