## Conceptual Dependency

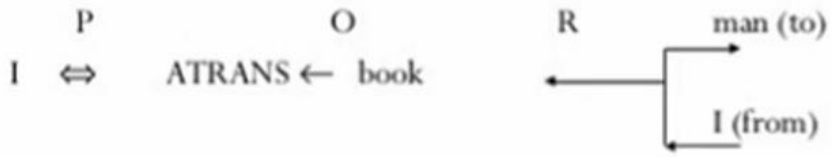
Used to represent the meaning of NL sentences.
It helps in drawing inferences.
Independent of the Language.
Independent of the words used in original input.
Sentences are represented as a series of diagrams depicting actions using both abstract and real physical situations.

**ATRANS**– Transfer of an abstract relationship. *e.g. give.*
**PTRANS**– Transfer of the physical location of an object. *e.g. go.*
**PROPEL**– Application of a physical force to an object. *e.g. push.*
**MTRANS**– Transfer of mental information. *e.g. tell.*
**MBUILD**– Construct new information from old. *e.g. decide.*
**SPEAK**– Utter a sound. *e.g. say.*
**ATTEND**– Focus a sense on a stimulus. *e.g. listen, watch.*
**MOVE**– Movement of a body part by owner. *e.g. punch, kick.*
**GRASP**– Actor grasping an object. *e.g. clutch.*
**INGEST**– Actor ingesting an object. *e.g. eat.*
**EXPEL**– Actor getting rid of an object from body. *e.g. ????.*

**PP**-- Real world objects.{Picture Producers}
**ACT**-- Real world actions. {One of the CD primitives}
**PA**-- Attributes of objects.{Picture Aiders}
**AA**-- Attributes of actions.{Action aiders}
**T**-- Times.
**LOC**-- Locations.

# Example

- I gave a book to the man. CD representation is as follows:




- It should be noted that this representation is same for different saying with same meaning. For example
  - I gave the man a book,
  - The man got book from me,
  - The book was given to man by me etc.

# Few conventions

- Arrows indicate directions of dependency
- Double arrow indicates two way link between actor and action.

O – for the object case relation

R – for the recipient case relation

P – for past tense

D - destination

- The use of tense and mood in describing events is extremely important and schank introduced the following modifiers:
- **p**– past
- **f**– future
- **t**– Transition
- **ts**-start Transition
- **tf**-Finished Transition
- **k** -Continuing
- **?** Interrogative
- **/** Negative
- Nil-Present
- **delta**– timeless
- **c**– conditional
- The absence of any modifier implies the *present tense*.

## Rule 1: PP ⇔ ACT

- It describes the relationship between an actor and the event he or she causes.
  - This is a two-way dependency, since neither actor nor event can be considered primary.
  - The letter P in the dependency link indicates past tense.
- Example: John ran

P

CD Rep: John ⇔ PTRANS

## Rule 2: ACT ← PP

- It describes the relationship between a ACT and a PP (object) of ACT.
  - The direction of the arrow is toward the ACT since the context of the specific ACT determines the meaning of the object relation.

- Example: John pushed the bike

CD Rep: John ⇔ PROPEL ← (o) bike

## Rule 3: PP ↔ PP

- It describes the relationship between two PP's, one of which belongs to the set defined by the other.

- Example: John is doctor

CD Rep: John ↔ doctor

## Rule 4: PP ← PP

- It describes the relationship between two PP's, one of which provides a particular kind of information about the other.
  - The three most common types of information to be provided in this way are possession ( shown as POSS-BY), location (shown as LOC), and physical containment (shown as CONT).
  - The direction of the arrow is again toward the concept being described.

- Example: John's dog

CD Rep: dog ←(poss-by) John

## Rule 5: PP ⇔ PA

- It describes the relationship between a PP and a PA that is asserted to describe it.
  - PA represents states of PP such as height, health etc.

- Example: John is fat

CD Rep John ⇔ weight (> 80)

## Rule 6: PP ← PA

- It describes the relationship between a PP and an attribute that already has been predicated of it.
  - Direction is towards PP being described.

- Example: Smart John

CD Rep John ← smart

Rule 7: ACT ← R → PP (to)
← PP (from)

- It describes the relationship between an ACT and the source and the recipient of the ACT

- Example: John took the book from Mary

CD Rep: John ⇔ ATRANS ← R → John
o ↑ ← Mary
book

Rule 8: PP → PA
← PA

- It describes the relationship that describes the change in state.

- Example: Tree grows

CD Rep: Tree ← → size > C
← size = C

Rule 9: ⇔ {x}
↑
⇔ {y}

- It describes the relationship between one conceptualization and another that causes it.
  - Here {x} is causes {y} i.e., if x then y

- Example: Bill shot Bob
  {x} : Bill shot Bob
  ↑
  {y} : Bob's health is poor

Rule 10:

$$\Leftrightarrow \{x\}$$
$$\downarrow$$
$$\Leftrightarrow \{y\}$$

- It describes the relationship between one conceptualization with another that is happening at the time of the first.
  - Here {y} is happening while {x} is in progress.

- Example: While going home I saw a snake

I am going home

↓

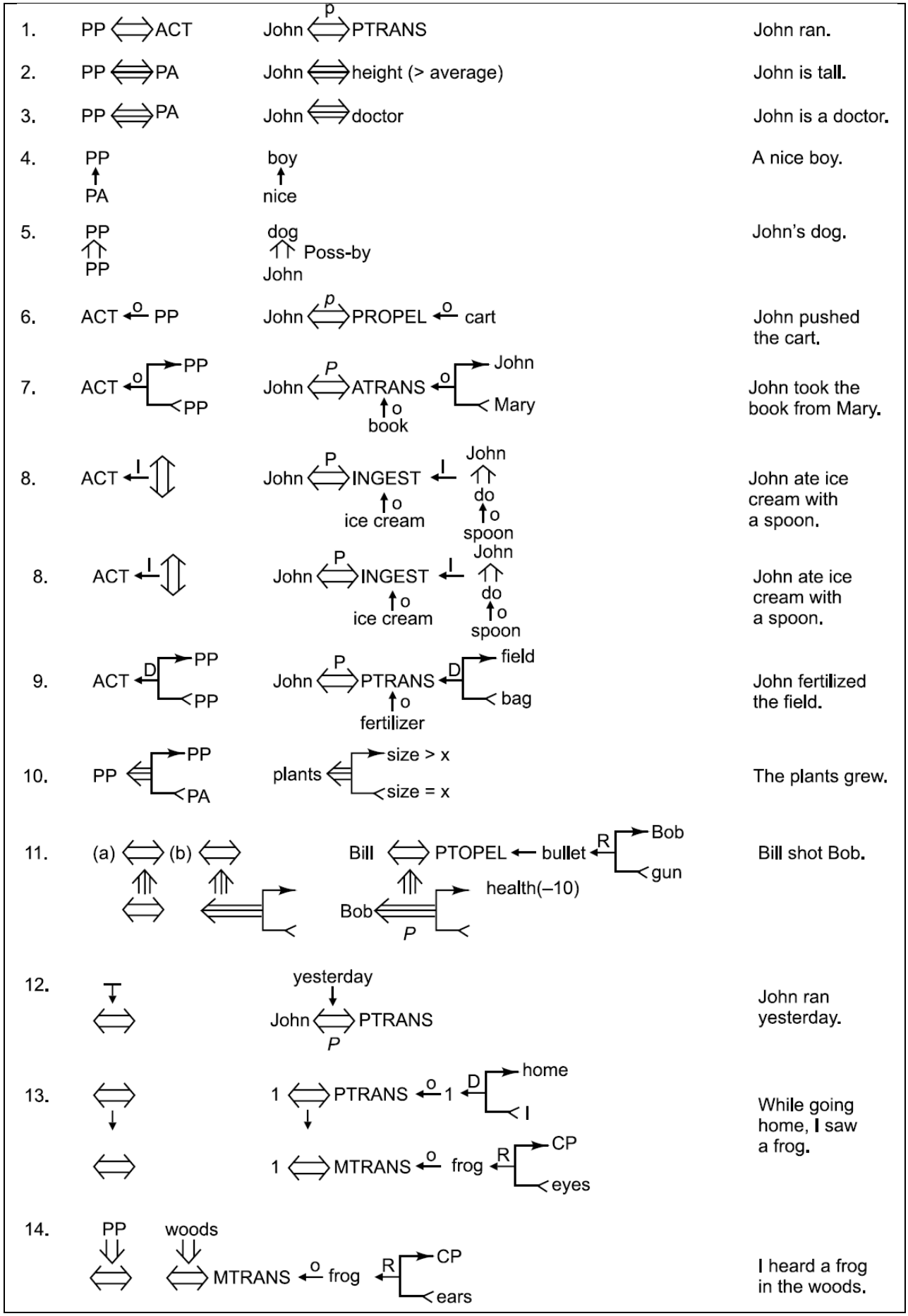
I saw a snake

## Advantages of CD:

- Using these primitives involves fewer inference rules.
- Many inference rules are already represented in CD structure.
- The holes in the initial structure help to focus on the points still to be established.

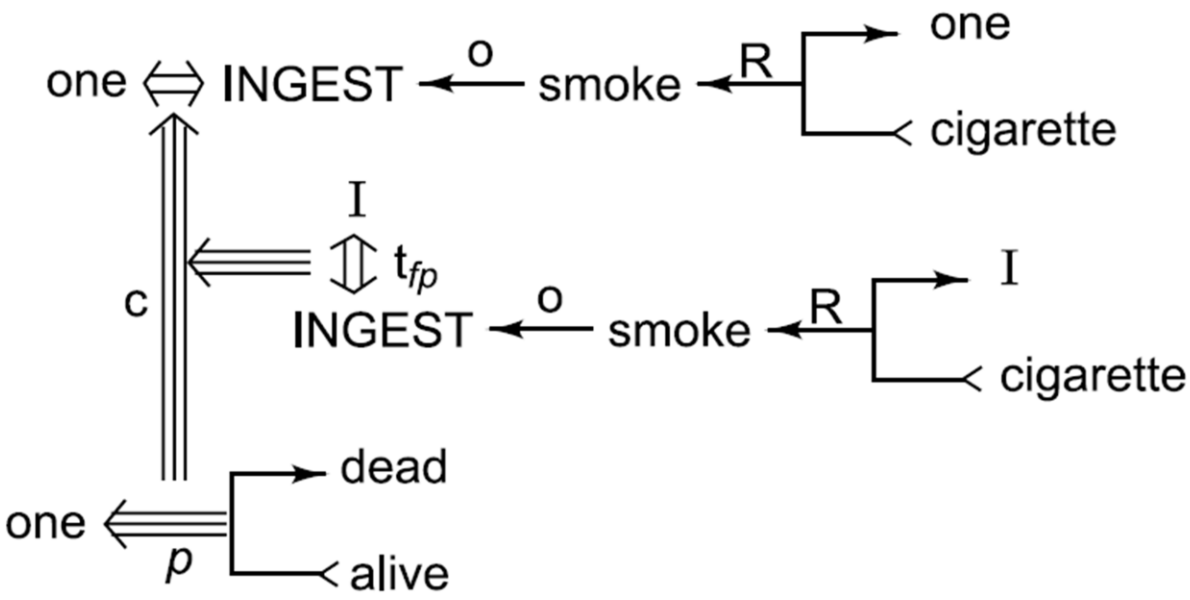
## Disadvantages of CD:

- Knowledge must be decomposed into fairly low level primitives.
- Impossible or difficult to find correct set of primitives.
- A lot of inference may still be required.
- Representations can be complex even for relatively simple actions. Consider: *Dave bet Frank five pounds that Wales would win the Rugby World Cup.*
- Complex representations require a lot of storage


1.
PP ⟺ ACT
John ⟺ (p) PTRANS
John ran.
2.
PP ⟺ PA
John ⟺ height (> average)
John is tall.
3.
PP ⟺ PA
John ⟺ doctor
John is a doctor.
4.
PP
↑
PA
boy
↑
nice
A nice boy.
5.
PP
↑↑
PP
dog
↑↑ Poss-by
John
John's dog.
6.
ACT ← o PP
John ⟺ (p) PROPEL ← o cart
John pushed the cart.
7.
ACT ← o → PP, PP
John ⟺ (P) ATRANS ← o → John, Mary
↑ o
book
John took the book from Mary.
8.
ACT ← I ⇕
John ⟺ (P) INGEST ← I John
↑ o ↑↑ do
ice cream ↑ o
spoon
John ate ice cream with a spoon.
8.
ACT ← I ⇕
John ⟺ (P) INGEST ← I John
↑ o ↑↑ do
ice cream ↑ o
spoon
John ate ice cream with a spoon.
9.
ACT ← D → PP, PP
John ⟺ (P) PTRANS ← D → field, bag
↑ o
fertilizer
John fertilized the field.
10.
PP ⟺ PP, PA
plants ⟺ size > x, size = x
The plants grew.
11.
(a) ⟺ (b) ⟺
⇑ ⇑
⟺ ⟹
Bill ⟺ PTOPEL ← bullet ← R → Bob, gun
⇑
Bob ⟹ health(–10)
P
Bill shot Bob.
12.
T
↓
⟺
yesterday
↓
John ⟺ (P) PTRANS
John ran yesterday.
13.
⟺
↓
1 ⟺ PTRANS ← o 1 ← D → home, I
While going home, I saw a frog.
⟺
1 ⟺ MTRANS ← o frog ← R → CP, eyes
14.
PP ⇓ ⟺
woods ⇓ ⟺
MTRANS ← o frog ← R → CP, ears
I heard a frog in the woods.

# Using Conceptual Tenses

- "Since smoking can kill you, I stopped."

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# The Components of a Script

Entry conditions Conditions that must, in general, be satisfied before the events described in the script can occur.

Result Conditions that will, in general, be true after the events described in the script have occurred.

Props Slots representing objects that are involved in the events described in the script. The presence of these objects can be inferred even if they are not mentioned explicitly.

Roles Slots representing people who are involved in the events described in the script. The presence of these people, too, can be inferred even if they are not mentioned explicitly. If specific individuals are mentioned, they can be inserted into the appropriate slots.

Track The specific variation on a more general pattern that is represented by this particular script. Different tracks of the same script will share many but not all components.

Scenes The actual sequences of events that occur. The events are represented in conceptual dependency formalism.

Script: RESTAURANT
Track: Coffee Shop
Props: Tables
Menu
F = Food
Check
Money

Roles: S = Customer
W = Waiter
C = Cook
M = Cashier
O = Owner

Entry conditions:

S is hungry.
S has money.

Resulls:

S has less money.
O has more money.
S is not hungry.
S is pleased (optional).

Scene 1: Entering
S PTRANS S into restaurant
S ATTEND eyes to tables
S MBUILD where to sit
S PTRANS S to table
S MOVE S to sitting position

Scene 2: Ordering
(Menu on table) (W brings menu)
S PTRANS menu to S

(S asks for menu)
S MTRANS signal to W
W PTRANS W to table
S MTRANS 'need menu' to W
W PTRANS W to menu

W PTRANS W to table
W ATRANS menu to S

S MTRANS W to table
* S MBUILD choice of F
S MTRANS signal to W
W PTRANS W to table
S MTRANS 'I want F to W

W PTRANS W to C
W MTRANS (ATRANS F) to C

C MTRANS 'no F' to W
W PTRANS W to S
W MTRANS 'no F' to S
(go back to *) or
(go to Scene 4 at no pay path)

C DO (prepare F script)
to Scene 3

Scene 3: Eating
C ATRANS F to W
W ATRANS F to S
S INGEST F
(Option: Return to Scene 2 to order more;
otherwise, go to Scene 4)

Scene 4: Exiting

S MTRANS to W

(W ATRANS check to S)

W MOVE (write check)
W PTRANS W to S
W ATRANS check to S
S ATRANS tip to W
S PTRANS S to M
S ATRANS money to M

(No pay path) S PTRANS S to out of restaurant