Conceptual Dependency & Scripts

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CS 340 - AI - Fall 2017
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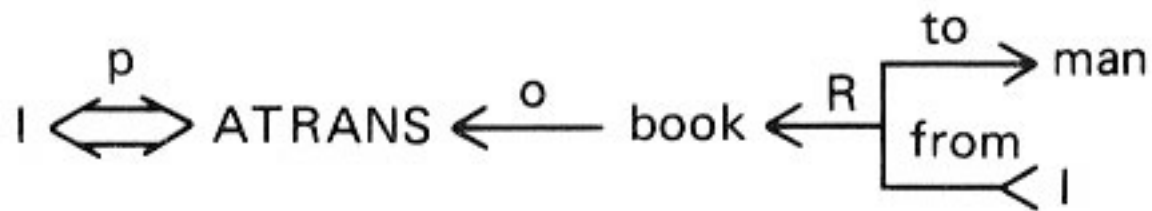
Conceptual Dependency

- Theory of representing nl semantics

- Facilitates drawing inferences

- Language independent
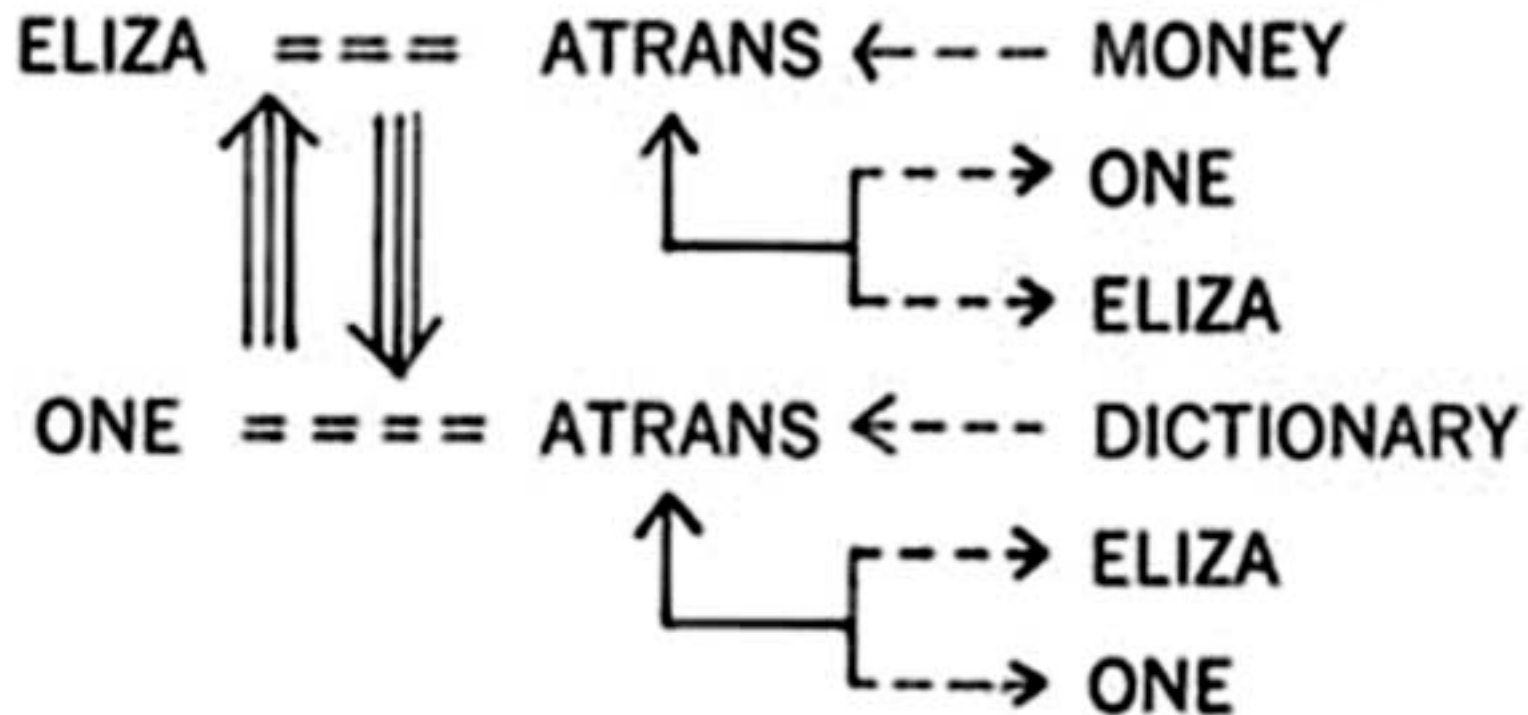
- described by Roger Schank in mid 1970s

Conceptual Dependency

- Instead of using words, Schank used conceptual primitives.

- e.g. "I gave the man a book."

[Rich 1983]

Primitive Acts

ATRANS	Transfer of an abstract relationship (e.g give)
PTRANS	Transfer of the physical location of an object (e.g., go)
PROPEL	Application of physical force to an object (e.g., push)
MOVE	Movement of a body part by its owner (e.g., kick)
GRASP	Grasping of an object by an actor (e.g., throw)
INGEST	Ingesting of an object by an animal (e.g., eat)
EXPEL	Expulsion of something from the body of an animal (e.g., cry)
MTRANS	Transfer of mental information (e.g., tell)
MBUILD	Building new information out of old (e.g., decide)
SPEAK	Producing of sounds (e.g., say)
ATTEND	Focusing of a sense organ toward a stimulus (e.g., listen), called CONC in some of Schank's earlier work [Schank, 1973b]

Primitive Conceptual Categories

ACT's	Actions
PP's	Objects (picture producers)
AA's	Modifiers of actions (action aiders)
PA's	Modifiers of PP's (picture aiders)

From these, dependency structures can be built.

Rule 1: Relationship between an actor and an event he or she causes. Neither is primary.

PP ⟺ ACT

John ⟺ᵖ PTRANS

[Rich 1983]

Rule 1: Relationship between an actor and an event he or she causes. Neither is primary.

PP $\Longleftrightarrow$ ACT

John $\overset{p}{\Longleftrightarrow}$ PTRANS

John ran.

[Rich 1983]

Rule 1: Relationship between and actor and an event he or she causes. Neither is primary.

PP ⟺ ACT

John ⟺ᵖ PTRANS

约翰跑了

[Rich 1983]

Rule 2: Relationship between a PP and a PA that is being asserted to describe it. May use numbers.

PP $\Longleftrightarrow$ PA

John $\Longleftrightarrow$ height (> average)

John is tall.

[Rich 1983]

Rule 3: Relationship between two PP's, one belonging to the set described by the other.

PP ⟺ PP

John ⟺ doctor

Rule 3: Relationship between two PP's, one belonging to the set described by the other.

PP ⬌ PP

John ⬌ doctor

John is a doctor.

Rule 4: Relationship between a PP and an attribute that describes it. Arrow toward described PP.

PP
↑
PA

boy
↑
nice

[Rich 1983]

Rule 4: Relationship between a PP and an attribute that describes it. Arrow toward described PP.

PP
↑
PA

boy
↑
nice

A nice boy

[Rich 1983]

Rule 5: Relationship between PP's, one showing a particular kind of information about the other. (Examples: possession, location, or containment.)
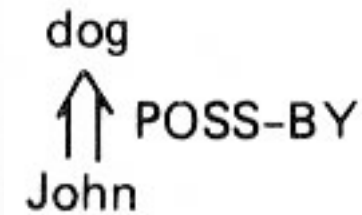
Rule 5: Relationship between PP's, one showing a particular kind of information about the other. (Examples: possession, location, or containment.)

PP
⇑
PP

dog
⇑ POSS-BY
John

John's dog

Rule 6: Relationship between ACT and the PP which is it's object. Arrow points to ACT.

Rule 6: Relationship between ACT and the PP which is it's object. Arrow points to ACT.

$$ACT \xleftarrow{\;o\;} PP$$

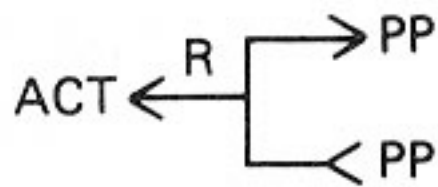$$John \overset{p}{\Longleftrightarrow} PROPEL \xleftarrow{\;o\;} cart$$
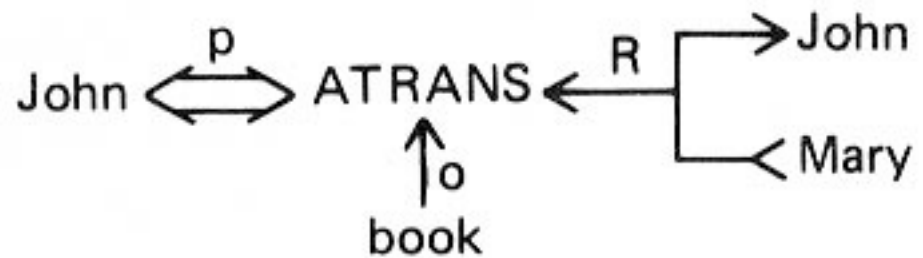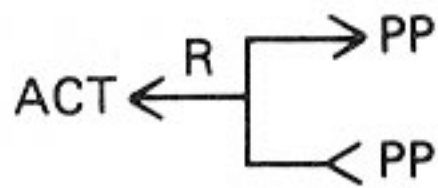
John pushed the cart.

Rule 7: Relationship between an ACT and the source and recipient of the ACT.
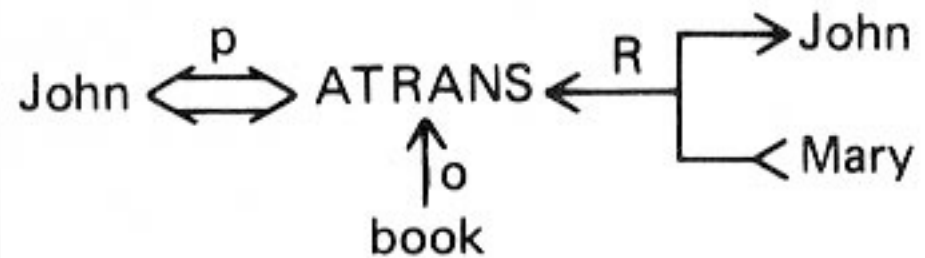
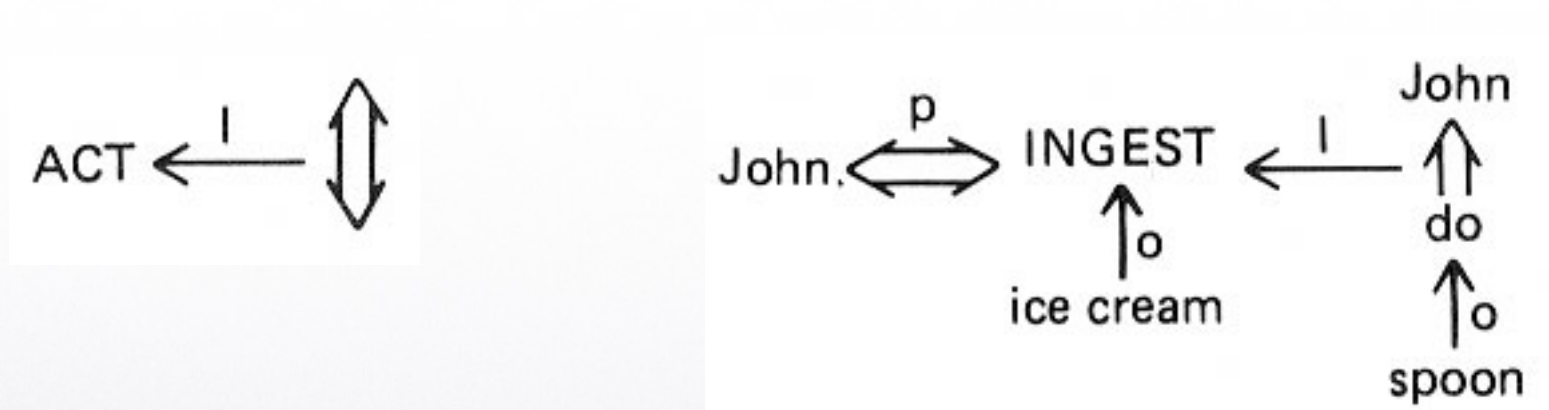# Rule 7: Relationship between an ACT and the source and recipient of the ACT.

John took the book from Mary.

[Rich 1983]

Rule 8: Relationship between an ACT and the instrument with which it is performed.

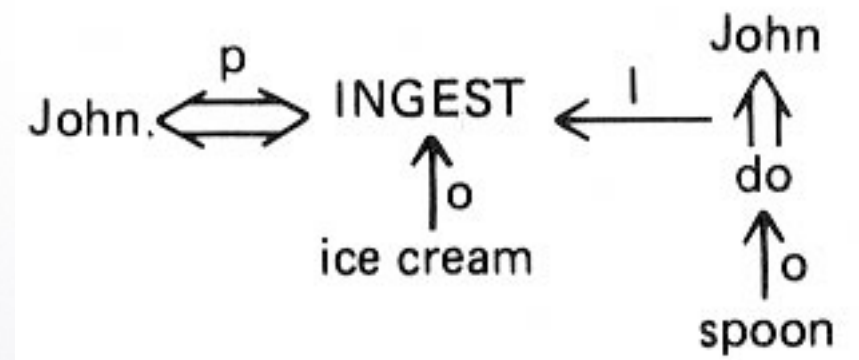# Rule 8: Relationship between an ACT and the instrument with which it is performed.
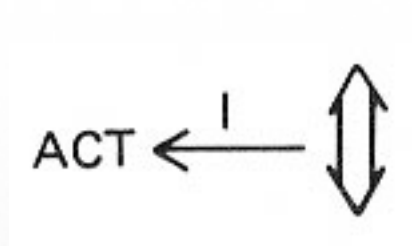
John ate ice cream with a spoon.

Rule 9: Relationship between an ACT and it's physical source and destination.
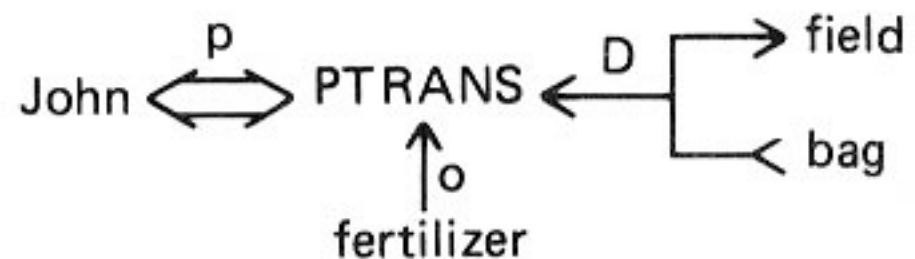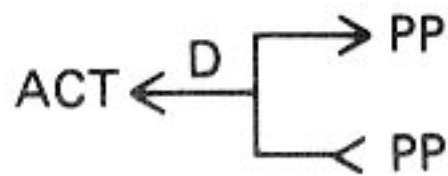
Rule 9: Relationship between an ACT and it's physical source and destination.
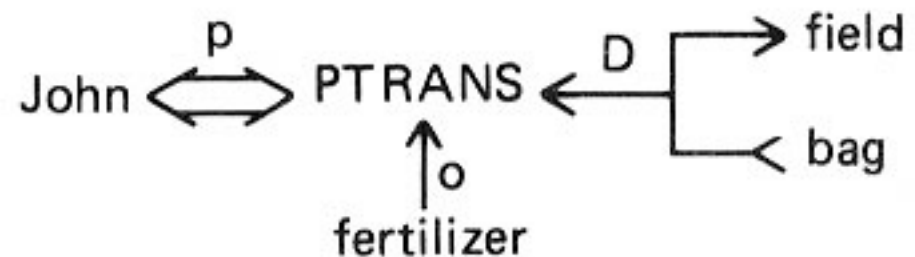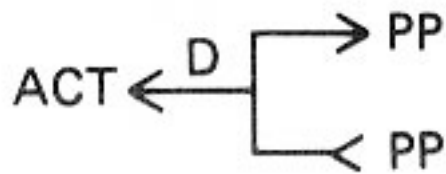
John fertilized the field.

Rule 10: Relationship between a PP and the state in which it started and ended.
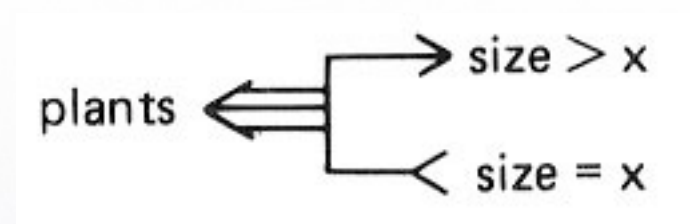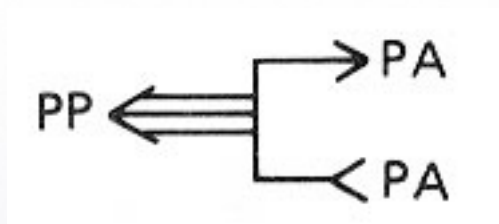
Rule 10: Relationship between a PP and the state in which it started and ended.
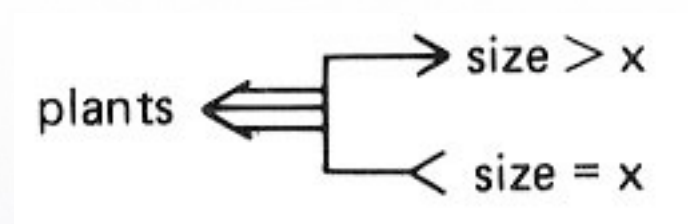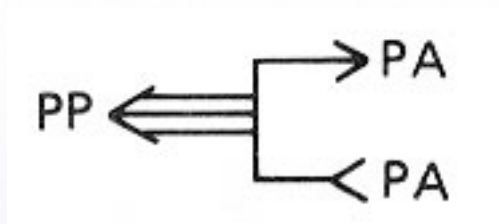
The plants grew.

Rule 11: Relationship between one conceptualization and another that caused it.
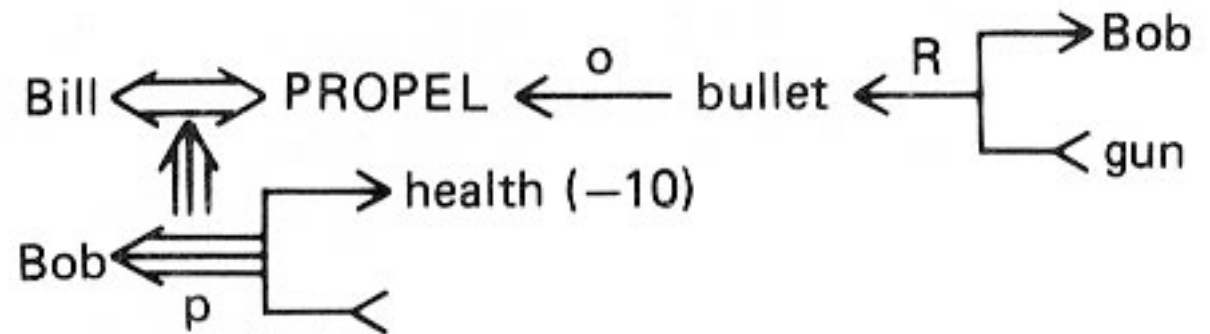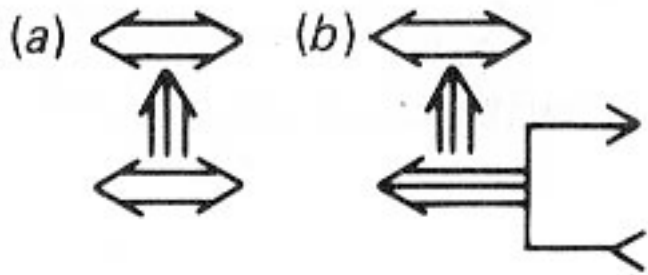
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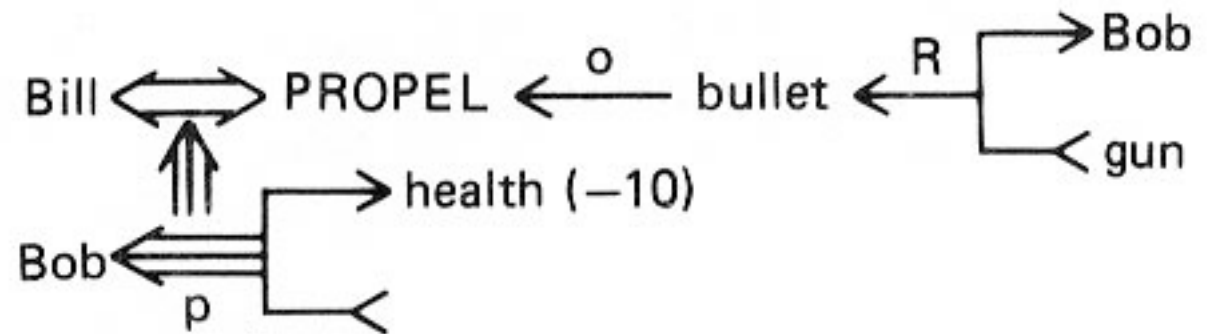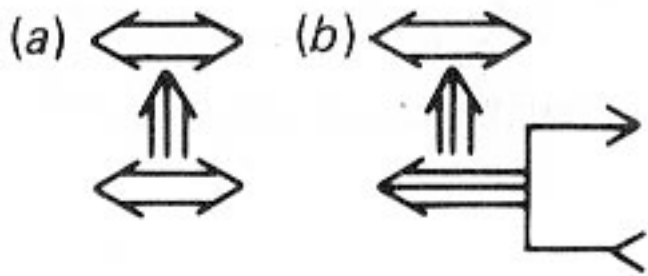
Bill shot Bob.

[Rich 1983]

Rule 12: Relationship between a conceptualization and the time when the event occurred.
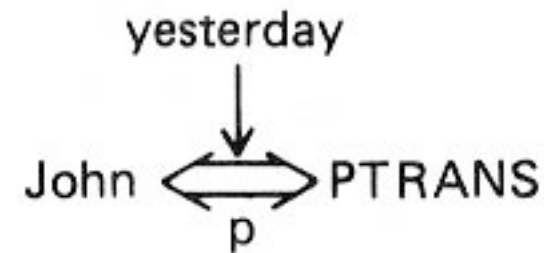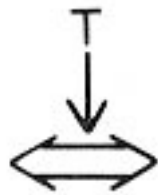
Rule 12: Relationship between a conceptualization and the time when the event occurred.
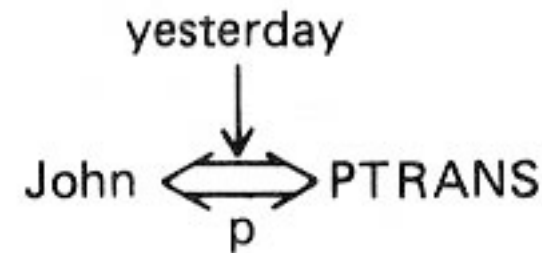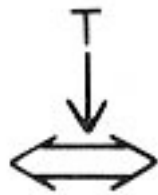
John ran yesterday.

Rule 13: Relationship between a conceptualization and another at the time of the first.
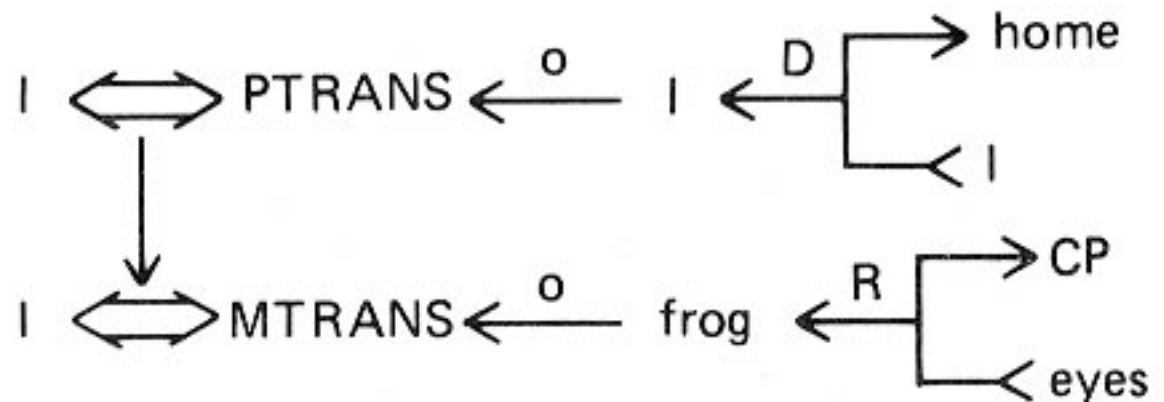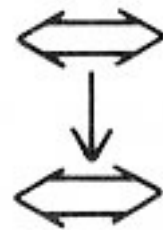
Rule 13: Relationship between a conceptualization and another at the time of the first.
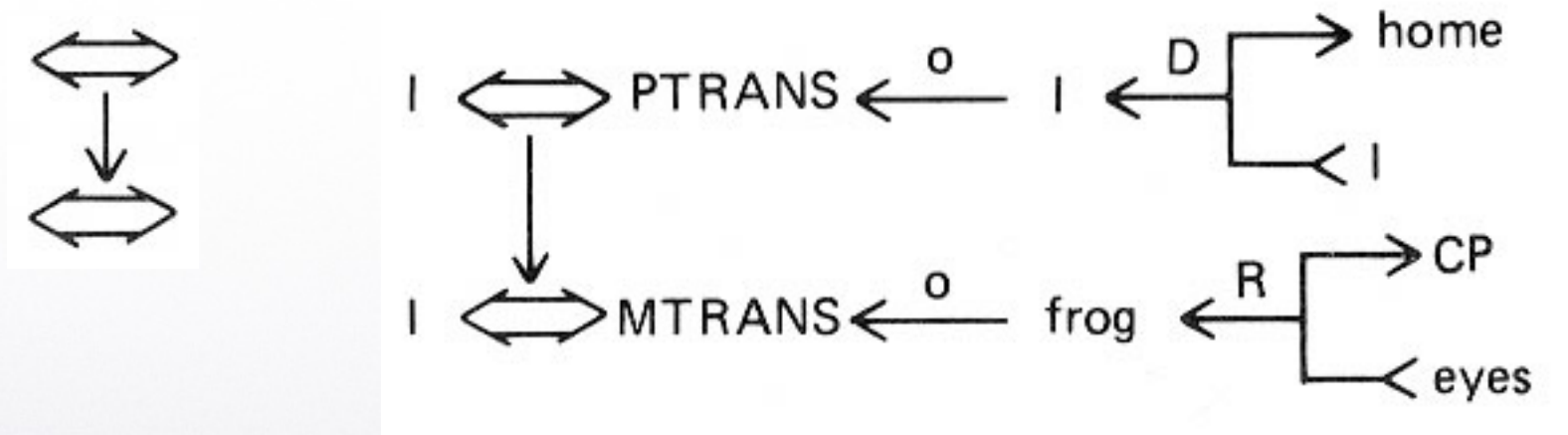
While going home, I saw a frog.

[Rich 1983]

Rule 14: Relationship between a conceptualization and the place where it occurred.
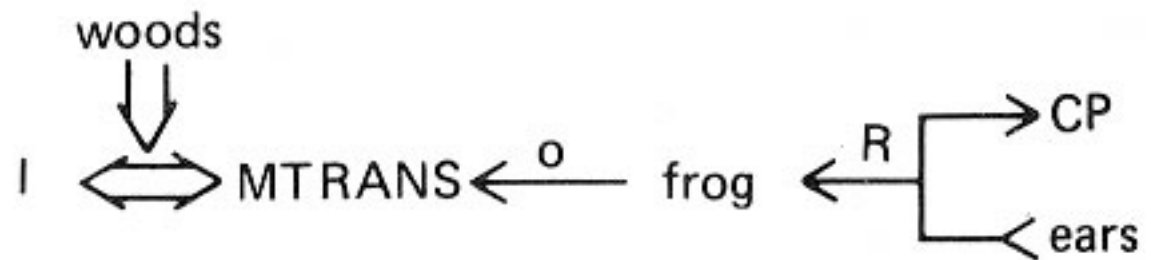
Rule 14: Relationship between a conceptualization and the place where it occurred.
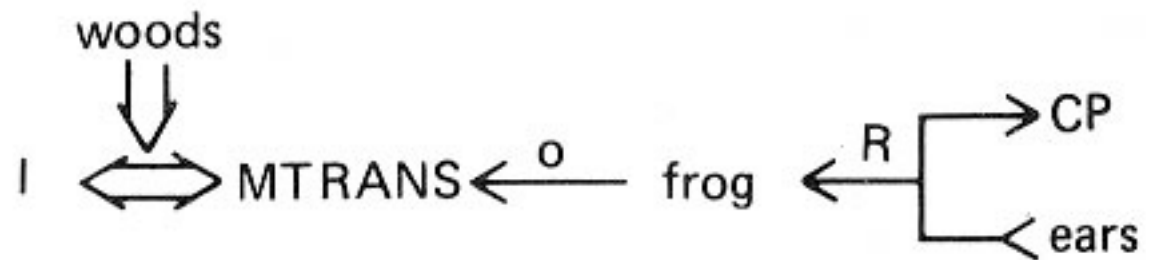
I heard a frog in the woods.
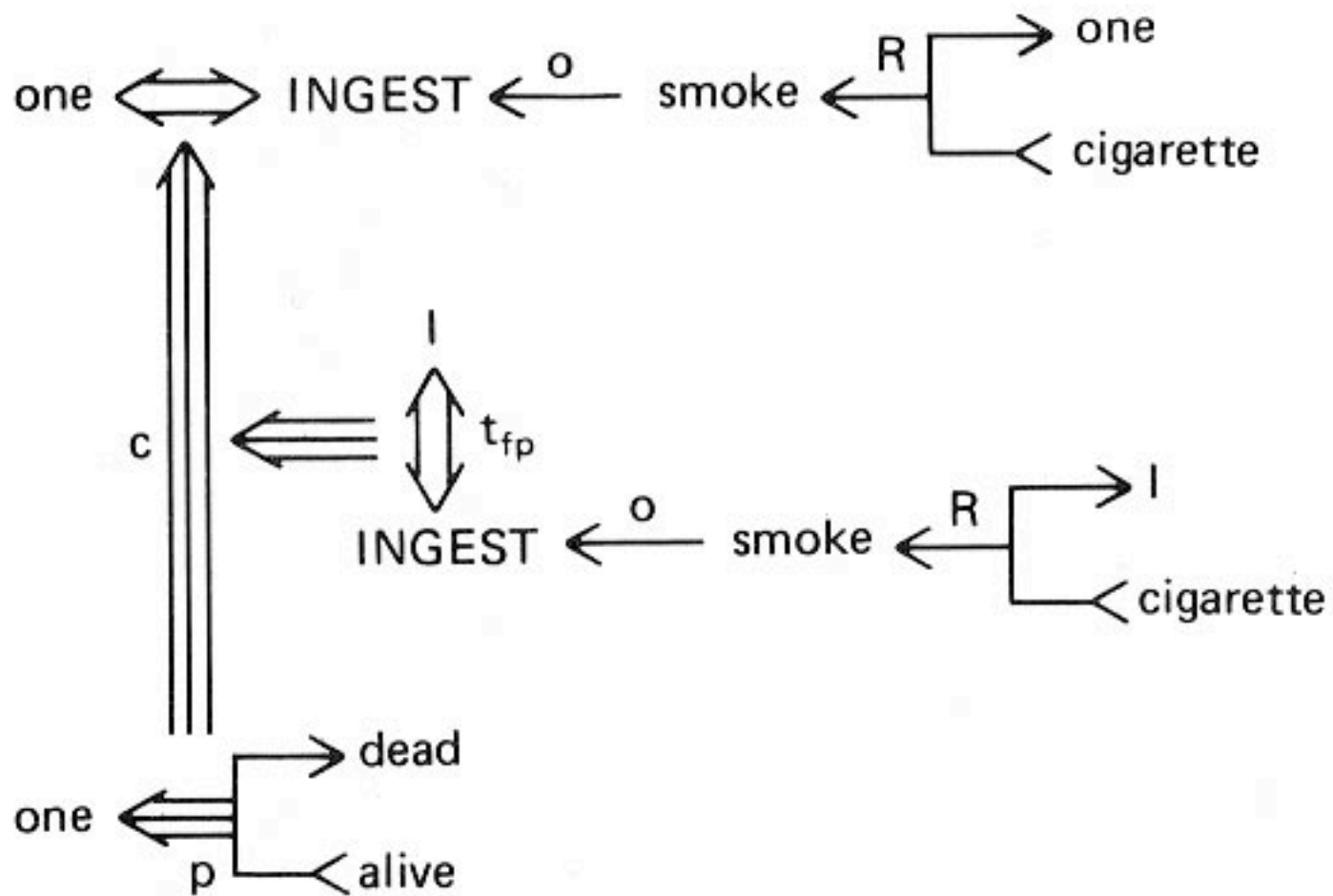
Another lobster tale

Jami entered the restaurant and the waitress seated *her*. Then *she* gave *her* a menu. After *she* read it *she* decided to order lobster. After *she* brought it to *her* *she* ate it. Later, *she* left *her* a big tip.

A Restaurant Script

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.

Results: 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 asks for menu)
S **PTRANS** menu to S　　　　　　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** food list to CP(S)
　　　*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　　　　　　　C **DO** (prepare F script)
W **PTRANS** W to S　　　　　　　　　to Scene 3
W **MTRANS** 'no F' to S
(go back to *) or
(go to Scene 4 at no pay path)

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

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

Roles: S = Customer
      W = Waiter
      C = Cook
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[Rich 1983]

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C = Cook
M = Cashier
O = Owner

Entry conditions: S is hungry.
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Results: S has less money
O has more money
S is not hungry
S is pleased (optional)

SCENE ONE:
Entering the Restaurant

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

Jami entered the restaurant and the waitress seated *her*.

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

Jami entered the restaurant and the waitress seated *her*.

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

JAMI <═ᴾ═) PTRANS ←ᴰ [→ RESTAURANT
                        ← OUTSIDE

Jami entered the restaurant and the waitress seated *her*.

Understanding the Story

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

Jami entered the restaurant and the waitress seated her.

SCENE TWO: Ordering Food

Scene 2: Ordering

(Menu on table) (W brings menu)   (S asks for menu)
S **PTRANS** menu **to** S   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** food list **to** CP(S)
*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   C **DO** (prepare F script)
W **PTRANS** W **to** S   to Scene 3
W **MTRANS** 'no F' **to** S
(go back to *) or
(go to Scene 4 at no pay path)

Then *she* gave *her* a menu.
After *she* read it
she decided to order lobster.

Scene 2: Ordering

(Menu on table)   (W brings menu)   (S asks for menu)
S **PTRANS** menu **to** S   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** food list **to** CP(S)
      *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   C **DO** (prepare F script)
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Then *she* gave *her* a menu.
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she decided to order lobster.

Scene 2: Ordering

(Menu on table)   (W brings menu)   (S asks for menu)
S PTRANS menu to S   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 food list to CP(S)
        *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   C DO (prepare F script)
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(go back to *) or
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Then *she* gave *her* a menu.
After *she* read it
she decided to order lobster.

[Rich 1983]

Scene 2: Ordering

(Menu on table)　　(W brings menu)　　(S asks for menu)
S **PTRANS** menu **to** S　　　　　　　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** food list **to** CP(S)
　　*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　　　　　　　　　　　C **DO** (prepare F script)
W **PTRANS** W **to** S　　　　　　　　　　　　　to Scene 3
W **MTRANS** 'no F' **to** S
(go back to *) or
(go to Scene 4 at no pay path)

Then *she* gave *her* a menu.
After *she* read it
she decided to order lobster.

SCENE THREE:
Eating!

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)

After *she* brought it to *her she* ate it.

[Rich 1983]

Scene 3: Eating

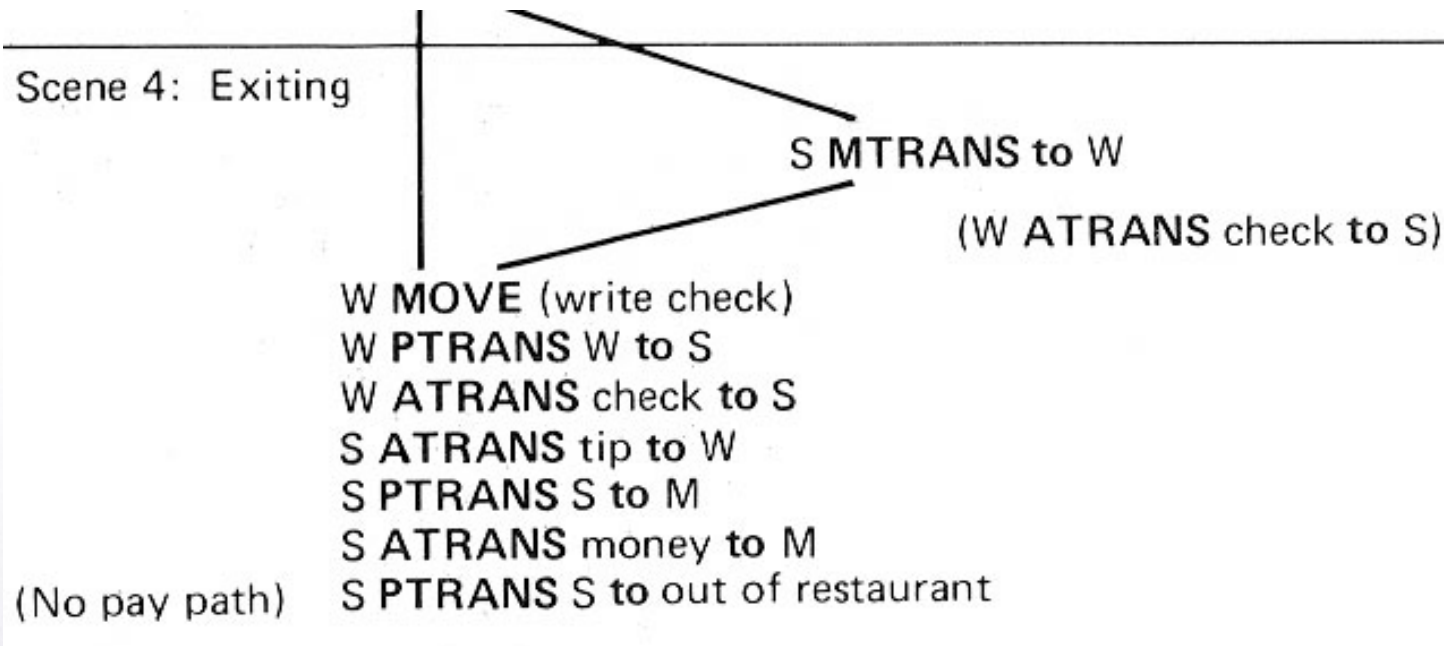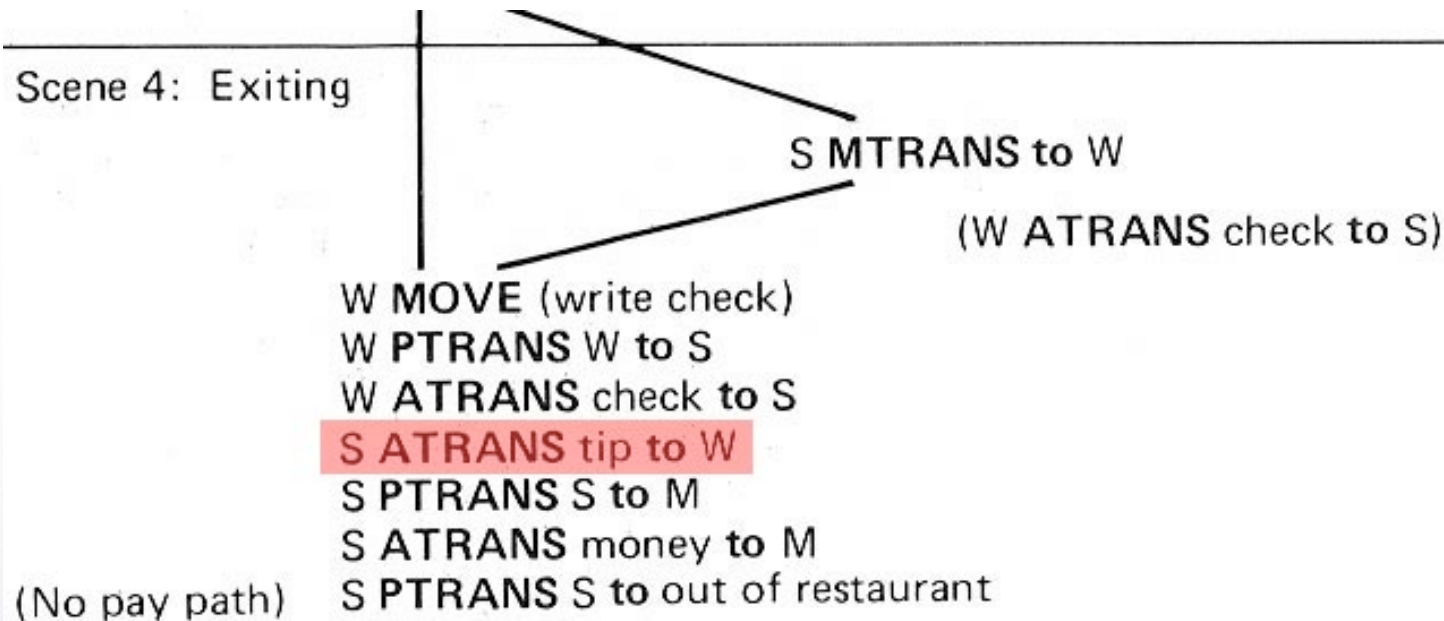C ATRANS F to W
W ATRANS F to S
S INGEST F

(Option: Return to Scene 2 to order more;
otherwise, go to Scene 4)

After *she* brought it to *her* *she* ate it.

[Rich 1983]

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)

After *she* brought it to *her* *she* ate it.

SCENE FOUR:
Exiting the Restaurant

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

Later, *she* left *her* a big tip.

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

Later, *she* left *her* a big tip.

Answering Questions

- Why did she enter the restaurant?

Entry conditions: S is hungry.
S has money.

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

[Rich 1983]

Answering Questions

- Did she pay?
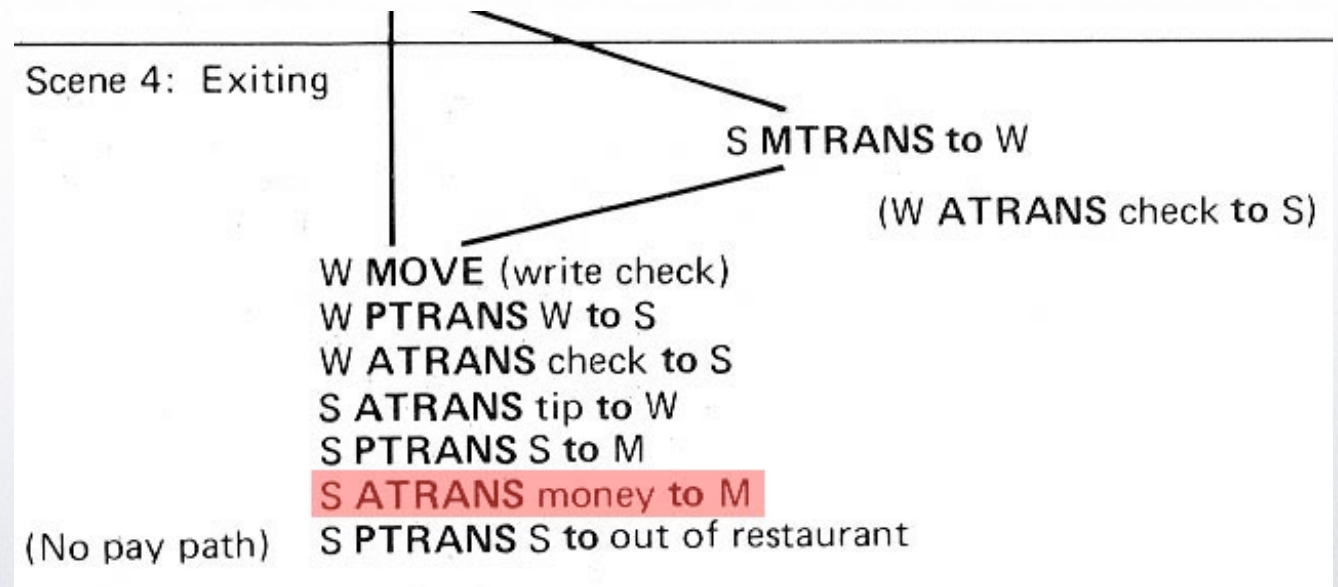
Another Story

Joe was hungry. He decided to go to a restaurant. He went to one. He sat down in a chair. A waiter did not go to the table. Joe became upset. He left the restaurant.

Questions

- Did Joe eat any food?

- Did Joe pay?

- Did Joe leave a tip?

- Why was Joe upset?

Another Domain

News Scripts
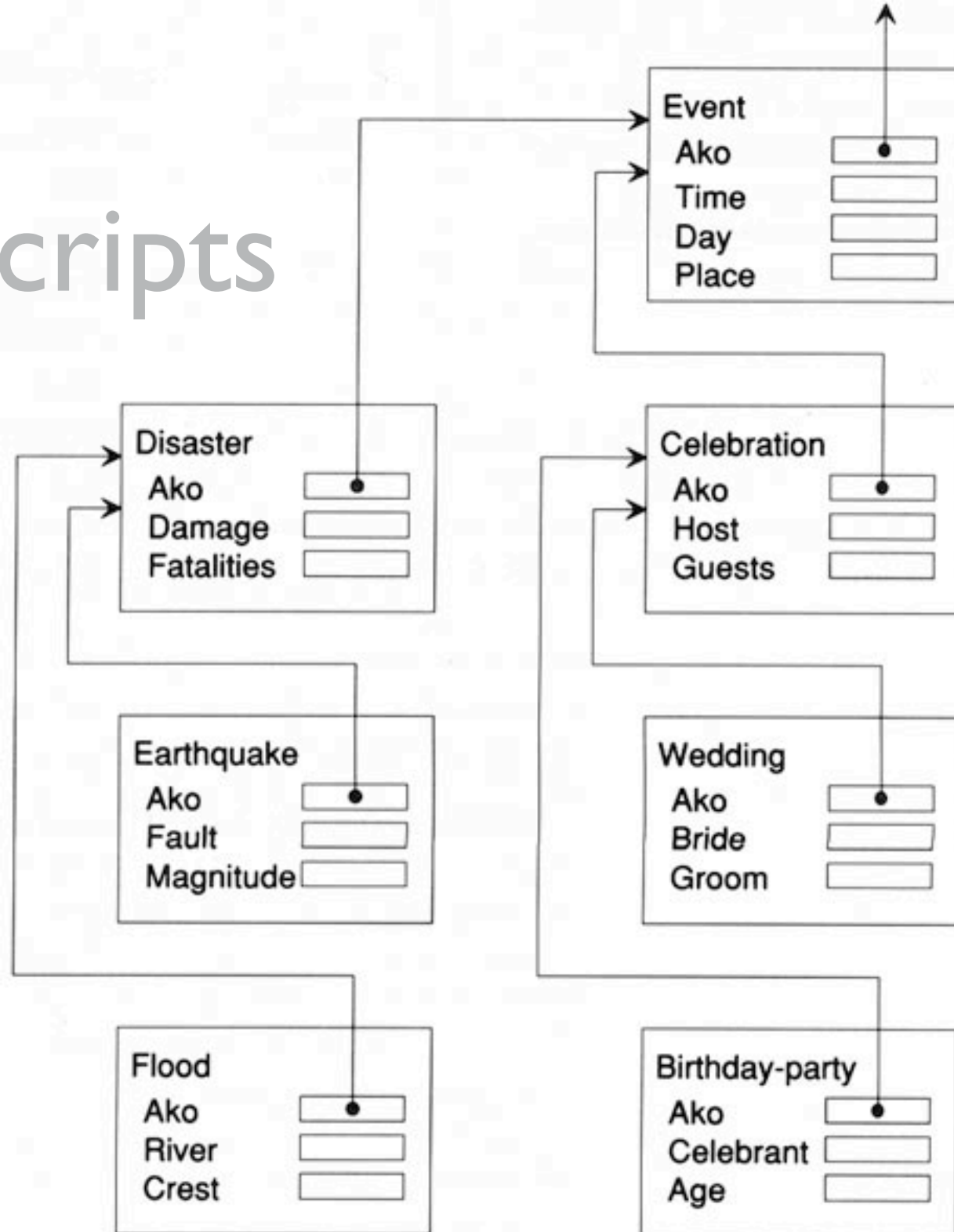
KR: Frame System

- represents a semantic net

- instead of nodes & links uses frames & slots

- Ako create a hierarchy of frame classes

- Isa link instances to classes

- procedures can be associated with slots

- this is just like a database....

Earthquake Slots

Place

Fault

Magnitude

Day

Time

Fatalities

Damage

Earthquake Rules

- Fill <time> with the number containing a colon.

- Fill <fatalities> with integer near word like kill, die.

- Fill <damage> with number containing $

- Fill <magnitude> with a decimal number between 1.0 and 10.0

More Rules

- Fill <day> with word such as yesterday, today, or a day of the week.

- Fill <place> with a word that appears in a dictionary of geographical names.

- Fill <fault> with the proper name appearing closes to the word fault.

Earthquake hits Lower Slabovia

Today, an extremely serious earthquake of magnitude 8.5 hit Lower Slabovia, killing 25 people and causing $500 million in damage. The President of Lower Slabovia said that the hard-hit area near the Sadie Hawkins fault has been a danger zone for years.

[Winston 1993]

Earthquake hits Lower Slabovia

Today, an extremely serious earthquake of magnitude 8.5 hit Lower Slabovia, killing 25 people and causing $500 million in damage. The President of Lower Slabovia said that the hard-hit area near the Sadie-Hawkins fault has been a danger zone for years.

[Winston 1993]

Example

Earthquake

Time	
Day	Today
Place	Lower-Slabovia
Damage	500,000,000
Fatalities	25
Fault	Sadie-Hawkins
Magnitude	8.5

[Winston 1993]

Earthquake Study Stopped

Today, the President of Lower Slabovia killed 25 proposals totaling $500 million for research in earthquake prediction. Our Lower Slabovian correspondent calculates that 8.5 research proposals are rejected for every one which is approved. There are rumors that the President's science advisor, Sadie Hawkins, is at fault.

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Example

Earthquake

Time	
Day	Today
Place	Lower-Slabovia
Damage	500,000,000
Fatalities	25
Fault	Sadie-Hawkins
Magnitude	8.5

- Good scripts are complex, containing common sense knowledge.

- Designing scripts is labor intensive.

- Perhaps scripts could be automatically learned by machine?

Representations

[Winston 1993]
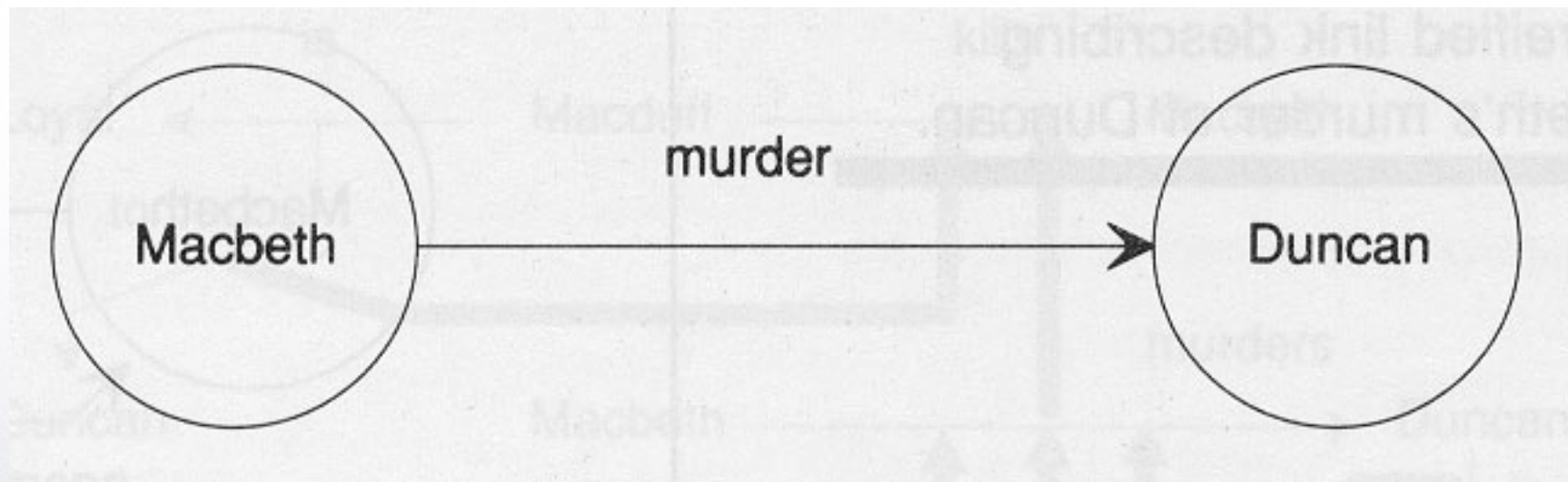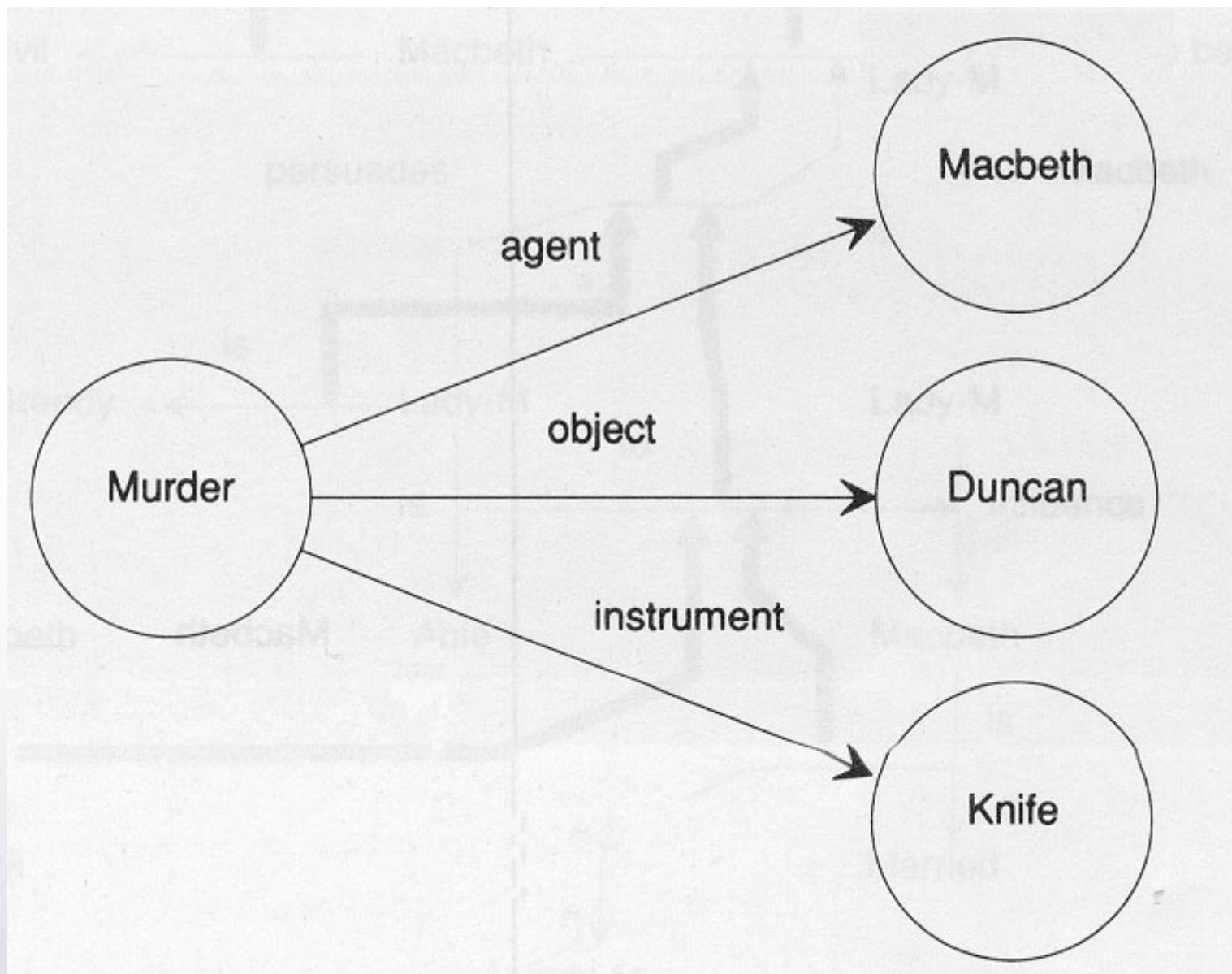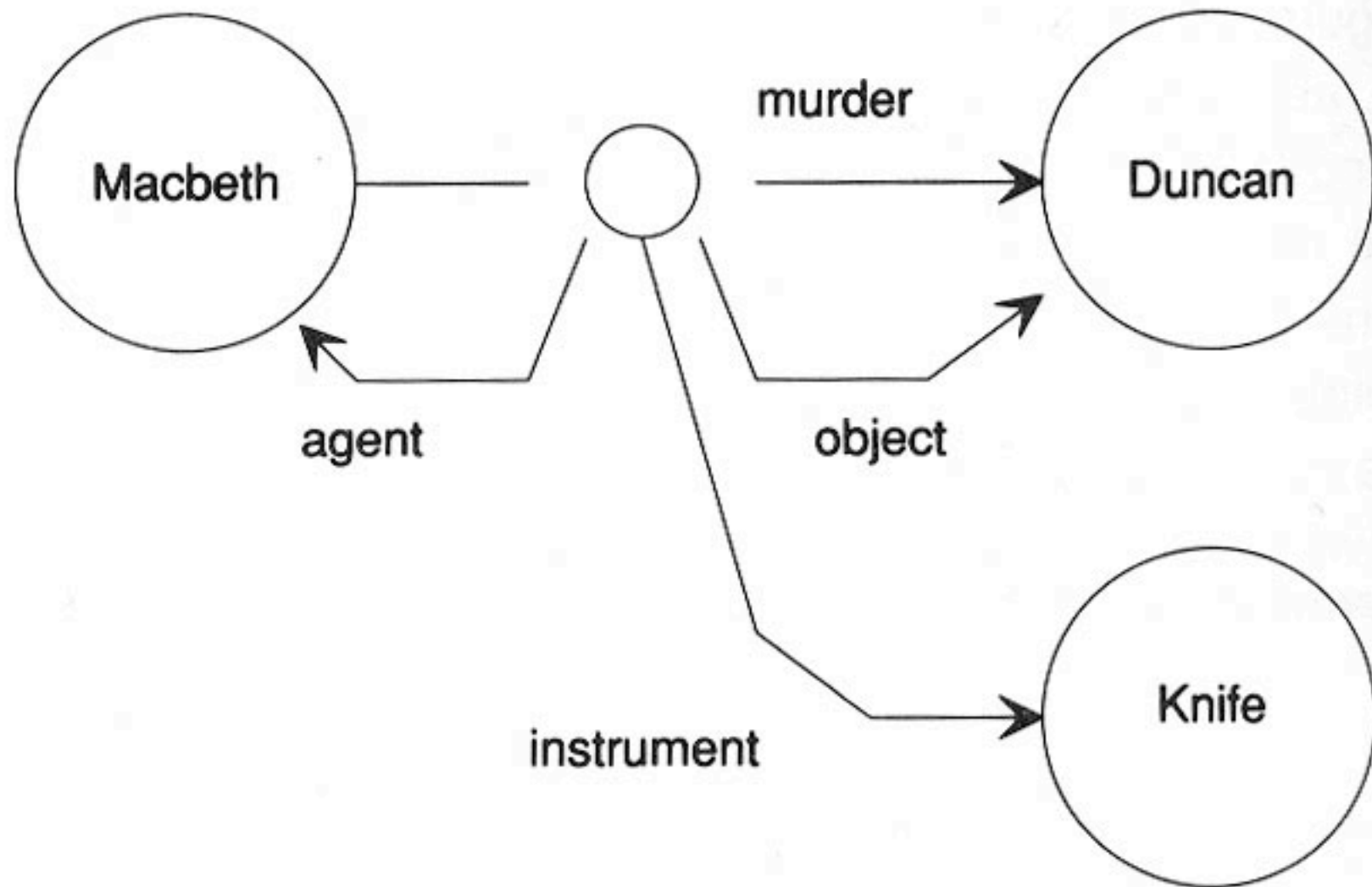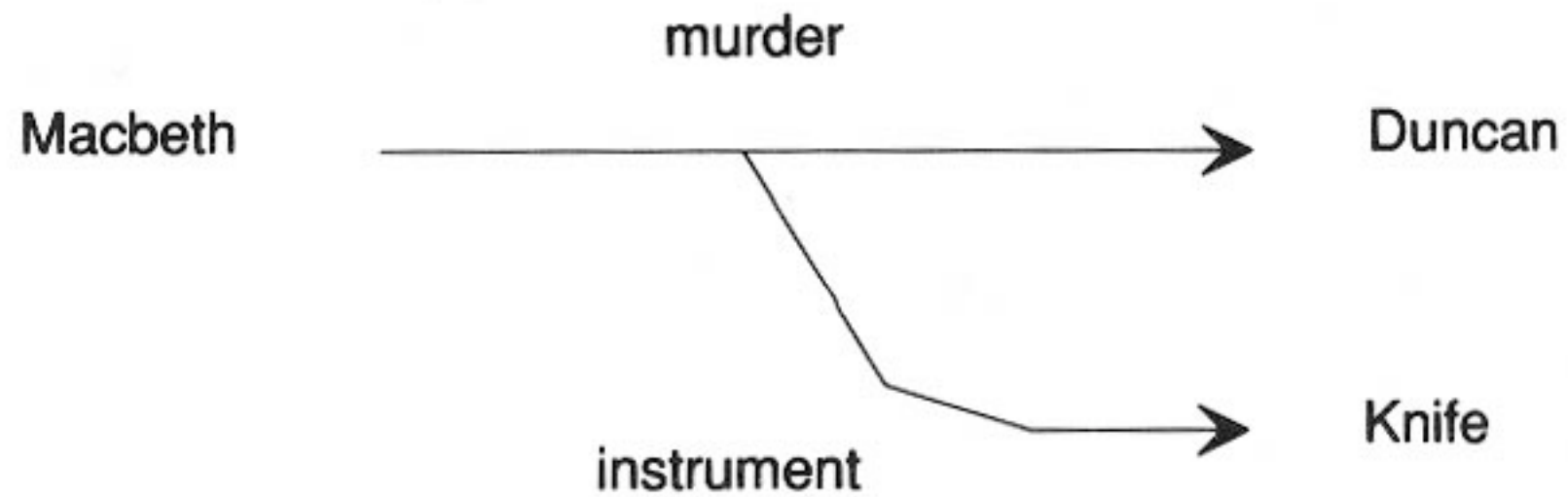
Macbeth

This is a story about Macbeth, Lady Macbeth, Duncan, and Macduff. Macbeth is an evil noble and Lady Macbeth is a greedy, ambitious woman. Duncan is a king and Macduff is a noble. Lady Macbeth persuades Macbeth to want to be king because she is greedy. She is able to influence him because he is married to her and because he is weak. Macbeth murders Duncan with a knife. Macbeth murders Duncan because Macbeth wants to be king, because Macbeth is evil, and because Duncan is king. Then Lady Macbeth kills herself. Finally, Macduff gets angry and kills Macbeth because Macbeth killed Duncan and because Macduff is loyal to Duncan.

[Winston 1993]

Greed

This is an exercise about a weak noble and a greedy woman. The noble is married to the woman. Explain why the noble is likely to want to be king.
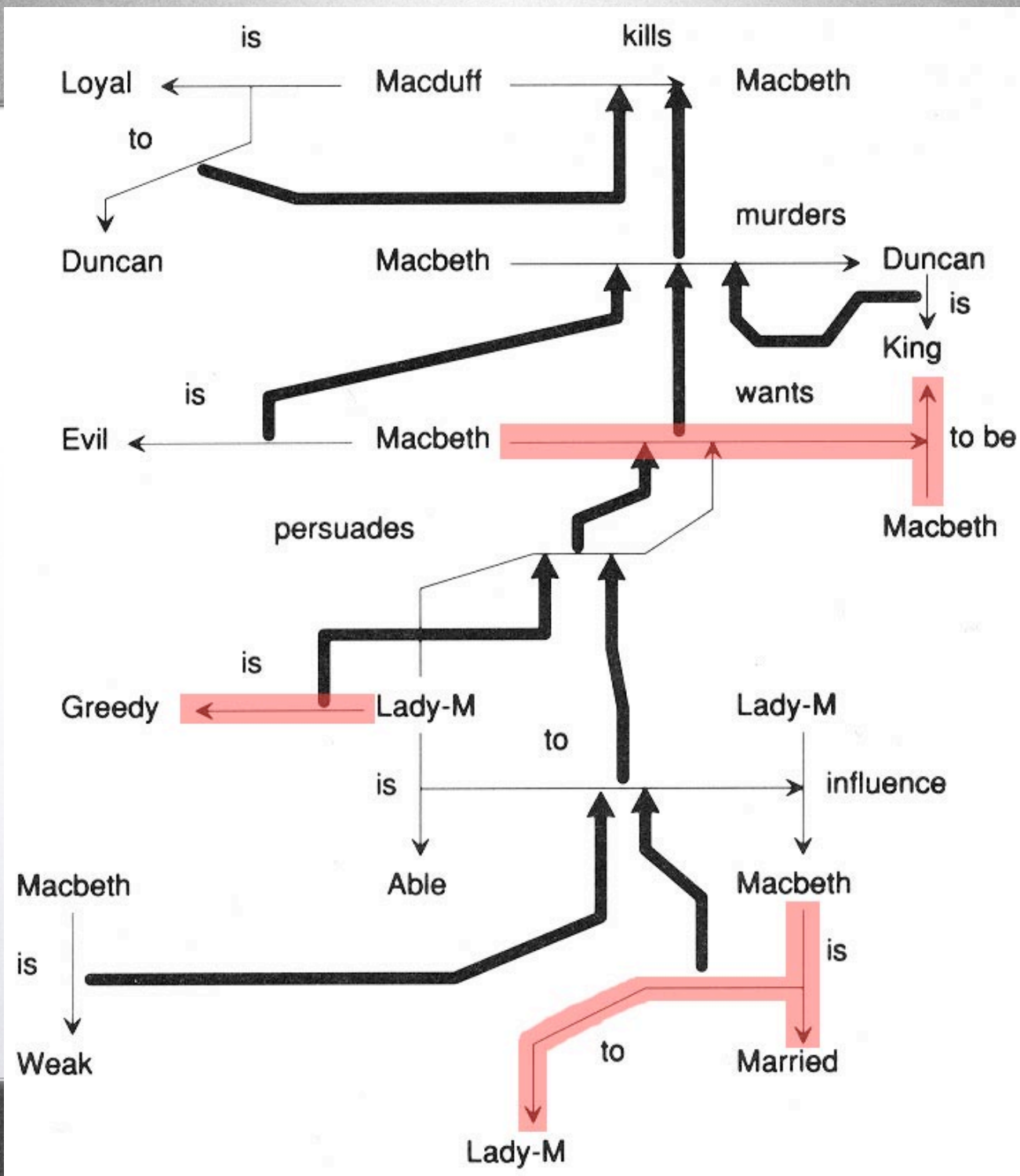
[Winston 1993]

[Winston 1993]
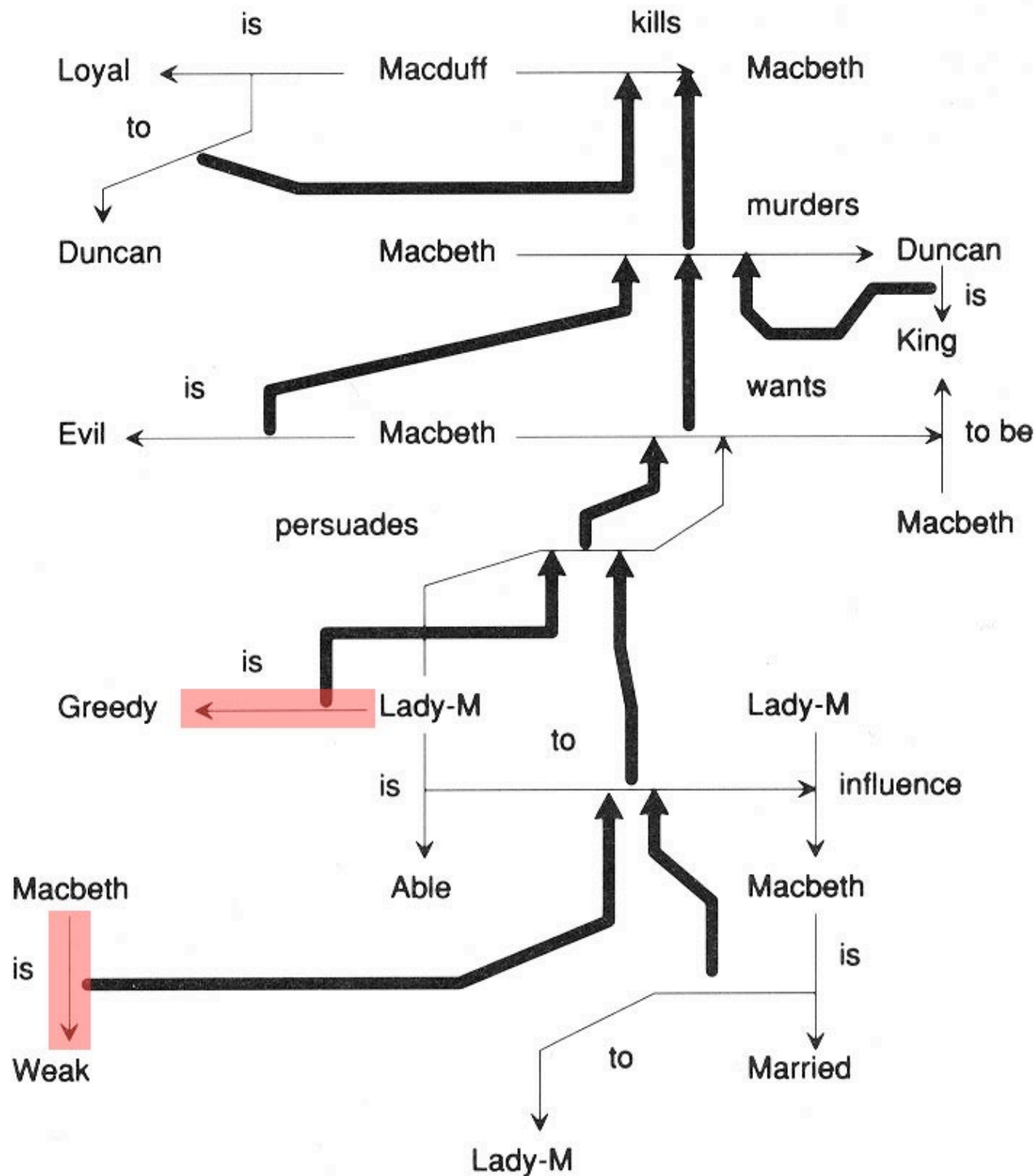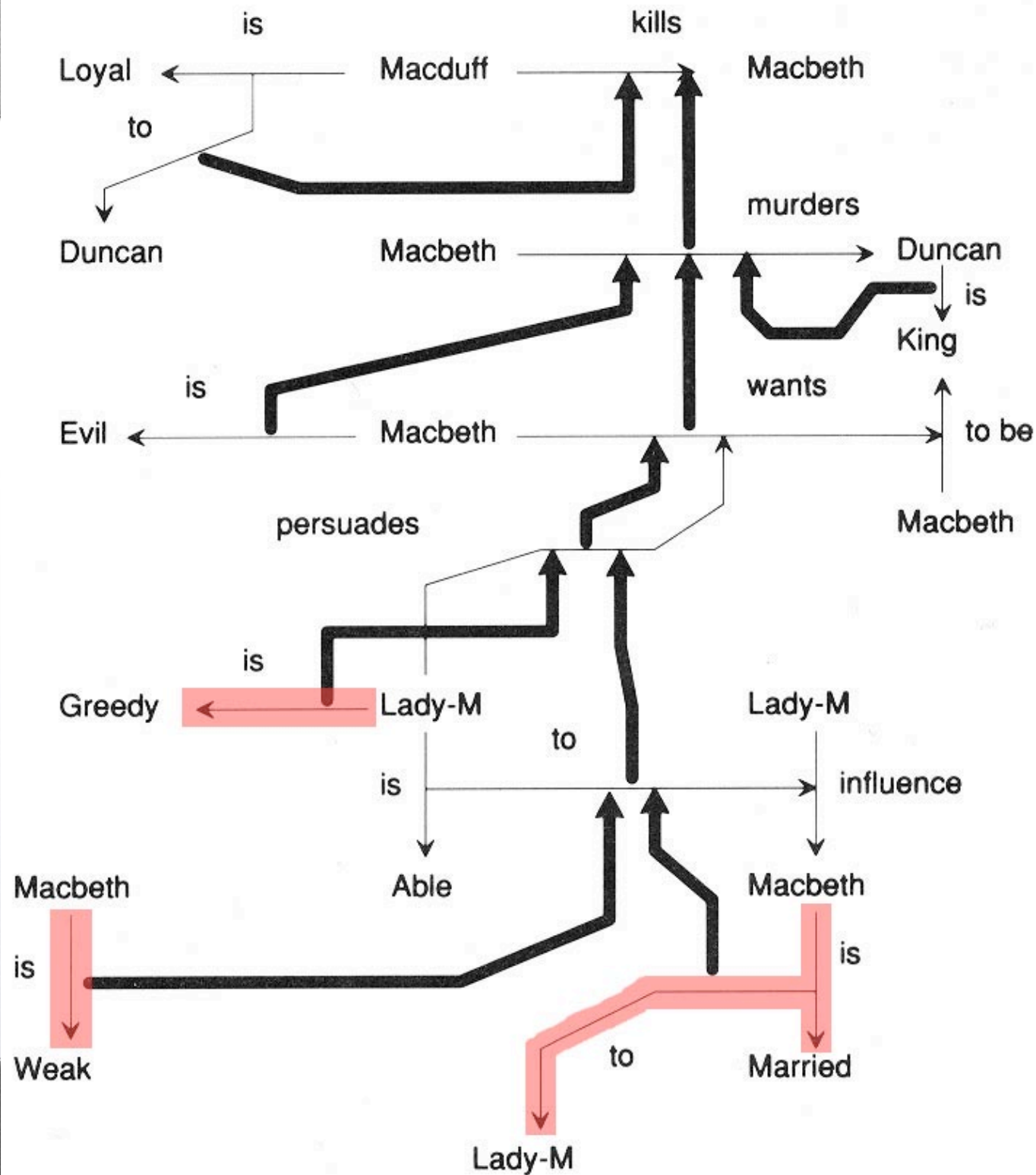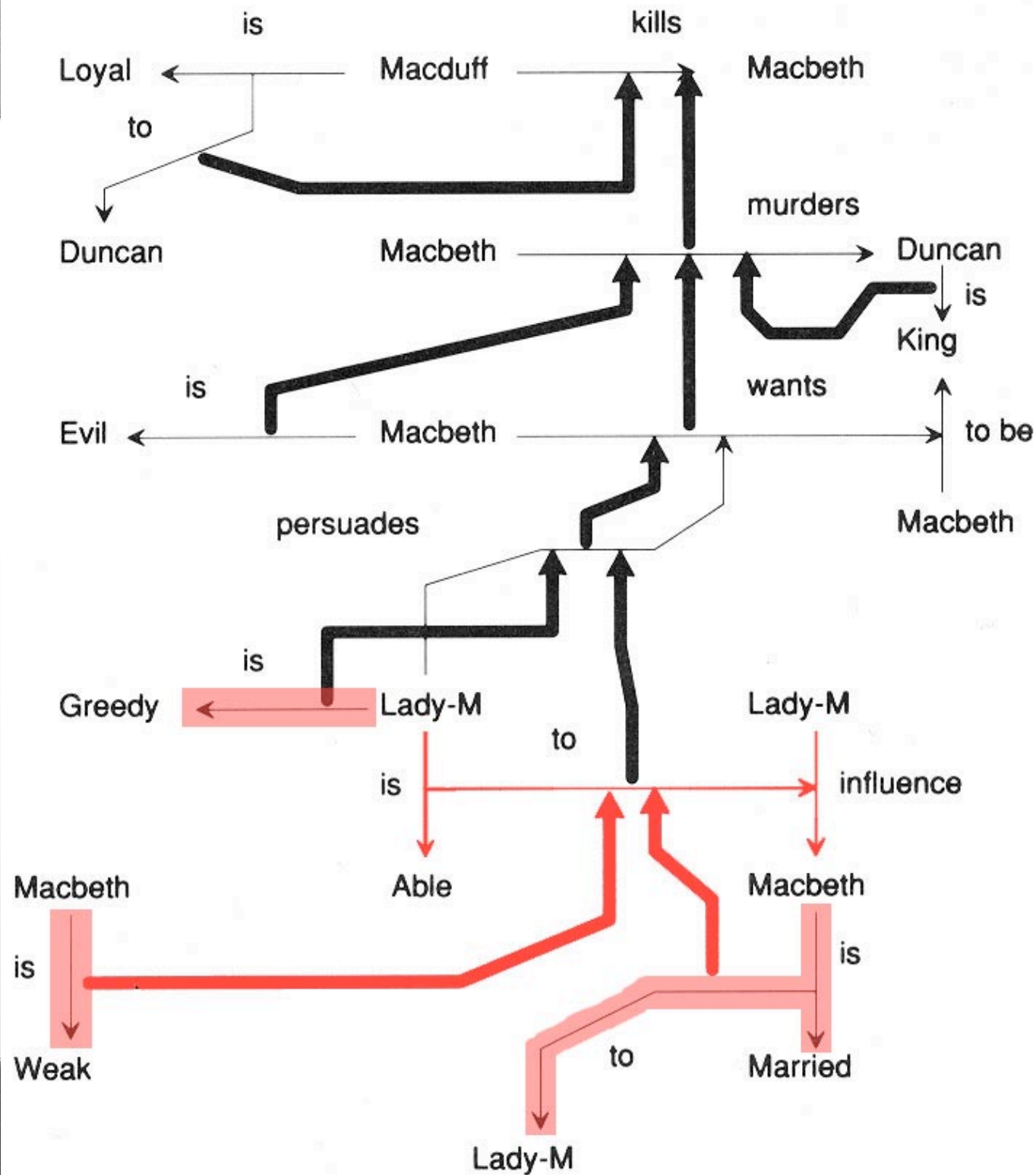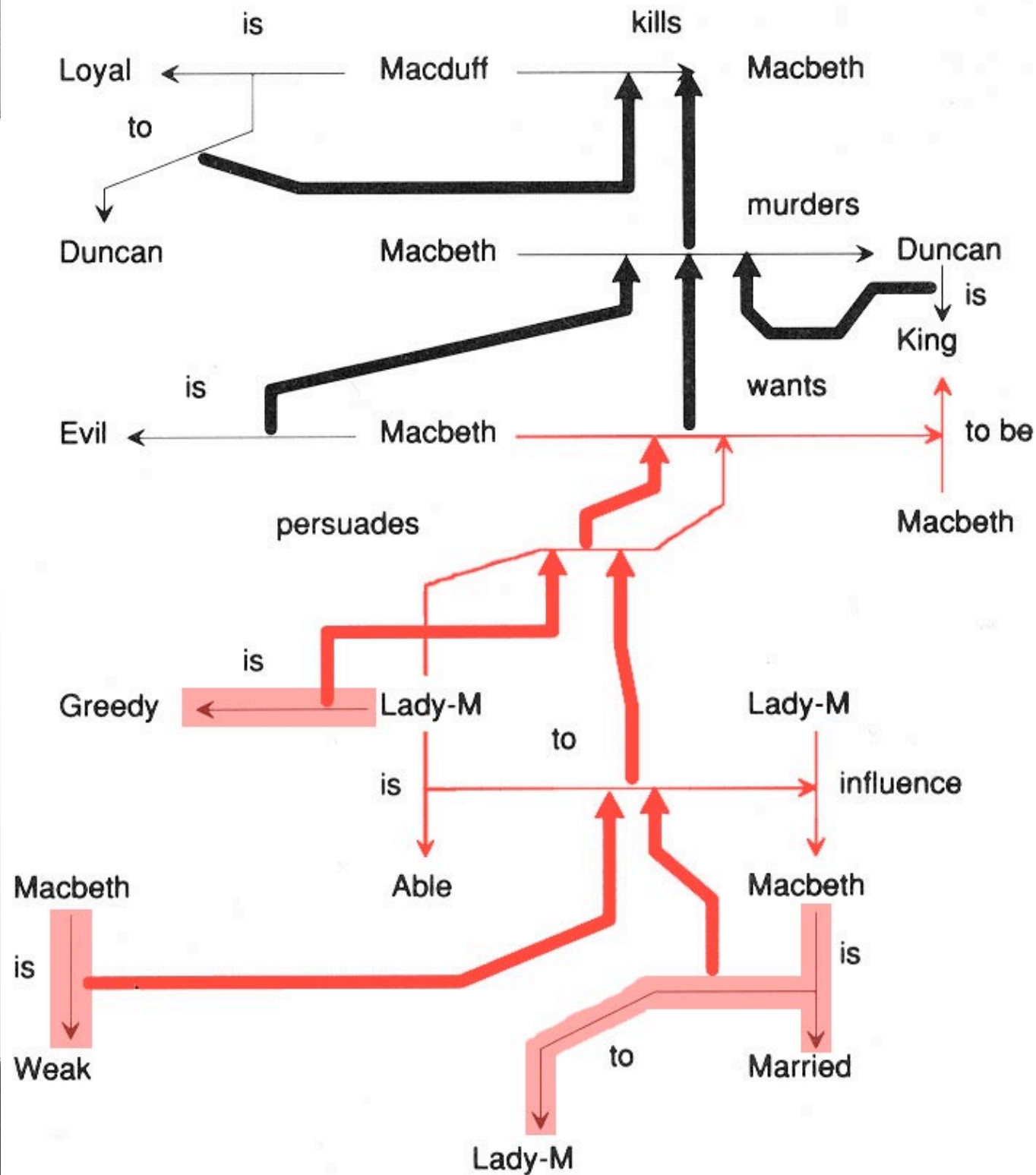
Domination

This is an exercise about a noble and a domineering, greedy woman. The noble is married to the woman. Show that the noble is likely to want to be king.
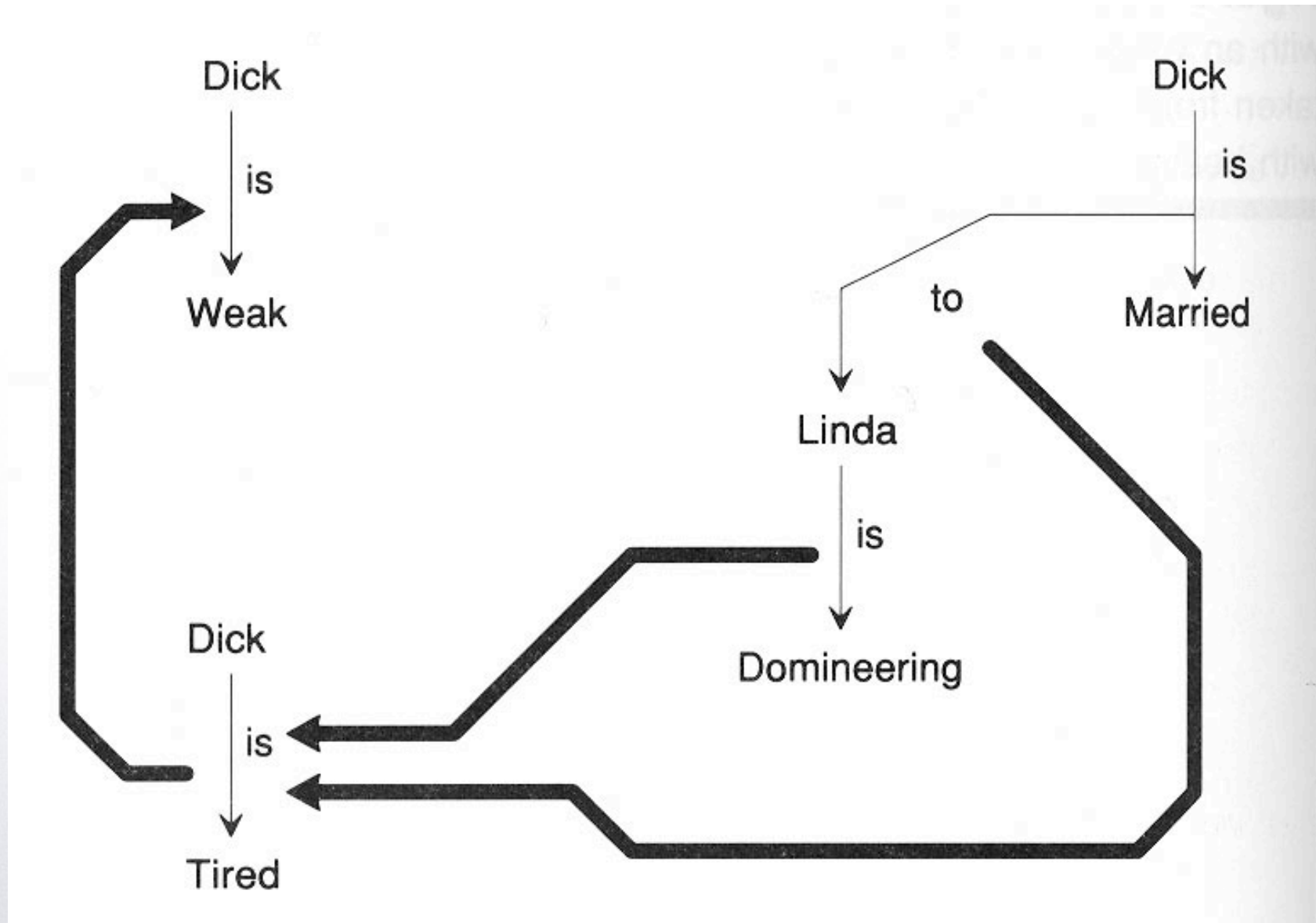
King

wants

Noble ·····················> to be

Noble

is

Greedy ← Woman

is

Domineering ← Woman

Noble

is

to
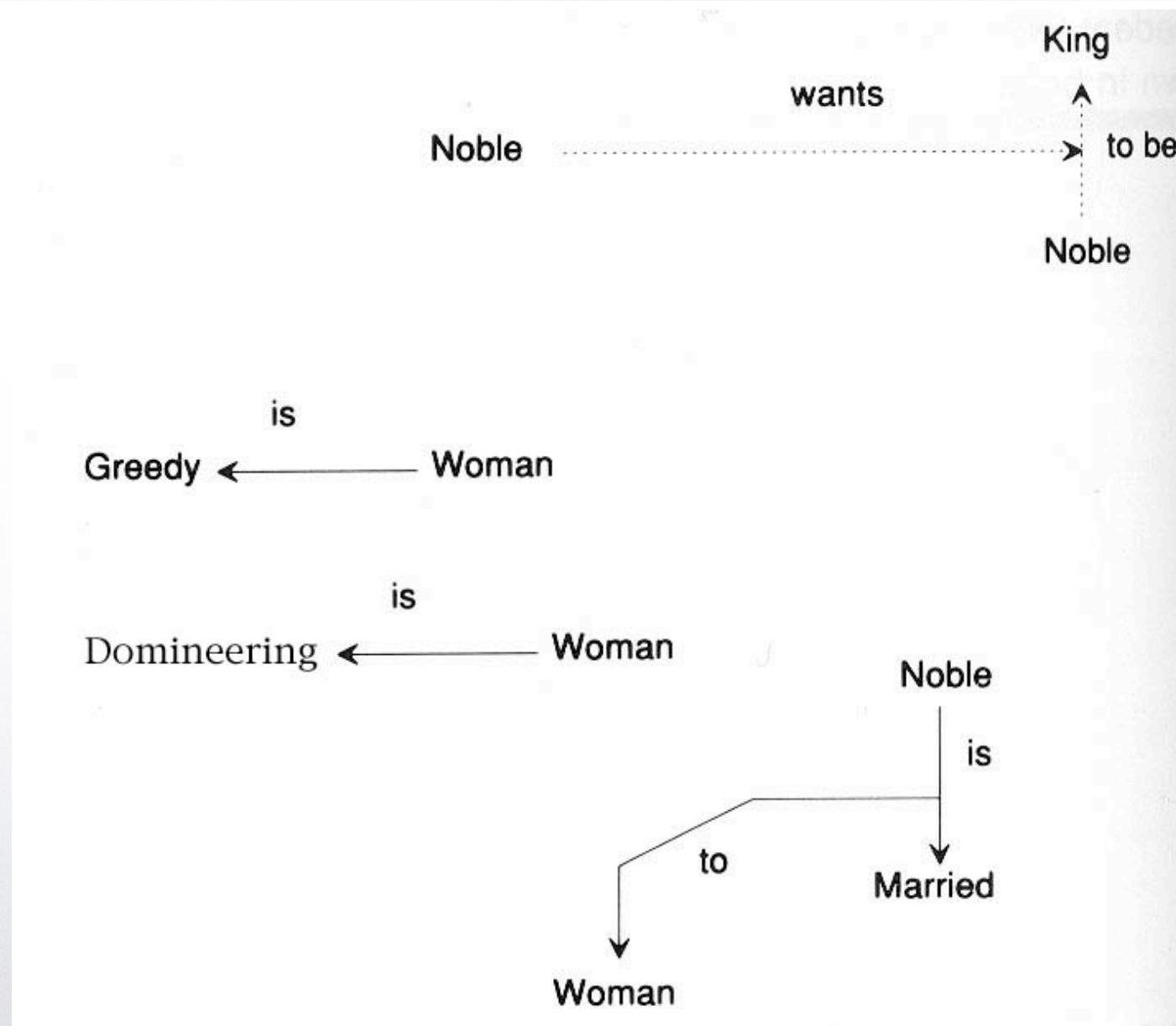
Married

Woman

Linda and Dick

This is a story about Linda and Dick. Linda is a woman, and Dick is a man. Dick is married to Linda. Dick is weak because he is tired. He is tired because Linda is domineering.

Dick is Weak

Dick is Married to Linda

Linda is Domineering

Dick is Tired

[Winston 1993]

Another Domain

A Cup

This is a description of an object. The object is a cup because it is stable and enables drinking.
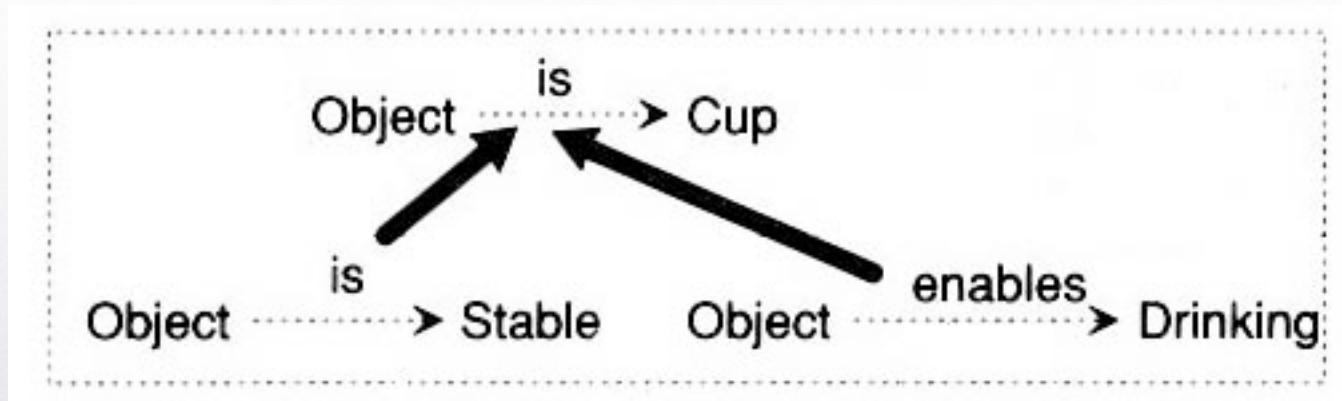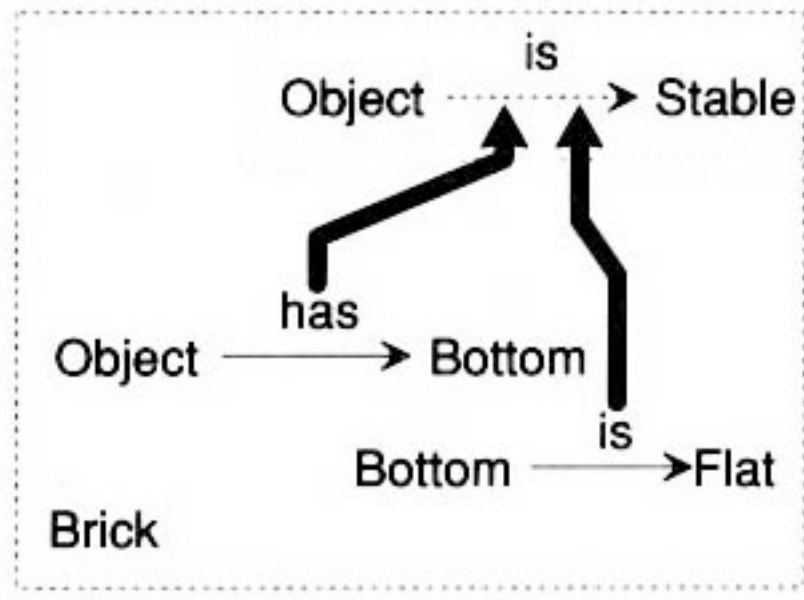
A Brick

This is a description of a brick. The brick is stable because the brick's bottom is flat. The brick is heavy.
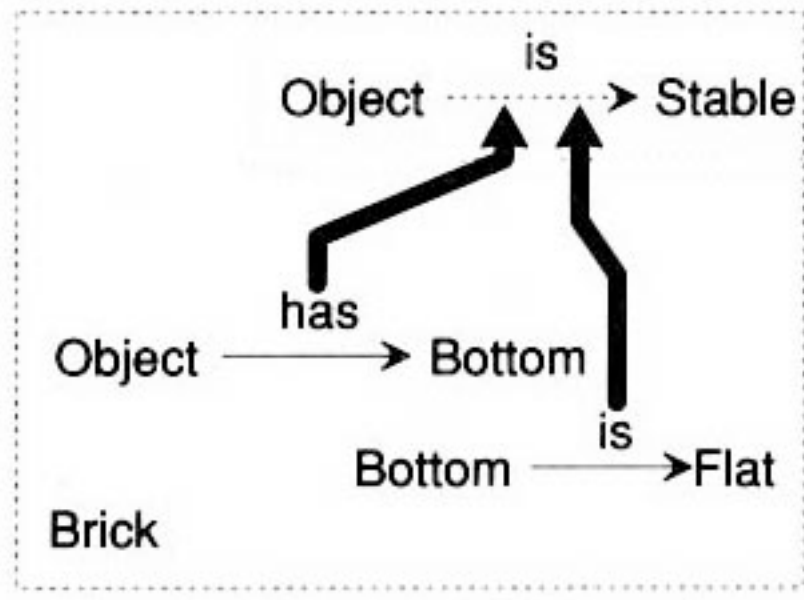
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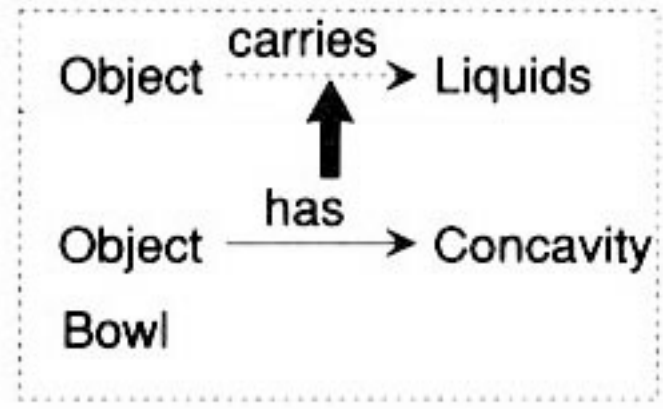

If ?object has flat bottom
Then ?object is stable.

A Bowl

This is a description of a bowl. The bowl carries liquids because it has a concavity. The bowl contains chicken soup.
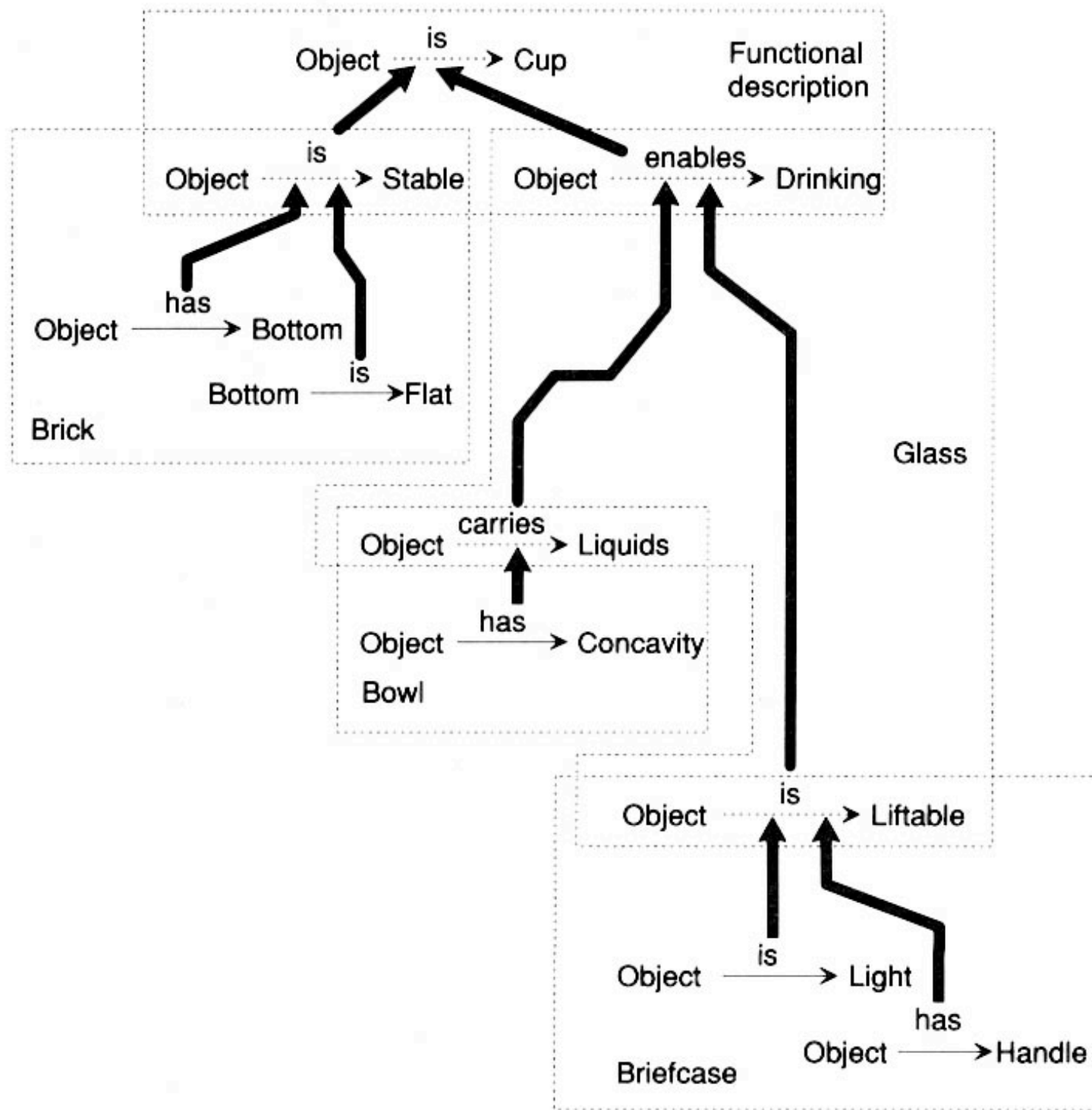

If ?object has concavity
Then ?object carries liquids.

[Winston 1993]

More Objects

- This is a description of a glass. The glass enables drinking because it carries liquids and is liftable. The glass is pretty.

- This is a description of a briefcase. The briefcase is liftable because it has a handle and because it is light. The briefcase is useful because it carries papers.
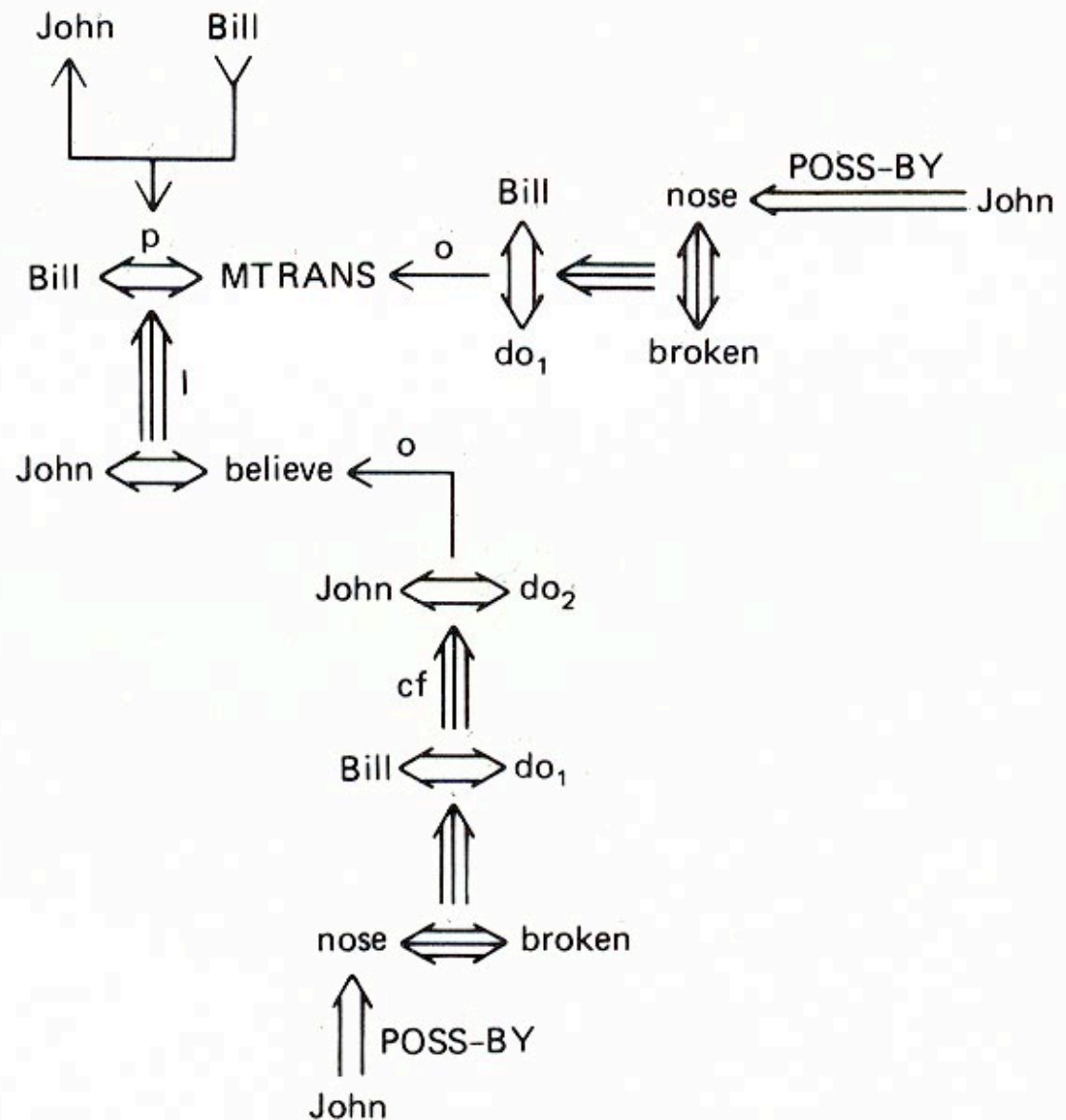
[Winston 1993]

An Unknown Object

This is an exercise about a light object that is made of porcelain. The object has a decoration, a concavity, and a handle. The object's bottom is flat.
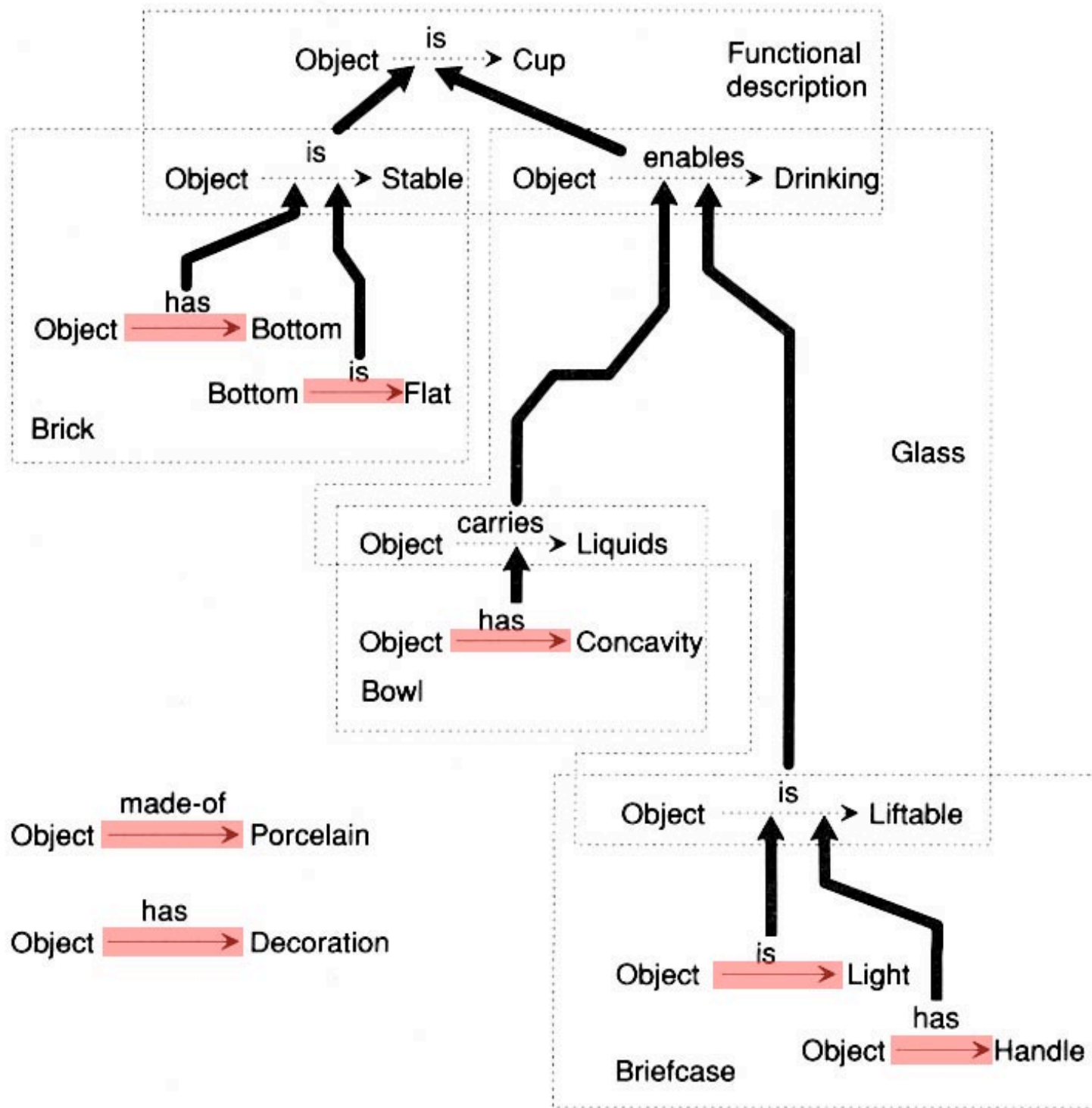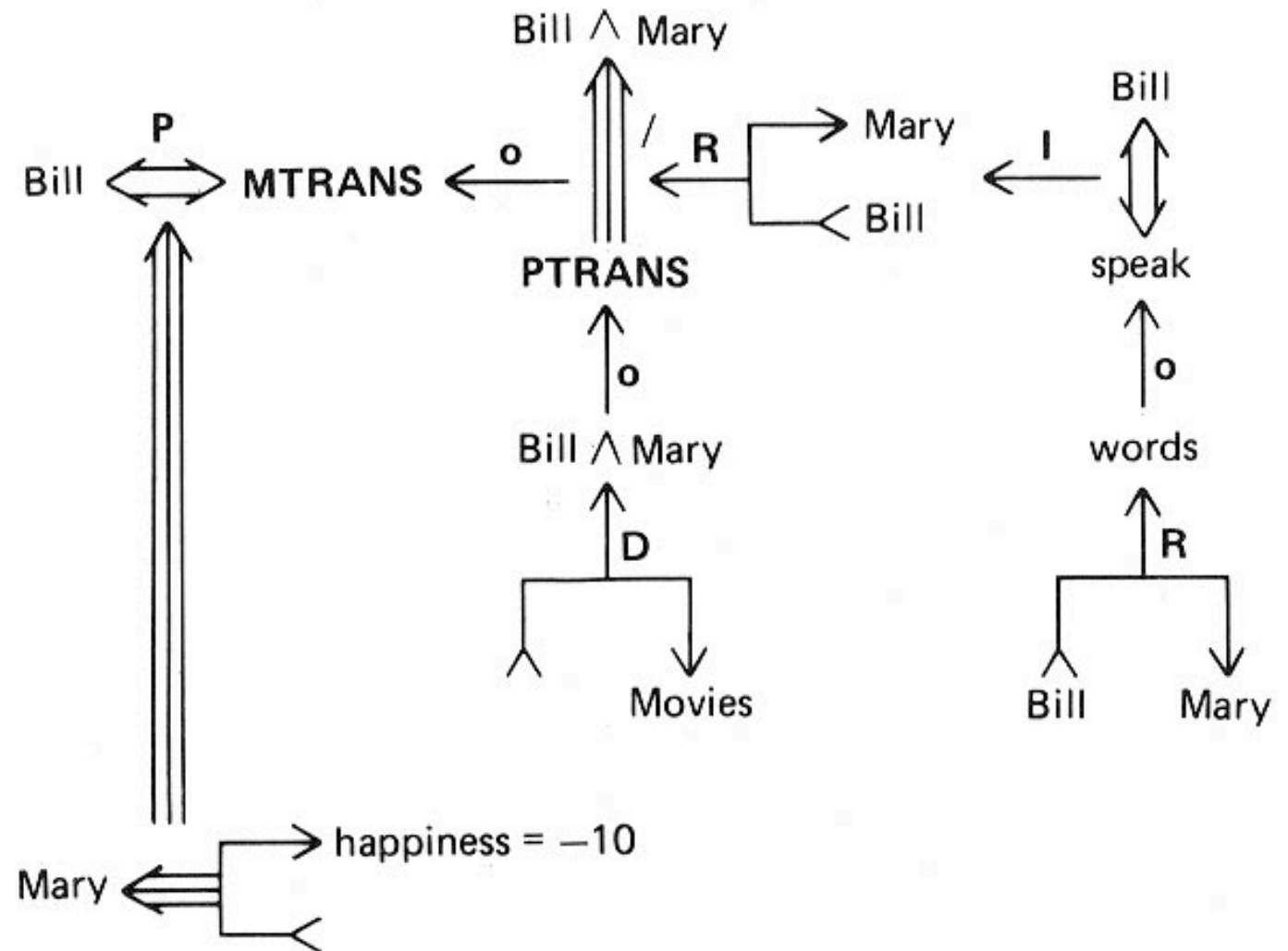
STUDY QUESTION

What does this represent?

STUDY QUESTION

What does this represent?

STUDY QUESTION

What is Cyc?

See wikipedia entry:
http://en.wikipedia.org/wiki/Cyc

STUDY QUESTION

Write a story about an object which is not a cup, but would fool our example system into classifying as one.