MARGIE Modeled Understanding as Inference

- **Components:**
  - **ELI (English Language Interpreter)**
  - **MEMORY (did inference)**
  - **BABEL (generator)**
- **MARGIE's task modes:**
  - **Paraphrase**
  - **Infer**
- **Also demonstrated knowledge-based machine translation**

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CD's Four Types of Causation

- Acts can RESULT in states.
- States can ENABLE actions.
- States or acts can INITIATE mental states.
- Mental states can be REASONS for acts.
- **Breakout groups:** Sketch rep for:
  1. When John saw the new car, he wanted it.
  2. John killed Fred.
  3. Mary gave John the car.
  4. John bought the car.
  5. John scared the mugger off.

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Goal of MARGIE: Rich Understanding
Sample MARGIE Outputs from
"John told Mary that Bill wants a book."

- John believes that Bill wants a book.
- Mary knows that Bill wants a book.
- Bill wants a book.
- Bill wants to come to possess a book.
- Bill probably wants to read a book.
- A book about what?
- John and Mary have been together recently.
- Bill might get himself a book.
- John might give Bill a book.
- Mary might give Bill a book.
- John may want Mary to give Bill a book.

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MARGIE's Goals Required More
Specificity: Rieger's 16 Inference Types

- SPECIFICATION
  - John picked up the rock. He hit Bill.
  - JOHN HIT BILL WITH THE ROCK.
- CAUSATIVE
  - John hit Bill.
  - JOHN WAS PROBABLY MAD AT BILL.
- MOTIVATIONAL
  - Mary hit John.
  - MARY PROBABLY WANTED JOHN TO BE HURT.

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Rieger's Inference Types (cont)

- RESULTATIVE
  - Mary gave John a car.
  - JOHN HAS THE CAR.
- ENABLEMENT
  - Pete went to Europe.
  - PETE MUST HAVE HAD MONEY.
- FUNCTION
  - John wants the book.
  - JOHN PROBABLY WANTS TO READ IT.

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Let's Generate Some Ourselves

- Dick looked in the cookbook to find out how to make stew.
- DICK WILL NOW BEGIN TO MAKE A STEW.
- ENABLEMENT-PREDICTION

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- Mary couldn't see the horses finish. She cursed the man in front of her.
- THE MAN BLOCKED HER VISION.
- MISSING-ENABLEMENT

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- The baby ran into the street. Mary ran after him.
- MARY WANTS TO PREVENT THE BABY FROM BEING HURT.
- INTERVENTION

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- Mary wanted some nails.
- SHE WENT TO THE HARDWARE STORE.
- ACTION-PREDICTION

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- Pete told Bill that Mary hit John with a bat.
- BILL KNEW THAT JOHN HAD BEEN HURT.
- KNOWLEDGE-PROPAGATION

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- Does Pete have a gall bladder?
- IT'S HIGHLY LIKELY.
- NORMATIVE

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- John handed a book to Mary yesterday. Is Mary still holding it?
- PROBABLY NOT.
- STATE-DURATION

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- Andy's diaper is wet.
- ANDY IS PROBABLY A BABY.
- FEATURE

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- Mary is going to a masquerade.
- SHE WILL PROBABLY WEAR A COSTUME.
- SITUATION

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- Mary couldn't jump the fence.
- WHY DID SHE WANT TO?
- INTENT

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Rieger's Representation Was Procedural: Inference Molecules

- Consider ATRANS:

(ATRANS
  Actor (X) Object (Y) To (Z) From (W))

- What inferences would ENABLEMENT involve?
- How could we code procedures to handle them?

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Enablement Molecule for ATRANS

Build (HAS-POSSESSION Actor () Object ())

Fill ``Actor'' with the ``From'' of the ATRANS.
Fill ``Object'' with ``Object'' of the ATRANS.
Establish ``Enables'' link from this
HAS-POSSESSION to the ATRANS.

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CAUSATIVE Molecule
for HAS-POSSESSION

CAUSATIVE molecule for HAS-POSSESSION:

(HAS-POSSESSION Actor (W) Object (Y))

Build (ATRANS Actor () Object () To () From ())

Fill ``To'' with ``Actor'' of HAS-POSSESSION.
Fill ``Object'' with ``Object''
Establish RESULTS link from this ATRANS to the HAS-POSSESSION.

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Sentences May Prompt Multiple Inferences

- John went over to the telephone.
- Inferences include:
  - RESULTATIVE: John is at the location of telephone.
  - MOTIVATIONAL: John wants to be at location of the telephone.
  - FUNCTIONAL: John wants to communicate something to someone.

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Part of FUNCTION Molecule for Want

(WANT Actor (X) (HAS-LOCATION Object (Y) Loc (Z)))

 If Y is human
    and Z is (LOCATION-OF Object W))
    and W has FUNCTION F
 then
    Build (WANT Actor () F)

    Fill actor with X.
    Fill actor of F with object of HAS-LOCATION.
    Make INITIATE link between this WANT and input WANT.

 Telephone function
    (MTRANS Actor (X) from (X)...)
    (MTRANS to (X)...)

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Example of SPECIFICATION

John hit Bill.
 (RESULTS
    (Action (PROPEL Actor (John) Object (X)
                   To (Bill) From (John)))
    (State (IN-PHYSICAL-CONTACT
              Object1 (X) Object2 (Bill)))))
General specification rule for X: Infer X is object in memory
with appropriate features, recently created or referenced.

 A specific rule for PROPEL:
    If actor had something in hand, assume it.
    Else, assume actor's hand.

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Notes

- Need for restricted vocabulary:
  - 12 CD acts x 16 inference types = 192 inf molecules
- Need for domain-specific inferences

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The Process

- Given a conceputalization:
- Retrieve inference molecules under predicate and objects.
- Apply them, generating new CDs.
- Compare each new CD with memory:
    - If it matches something known, merge.
    - If it contradicts, change certainty.
    - If neither, store and put on end of inference queue, to infer from it later.
- Continue breadth-first expansion of the inference queue.

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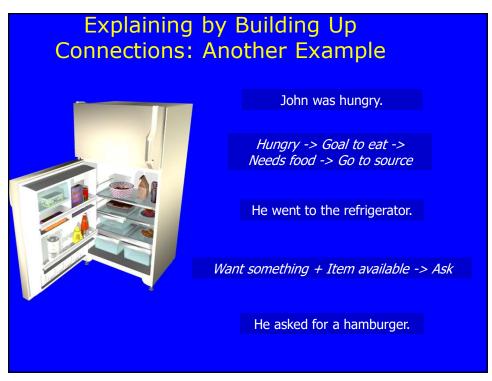# Sample Conclusions by MARGIE, from "John told Mary that Bill wants a book."

- John believes that Bill wants a book.
- Mary knows that Bill wants a book.
- Bill wants a book.
- Bill wants to come to possess a book.
- Bill probably wants to read a book.
- A book about what?
- John and Mary have been together recently.
- Bill might get himself a book.
- John might give Bill a book.
- Mary might give Bill a book.
- John may want Mary to give Bill a book.

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Problems

- What do you infer from "John hit Mary"?
- MARGIE's inferences include:
  - John probably used his hand.
  - Mary was probably hurt.
  - John probably wanted to hurt Mary.
  - Mary now wants to feel better.
  - John may want Mary to feel better
- How do you know when to stop?

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Problems (cont): Context

John was hungry.

Hungry -> Goal to eat -> Needs food -> Go to source

He went to a restaurant.

Want something + Item available -> Ask

He asked for a hamburger.

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Explaining by Building Up Connections: Another Example

John was hungry.

Hungry -> Goal to eat -> Needs food -> Go to source

He went to the refrigerator.

Want something + Item available -> Ask

He asked for a hamburger.

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Explaining Can Be Hard for People Too
Washing Clothes

The procedure is actually quite simple. First, you arrange things into different groups. Of course, one pile may be sufficient depending on how much there is to do. If you have to go somewhere else due to lack of facilities, that is the next step; otherwise, you are pretty well set. It is important not to overdo things. That is, it is better to do too few things at once than too many. In the short run, this may not seem important, but complications can arise. A mistake can be expensive as well. At first, the whole procedure will seem complicated. Soon however, it will become just another facet of life. It is difficult to foresee any end to the necessity for this task in the immediate future, but then one never can tell. After the procedure is completed, one arranges the materials into different groups again. Then they can be put into their appropriate places. Eventually, they will be used once more and the whole cycle will then have to be repeated. However, this is part of life.

Bransford & Johnson 1973, p. 400

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Scripts (Schank & Abelson, 77)

- Scripts record standard events in stereotyped contexts (e.g., restaurant, laundry, airport,…)
- The restaurant script might include *enter, be seated, order, receive food, eat, pay, leave…*
- Once an appropriate script is selected, that script provides context-relevant inferences, enabling efficient formation of connections to explain routine events, and helping to identify the non-routine.
- But how to explain the non-routine?

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