



COMPUTATIONALISM

PRAGYANPARAMITA MOHAPATRA

DEPARTMENT OF PHILOSOPHY

UTKAL UNIVERSITY, BHUBANESWAR - 751004 INDIA

Email-id: pragyanparamita@utkaluniversity.ac.in

COMPUTATIONALISM

- COULD A MACHINE THINK? COULD THE MIND ITSELF BE A THINKING MACHINE? THE COMPUTER REVOLUTION TRANSFORMED DISCUSSION OF THESE QUESTIONS, OFFERING OUR BEST PROSPECTS YET FOR MACHINES THAT COPY REASONING, DECISION-MAKING, PROBLEM SOLVING, PERCEPTION, LINGUISTIC COMPREHENSION, AND OTHER CHARACTERISTIC MENTAL PROCESSES. **ADVANCES IN COMPUTING RAISE THE PROSPECT THAT THE MIND ITSELF IS A COMPUTATIONAL SYSTEM—A POSITION KNOWN AS THE COMPUTATIONAL THEORY OF MIND (CTM).**

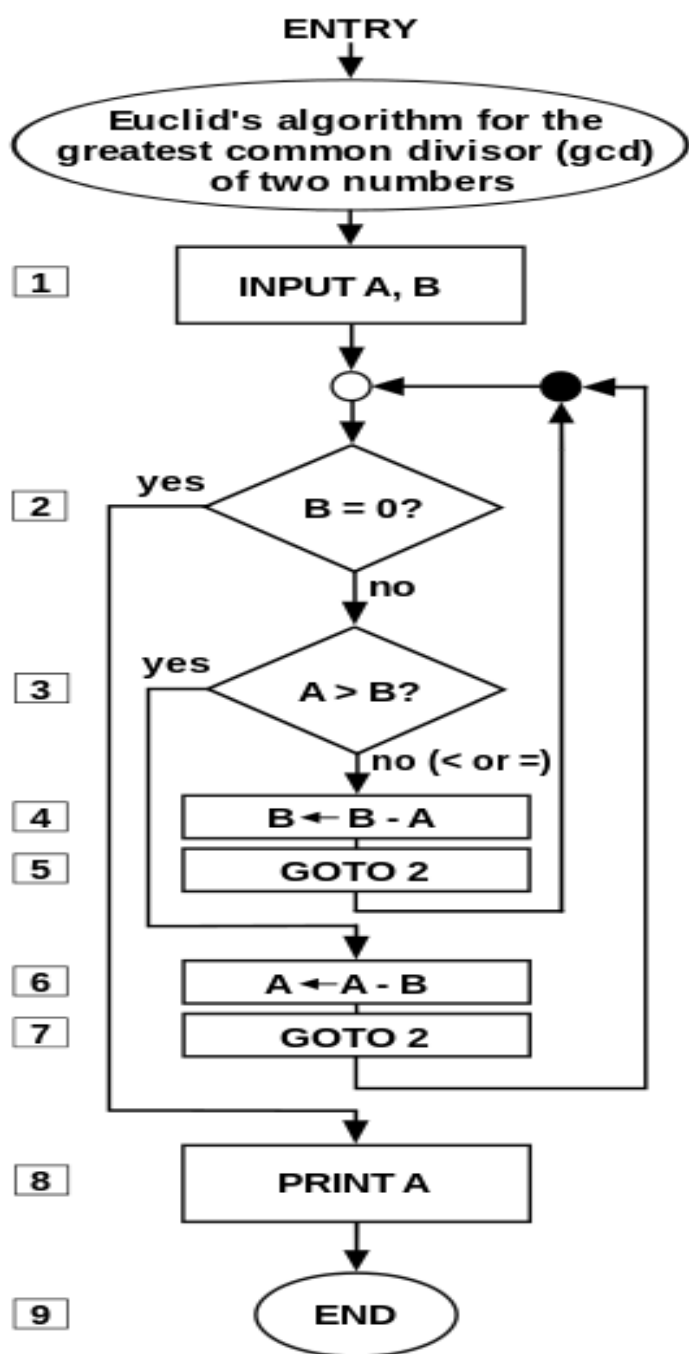
- IN PHILOSOPHY, A **CTM** NAMES A VIEW THAT THE **HUMAN MIND OR THE HUMAN BRAIN (OR BOTH) IS AN INFORMATION PROCESSING SYSTEM AND THAT THINKING IS A FORM OF COMPUTING.** THE THEORY WAS PROPOSED IN ITS MODERN FORM BY **HILARY PUTNAM** IN 1961, AND DEVELOPED BY THE MIT PHILOSOPHER AND COGNITIVE SCIENTIST **JERRY FODOR** (WHO WAS PUTNAM'S PHD STUDENT) IN THE 1960S, 1970S AND 1980S. DESPITE BEING VIGOROUSLY DISPUTED IN ANALYTIC PHILOSOPHY IN THE 1990S (DUE TO WORK BY **PUTNAM** HIMSELF, **JOHN SEARLE**, AND OTHERS), THE VIEW IS COMMON IN MODERN COGNITIVE PSYCHOLOGY AND IS PRESUMED BY MANY THEORISTS OF EVOLUTIONARY PSYCHOLOGY; IN THE 2000S AND 2010S THE VIEW HAS RESURFACED IN ANALYTIC PHILOSOPHY.



• **THE COMPUTATIONAL THEORY OF MIND HOLDS THAT THE MIND IS A COMPUTATION THAT ARISES FROM THE BRAIN ACTING AS A COMPUTING MACHINE.** THE THEORY CAN BE ELABORATED IN MANY WAYS, THE MOST POPULAR OF WHICH IS THAT THE BRAIN IS A COMPUTER AND THE MIND IS THE RESULT OF THE PROGRAM THAT THE BRAIN RUNS. A PROGRAM IS THE FINITE DESCRIPTION OF AN ALGORITHM OR EFFECTIVE PROCEDURE, WHICH PRESCRIBES A SEQUENCE OF DISCRETE ACTIONS THAT PRODUCES OUTPUTS BASED ONLY ON INPUTS AND THE INTERNAL STATES (MEMORY) OF THE COMPUTING MACHINE. FOR ANY ADMISSIBLE INPUT, ALGORITHMS TERMINATE IN A FINITE NUMBER OF STEPS. **SO THE COMPUTATIONAL THEORY OF MIND IS THE CLAIM THAT THE MIND IS A COMPUTATION OF A MACHINE (THE BRAIN) THAT DERIVES OUTPUT REPRESENTATIONS OF THE WORLD FROM INPUT REPRESENTATIONS AND INTERNAL MEMORY IN A WAY THAT IS CONSISTENT WITH THE THEORY OF COMPUTATION.**

• CTM IS OFTEN UNDERSTOOD AS A SPECIFIC VARIANT OF THE REPRESENTATIONAL THEORY OF MIND (RTM), WHICH CLAIMS THAT COGNITION IS MANIPULATION OF REPRESENTATION. THE MOST POPULAR VARIANT OF CTM, CLASSICAL CTM, OR SIMPLY CTM WITHOUT ANY QUALIFICATION, IS RELATED TO THE LANGUAGE OF THOUGHT HYPOTHESIS (LOTH), THAT HAS BEEN FORCEFULLY DEFENDED BY JERRY FODOR.





thm

- COMPUTATIONAL THEORIES OF MIND ARE OFTEN SAID TO REQUIRE MENTAL REPRESENTATION BECAUSE '**INPUT**' INTO A COMPUTATION COMES IN THE FORM OF SYMBOLS OR REPRESENTATIONS OF OTHER OBJECTS. A COMPUTER CANNOT COMPUTE AN ACTUAL OBJECT, BUT MUST INTERPRET AND REPRESENT THE OBJECT IN SOME FORM AND THEN COMPUTE THE REPRESENTATION. THE COMPUTATIONAL THEORY OF MIND IS RELATED TO THE REPRESENTATIONAL THEORY OF MIND IN THAT THEY BOTH REQUIRE THAT MENTAL STATES ARE REPRESENTATIONS.

- HOWEVER THE TWO THEORIES DIFFER IN THAT THE REPRESENTATIONAL THEORY CLAIMS THAT ALL MENTAL STATES ARE REPRESENTATIONS WHILE THE COMPUTATIONAL THEORY LEAVES OPEN THAT CERTAIN MENTAL STATES, SUCH AS PAIN OR DEPRESSION, MAY NOT BE REPRESENTATIONAL AND THEREFORE MAY NOT BE SUITABLE FOR A COMPUTATIONAL TREATMENT. THESE NON-REPRESENTATIONAL MENTAL STATES ARE KNOWN AS **QUALIA**. IN FODOR'S ORIGINAL VIEWS, THE COMPUTATIONAL THEORY OF MIND IS ALSO RELATED TO THE **LANGUAGE OF THOUGHT**. THE LANGUAGE OF THOUGHT THEORY ALLOWS THE MIND TO PROCESS MORE COMPLEX REPRESENTATIONS WITH THE HELP OF SEMANTICS.

- ONE OF THE BASIC PHILOSOPHICAL ARGUMENTS FOR CTM IS THAT IT CAN MAKE CLEAR HOW THOUGHT AND CONTENT ARE CAUSALLY RELEVANT IN THE PHYSICAL WORLD. IT DOES THIS BY SAYING THOUGHTS ARE SYNTACTIC ENTITIES THAT ARE COMPUTED OVER: THEIR FORM MAKES THEM CAUSALLY RELEVANT IN JUST THE SAME WAY THAT THE FORM MAKES FRAGMENTS OF SOURCE CODE IN A COMPUTER CAUSALLY RELEVANT.

- **CLASSICAL CTM:**

ALAN MATHISON TURING WAS AN ENGLISH COMPUTER SCIENTIST, MATHEMATICIAN, LOGICIAN, CRYPTANALYST AND THEORETICAL BIOLOGIST. HE WAS HIGHLY INFLUENTIAL IN THE DEVELOPMENT OF THEORETICAL COMPUTER SCIENCE, PROVIDING A FORMALISATION OF ~~THE CONCEPTS OF ALGORITHM AND COMPUTATION~~ WITH THE TURING MACHINE, WHICH CAN BE CONSIDERED A MODEL OF A GENERAL PURPOSE COMPUTER. TURING IS WIDELY CONSIDERED TO BE THE FATHER OF THEORETICAL COMPUTER SCIENCE AND ARTIFICIAL INTELLIGENCE.

- TURING ADDRESSED THE PROBLEM OF ARTIFICIAL INTELLIGENCE, AND PROPOSED AN EXPERIMENT THAT BECAME KNOWN AS THE TURING TEST, AN ATTEMPT TO DEFINE A STANDARD FOR A MACHINE TO BE CALLED "INTELLIGENT". THE IDEA WAS THAT A COMPUTER COULD BE SAID TO "THINK" IF A HUMAN INTERROGATOR COULD NOT TELL IT APART, THROUGH CONVERSATION, FROM A HUMAN BEING.



A TURING MACHINE IS AN ABSTRACT MODEL OF AN IDEALIZED COMPUTING DEVICE WITH UNLIMITED TIME AND STORAGE SPACE AT ITS DISPOSAL. THE DEVICE MANIPULATES SYMBOLS, MUCH AS A HUMAN COMPUTING AGENT MANIPULATES PENCIL MARKS ON PAPER DURING ARITHMETICAL COMPUTATION. TURING SAYS VERY LITTLE ABOUT THE NATURE OF SYMBOLS. HE ASSUMES THAT PRIMITIVE SYMBOLS ARE DRAWN FROM A FINITE ALPHABET. HE ALSO ASSUMES THAT SYMBOLS CAN BE INSCRIBED OR ERASED AT “MEMORY LOCATIONS”. TURING’S MODEL WORKS AS FOLLOWS:

1. THERE ARE INFINITELY MANY MEMORY LOCATIONS, ARRAYED IN A LINEAR STRUCTURE. METAPHORICALLY, THESE MEMORY LOCATIONS ARE “CELLS” ON AN INFINITELY LONG “PAPER TAPE”. MORE LITERALLY, THE MEMORY LOCATIONS MIGHT BE PHYSICALLY REALIZED IN VARIOUS MEDIA (E.G., SILICON CHIPS).

2. THERE IS A CENTRAL PROCESSOR, WHICH CAN ACCESS ONE MEMORY LOCATION AT A TIME. METAPHORICALLY, THE CENTRAL PROCESSOR IS A “SCANNER” THAT MOVES ALONG THE PAPER TAPE ONE “CELL” AT A TIME.

3. THE CENTRAL PROCESSOR CAN ENTER INTO FINITELY MANY MACHINE STATES.

4. THE CENTRAL PROCESSOR CAN PERFORM FOUR ELEMENTARY OPERATIONS: WRITE A SYMBOL AT A MEMORY LOCATION; ERASE A SYMBOL FROM A MEMORY LOCATION; ACCESS THE NEXT MEMORY LOCATION IN THE LINEAR ARRAY (“MOVE TO THE RIGHT ON THE TAPE”); ACCESS THE PREVIOUS MEMORY LOCATION IN THE LINEAR ARRAY (“MOVE TO THE LEFT ON THE TAPE”).

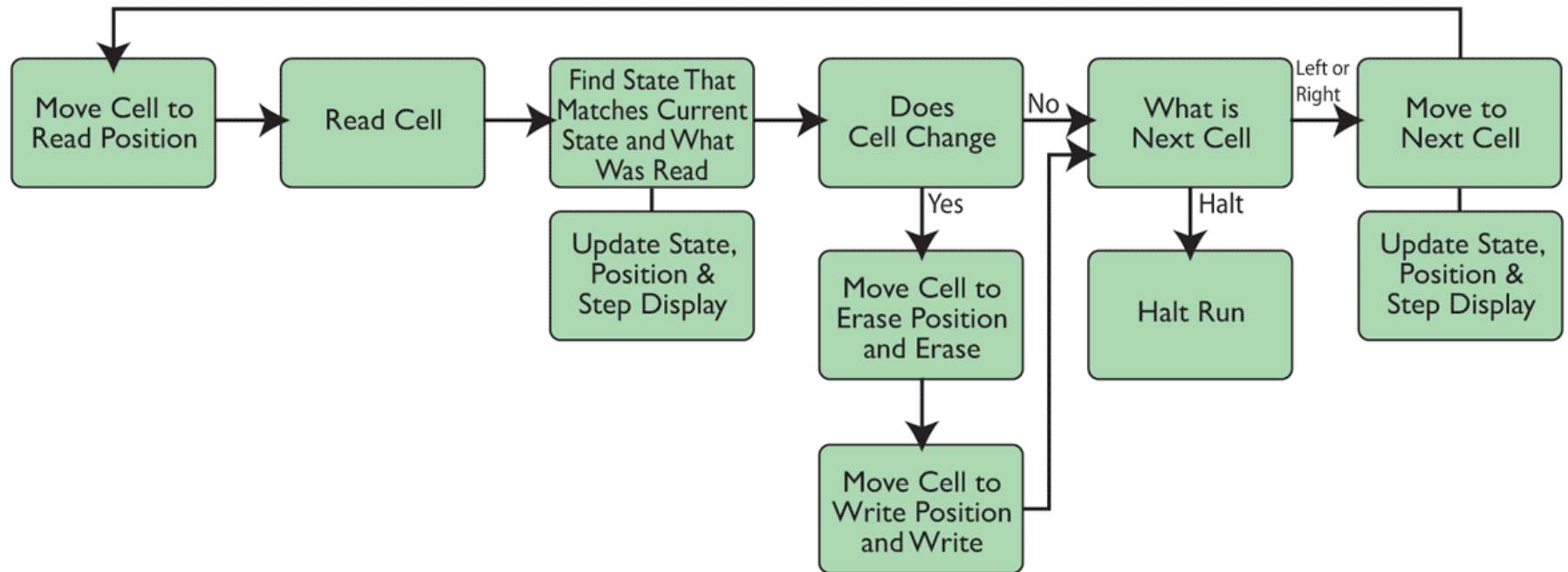
5. WHICH ELEMENTARY OPERATION THE CENTRAL PROCESSOR PERFORMS DEPENDS ENTIRELY UPON TWO FACTS: WHICH SYMBOL IS CURRENTLY INSCRIBED AT THE PRESENT MEMORY LOCATION; AND THE SCANNER’S OWN CURRENT MACHINE STATE.

A MACHINE TABLE DICTATES WHICH ELEMENTARY OPERATION THE CENTRAL PROCESSOR PERFORMS, GIVEN ITS CURRENT MACHINE STATE AND THE SYMBOL IT IS CURRENTLY ACCESSING. THE MACHINE TABLE ALSO DICTATES HOW THE CENTRAL PROCESSOR’S MACHINE STATE CHANGES GIVEN THOSE SAME FACTORS. THUS, THE MACHINE TABLE ENSHRINES A FINITE SET OF ROUTINE MECHANICAL INSTRUCTIONS GOVERNING COMPUTATION.



- TURING MOTIVATES HIS APPROACH BY REFLECTING ON IDEALIZED HUMAN COMPUTING AGENTS. CITING FINITARY LIMITS ON OUR PERCEPTUAL AND COGNITIVE APPARATUS, HE ARGUES THAT ANY SYMBOLIC ALGORITHM EXECUTED BY A HUMAN CAN BE REPLICATED BY A SUITABLE TURING MACHINE. HE CONCLUDES THAT THE TURING

Turing Machine Loop Block Diagram



- IN 1975, JERRY FODOR LINKED CTM WITH LOTH. HE ARGUED THAT COGNITIVE REPRESENTATIONS ARE TOKENS OF THE LANGUAGE OF THOUGHT AND THAT THE MIND IS A DIGITAL COMPUTER THAT OPERATES ON THESE TOKENS.

- **WHAT IS LOTH?**

WHEN WE HAVE A THOUGHT SAY A BELIEF THAT *THE PRICE OF PROPERTY IS RISING AGAIN*, THERE IS WRITTEN IN OUR HEAD A SENTENCE WHICH MEANS THE SAME AS THE ENGLISH SENTENCE “THE PRICE OF PROPERTY IS RISING AGAIN”. ~~THIS SENTENCE IN OUR HEAD IS NOT ITSELF NORMALLY~~ CONSIDERED TO BE AN ENGLISH SENTENCE, OR A SENTENCE OF ANY PUBLIC LANGUAGE. IT IS RATHER A SENTENCE OF A POSTULATED MENTAL LANGUAGE THAT IS THE **LANGUAGE OF THOUGHT** OR SOMETIMES CALLED **MENTALESE**. **THAT MEANS SENTENCES ARE WRITTEN IN HEAD.**

- WHEN WE FIRST THINK OF WORDS OR OTHER SYMBOLS (E.G. PICTURES), WE THINK OF THEM AS VISUALLY DETECTABLE, WE SEE WORDS ON THE PAGE, TRAFFIC SIGNS AND SO ON.

- THERE ARE MANY WAYS IN WHICH SYMBOLS CAN BE STORED AND TRANSMITTED. INDEED THERE ARE MANY WAYS IN WHICH EVERY SAME SYMBOLS CAN BE STORED, TRANSMITTED OR REALIZED. BUT IN SOME SENSE, IT IS STILL THE SAME SENTENCE.
- EXAMPLE OF TYPE-TOKEN WILL MAKE IT CLEAR, IF WE WRITE THE WORD 'MAN' THREE TIMES MAN! MAN! MAN!, THEN THE SAME TYPE OF WORD APPEARS THREE TIMES, SO IT IS THREE *TOKENS* OF THE SAME *TYPE*.
- SO THE SAME SENTENCE-TYPE HAS MANY PHYSICAL *TOKENS*, AND THE TOKENS CAN BE REALIZED IN VERY DIFFERENT WAYS. SO IN DIFFERENT **MEDIA** DIFFERENT TOKENS OF THE SAME TYPE CAN BE REALIZED.

WRITTEN ENGLISH WORDS ARE ONE MEDIUM, SPOKEN ENGLISH WORDS ARE ANOTHER ~~AND WORDS ON MAGNETIC TAPE YET ANOTHER~~. THE SAME SENTENCE CAN BE REALIZED IN MANY DIFFERENT MEDIA.

- WHENEVER SOMEONE BELIEVES SAY, THAT *THE PRICE OF PROPERTY IS RISING AGAIN*, THE VEHICLE OF THIS THOUGHT IS A SENTENCE. AND THE MEDIUM IN WHICH THIS SENTENCE IS REALIZED IS THE NEURAL STRUCTURE OF THE BRAIN.
- THE IDEA IS- THINK OF THE BRAIN AS A COMPUTER, WITH ITS NEURONS AND SYNAPSES MAKING UP ITS 'PRIMITIVE PROCESSOR'.



- ON FODOR'S VERSION OF RTM, THESE MENTAL REPRESENTATIONS HAVE BOTH SYNTACTIC STRUCTURE AND A COMPOSITIONAL SEMANTICS. THINKING THUS TAKES PLACE IN AN INTERNAL LANGUAGE OF THOUGHT.

SYNTAX AND SEMANTICS:

TO SAY THAT A SYSTEM OF REPRESENTATION IS A LANGUAGE IS TO SAY THAT ITS ELEMENTS (SENTENCES AND WORDS) HAVE A SYNTACTIC AND SEMANTIC STRUCTURE.

SYNTAX: SYNTACTIC FEATURES OF WORDS AND SENTENCES IN A LANGUAGE ARE THOSE THAT RELATES TO THEIR FORM RATHER THAN THEIR MEANING. A THEORY OF SYNTAX FOR A LANGUAGE WILL TELL US WHAT THE BASIC KINDS OF EXPRESSION ARE IN THE LANGUAGE, AND WHICH COMBINATIONS OF EXPRESSIONS ARE LEGITIMATE IN THE LANGUAGE, I.E., WHICH COMBINATIONS OF EXPRESSIONS ARE GRAMMATICAL OR WELL-FORMED.

EXAMPLE: IT IS SYNTACTIC FEATURE OF THE COMPLEX EXPRESSION 'THE POPE' THAT IT IS A NOUN PHRASE, AND THAT IT CAN ONLY LEGITIMATELY OCCUR IN SENTENCES IN CERTAIN POSITIONS: 'THE POPE LEADS A JOLLY LIFE' IS GRAMMATICAL BUT 'LIFE LEAD A JOLLY THE POPE' IS NOT.

THEREFORE SYNTACTIC THEORY SAYS WHAT ARE FUNDAMENTAL SYNTACTICAL CATEGORIES ARE, WHICH RULES GOVERN THE PRODUCTION OF GRAMMATICALLY COMPLEX EXPRESSIONS FROM COMBINATIONS OF THE SIMPLE EXPRESSIONS.

SEMANTICS: SEMANTIC FEATURES OF WORDS AND SENTENCES ARE THOSE THAT RELATE TO THEIR MEANING. WHILE IT IS A SYNTACTIC FEATURE OF THE WORD 'PUSILLANIMOUS' THAT IT IS AN ADJECTIVE, ~~AND SO CAN ONLY APPEAR IN CERTAIN PLACES IN SENTENCES,~~ IT IS SEMANTIC FEATURE OF 'PUSILLANIMOUS' THAT MEANS, SPINELESS, WEAK-WILLED, A PUSHOVER.

A THEORY OF MEANING FOR A LANGUAGE IS CALLED A 'SEMANTIC THEORY', AND 'SEMANTICS' IS THAT PART OF LINGUISTICS WHICH DEALS WITH THE SYSTEMATIC STUDY OF MEANING.