ARTIFICIAL INTELLIGENCE
UNIT – 1 : AGENTS AND ENVIRONMENT

What is AI ?

* Simulated cognition.

* $\underline{\underline{T}}$hinking, $\underline{P}$erception and $\underline{A}$ction → Aspects of AI

* AI develops models which are targetted at Thinking, Perception and Action.

DEFINITION OF AI :

$\left.\begin{array}{c} T \\ P \\ A \end{array}\right\{$
* Performs Thinking
* Perceives the Environment
* Acts according to the environment
$\left.\begin{array}{c} \\ \\ \end{array}\right\}$ Definition of a human.

↳ Model are targetted at thinking, perceiving and acting according to the environment.

↳ Representations that allows models targetted at thinking, perceiving and acting acc to the environment.

* CONSTRAINSTS :

When a baby crawls towards the lamp,
↳ Action of adult   * Move the lamp away
                    * Pick the baby.
$\left.\begin{array}{c} \\ \\ \end{array}\right\} \Downarrow$

Environment Changes/ Constraints in the environment

CONSTRAINTS :

* Happens based on how environment reacts to us and we react to the environment
* Guided buy actions.

→ Constraints exposed by Representations that allows models targetted at thinking, perceiving and acting according to the environment.

↳ Algorithms enabled by constraints exposed by Representations that allows models targetted at thinking, perceiving and acting according to the environment.

DEFINITION OF AI

AI is defined as Algorithms enabled by constraints exposed by Representations that allows models targetted at thinking, perceiving and acting according to the environment.

NATURAL LANGUAGE PROCESSING (NLP) :

* Sub branch of AI
* Gives computers ability to understand text and spoken words.
* Enhances on 5 aspects of AI.
* About Language
  ↳ Ideas of Rules
    ↳ A Grammar is needed
      ↳ A Structured is used to Represent
        ↳ Memory Buckets
          (To store many such
            language Buckets)
          (Within Buckets ⇒ Bounded)

RUMPLESTILSKIN PRINCIPLE IN PSYCHOLOGY

BEST ALGORITHM TO USE:
GENERATE ANT TEST:

1. Generate a hypothesis
2. Test the hypothesis to check its validity.

REWARD AND PENALTY:
Most successful psychological aspect to control the behaviour.

AGENT AND ENVIRONMENT:

AI System ⟶ 1. Agent
           ⟶ 2. Environment

AGENT:
Entity that interacts with environment with following Activitres:

* Perception of Environment
* Percept Sequence.
* State diagram for agent.
* State diagram for environment.
* Goals
* Presence of environment and Goals.
* Performance Measure
* Standard ⟶↑ Defines
* Critic ⟶ aware of performance standards and evaluates
* Actor Critic Model.   performance measure
   ↳ self contained AI   of agents.
    models that allows
    self evaluation.

THE BEHAVIOUR OF ONE AGENT DEPENDS ON :

1. Agent's Move
2. Other agent's Move
3. Environmental changes
4. Time

RATIONAL AGENT :

TYPES OF SENSORS :
1. External
2. Internal (Interoceptive / Interion)

RATIONALITY :
For each possible percept seq, a rational agent should select an action that is expected to max its perf measure, given the evidence provided by the percept seq, & whatever built in knowledge the agent has

1. Perception
2. Percept sequence
3. Customisation Of Algorithm
   (Respondary to multiple versions of environment with skeletal algorithm).
4. Learning
5. Searching
6. Not Omniscience.

OMNISCIENCE:

↪ The character of any entity which will predict future and act according.

AGENT TYPE	ALGORITHM	CONST	REP	MODEL	THINK	PERCEIVE	ACT
Calculaton	✓	✓	✓	X (we cannot modify charac)	X	X	X
Rational Agent	✓	✓	✓	✓	✓	✓	✓
Omniscience Agent	✓	✓	✓	✓	✓	✓	✓

(Along with Accurate predictions of future)

	Agent Type	Perception	Percept Sequence	Model	Plan	Search	Reason	Utility	Learning Quantified	
1.	REFLEX	✓	✗	✗	✗	✗	✗	✗	Binary learning	Specifications of different types of Agents. ↵
2.	MODEL	✓	✓	✓	Mild	Mild	Binary Reason	✗	Binary learning	
3.	GOAL	✓	✓	✓	✓	✓	More informed	✗	Binary learning	
4.	UTILITY	✓	✓	✓	✓	✓	✓	✓	More cognitive Improved learning	
5.	LEARNING	✓	✓	✓	✓	✓	✓	✓		
6.	MODEL FREE	✓	✓	✗	✓	✓	✓	✓	✓	
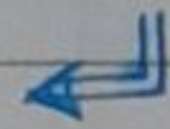
AGENT DESIGN AND ARCHITECTURES

GENERAL ARCHITECTURE :

Mathematical model :

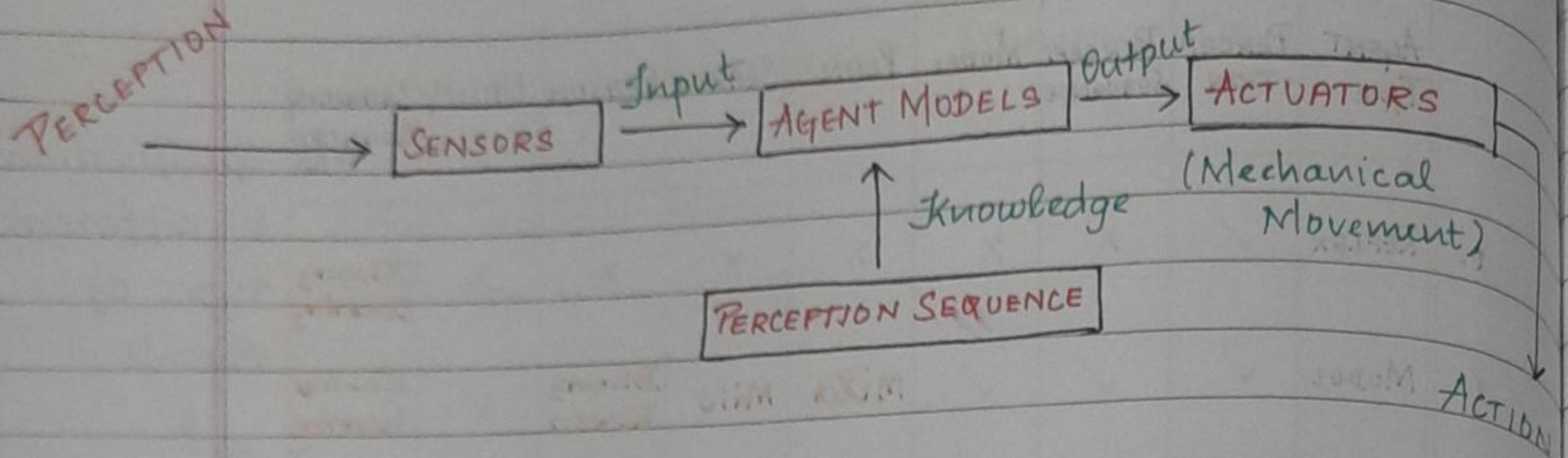$$\text{Agent} = f(x_1, \ldots, x_n)$$

⇒ Agent is a function of one or more variables.

PROGRAM BASED MODEL :

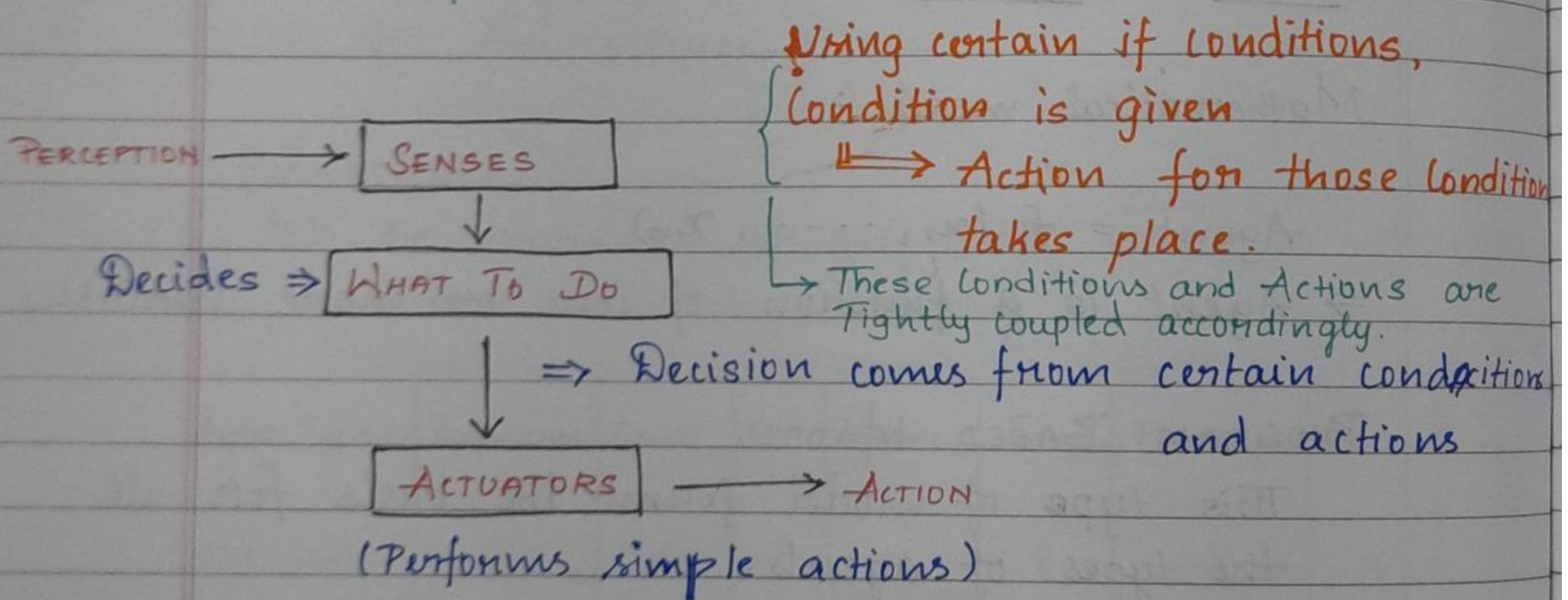This type of model forms the basis for all the types of agents.

ARCHITECTURAL MODEL :

Has a bunch of sensors which ~~behave as~~ help in perception of agent and Triggers the Actuators to perform actions.

PERCEPTION $\longrightarrow$ | SENSORS | $\xrightarrow{\text{Input}}$ | AGENT MODELS | $\xrightarrow{\text{Output}}$ | ACTUATORS |

(Mechanical Movement)

$\uparrow$ Knowledge

| PERCEPTION SEQUENCE |

ACTION

TYPES OF AGENTS :

1. ℙ Reflex Agent
2. Model Based Agent
3. Goal Based Agent
4. Utility Based Agent
5. Learning Based Agent
6. Model free Agent

1. REFLEX AGENT :
(PRIMARY FORM)

PERCEPTION $\longrightarrow$ | SENSES |

Decides $\Rightarrow$ | WHAT TO DO |

| ACTUATORS | $\longrightarrow$ ACTION

(Performs simple actions)

{ Using certain if conditions, Condition is given
$\Longrightarrow$ Action for those condition takes place.

$\rightarrow$ These conditions and Actions are Tightly coupled accordingly.

$\Rightarrow$ Decision comes from certain conditions and actions

★ Binary learning : Minimum amount of learning.

2. MODEL BASED AGENT :

Contains   * Perception Sequence
     * Transition Model
     * Sensory Model   in addition to Reflex Agent.
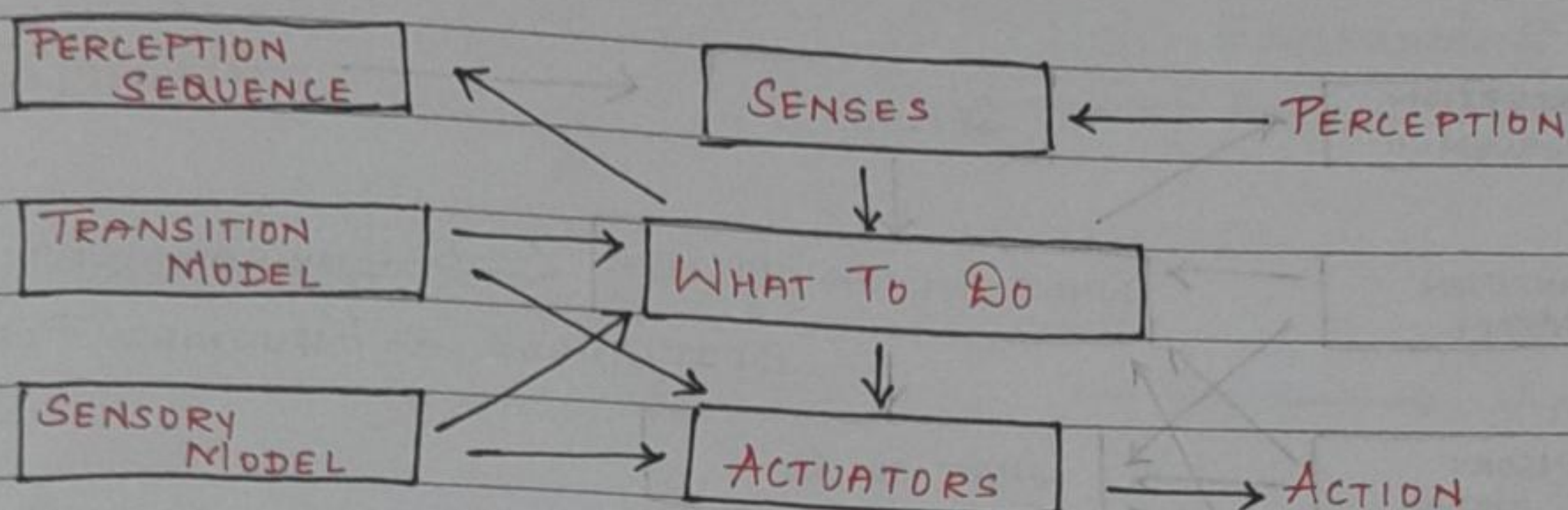
CHANGE IN THE ENVIRONMENT :

  * Changes from one state to other based on
   the action of Reflex agent
  * Therefore, to decide what to do we need to
   go through perception Sequence.

* Has Trivial Model
* Mild Planning
* ~~Mild Reasoning~~
* Binary Reasoning
* Binary Learning.

Binary Learning :
Here, Recognises patterns of Binary learning.

DRAWBACK :
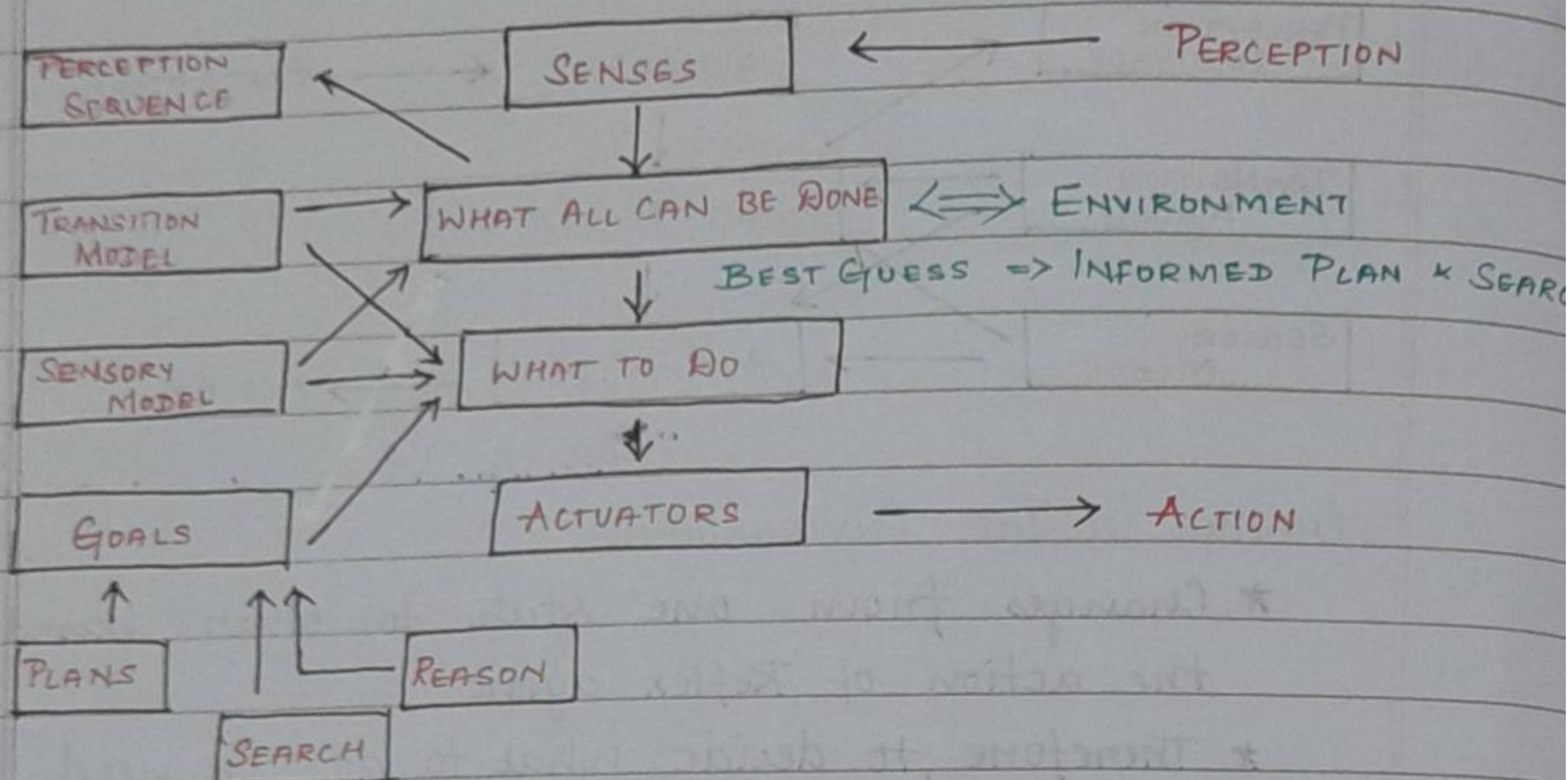Doesn't know where it is taken
  ↳ Utility

3. GOAL BASED AGENT :
Contains * Goals
         * What all can be done (Guesses)
in addition to model Based agent.

To perform better goals are used to take decisions.
These Goals are set based on
  * informed planning
  * Searching of the enviroment
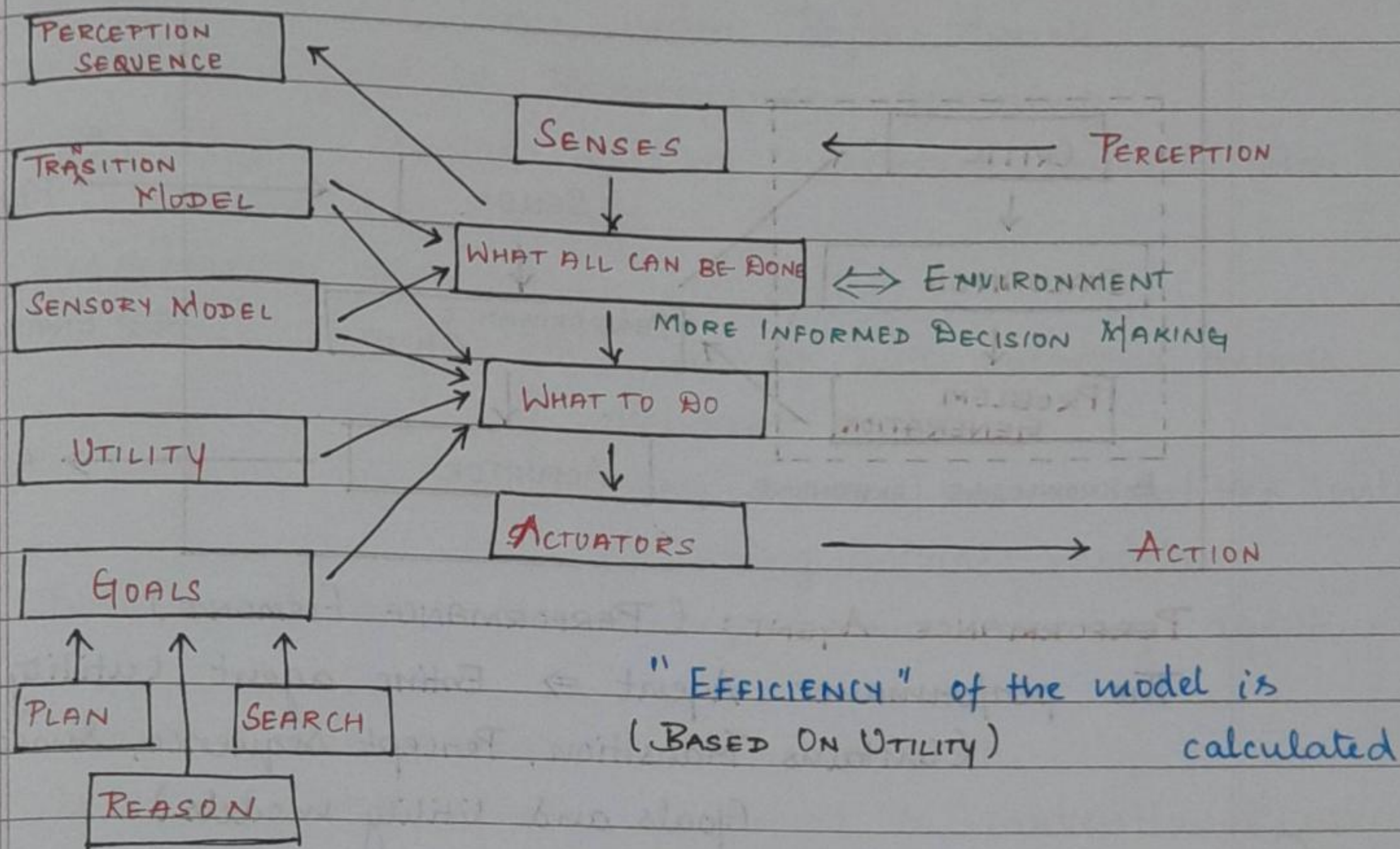 * Reasoning for that particular Goals.

  ↳ What all can be done is guessed and decision
    is taken based on the Goals.
    → Reasoning is done based on the guesses.

DRAWBACK :
* Doesn't know how well it has performed.
  (Evaluation of Performance)
* Doesn't know where it is taken
  (Utility)

4. **UTILITY BASED MODEL AGENT :**

```
┌─────────────┐
│ PERCEPTION  │
│  SEQUENCE   │ ←──────────┐
└─────────────┘            │
┌─────────────┐      ┌──────────┐          ┌───────────────┐
│ TRASITION   │─────→│  SENSES  │ ←─────────  PERCEPTION
│   MODEL     │      └──────────┘
└─────────────┘           ↓
┌─────────────┐    ┌─────────────────┐
│SENSORY MODEL│───→│ WHAT ALL CAN BE DONE│ ⟺ ENVIRONMENT
└─────────────┘    └─────────────────┘   MORE INFORMED DECISION MAKING
┌─────────────┐           ↓
│  .UTILITY   │───→  ┌──────────┐
└─────────────┘      │ WHAT TO DO│
                     └──────────┘
┌─────────────┐           ↓
│   GOALS     │      ┌──────────┐
└─────────────┘      │ ACTUATORS│ ────────→ ACTION
  ↑   ↑   ↑          └──────────┘
┌──────┐ ┌────────┐
│ PLAN │ │ SEARCH │
└──────┘ └────────┘
┌──────────┐
│  REASON  │
└──────────┘
```

" EFFICIENCY " of the model is
(BASED ON UTILITY)   calculated

PERFORMANCE MEASURE :

→ Quantified in case of utility Based.

↳ Helps to decide how useful the model is.
When there are several goals the utility agent
predicts the outcomes of each goal and according
to performance measure and decide the exact/
proper goal. ⇒ Based on that goal the agent
The utility penetrates into other models.   works.

Gives perf   ⎧ * Transition ←──⎫ When the agent
measure for all   ⎨ * Sensory   ⎬ matures
the attributes   ⎩ * Goals   ⎭ ↳ Environment matures

* Mild cognitive improved learning.
* Reasoning is based on Ranking the performance.
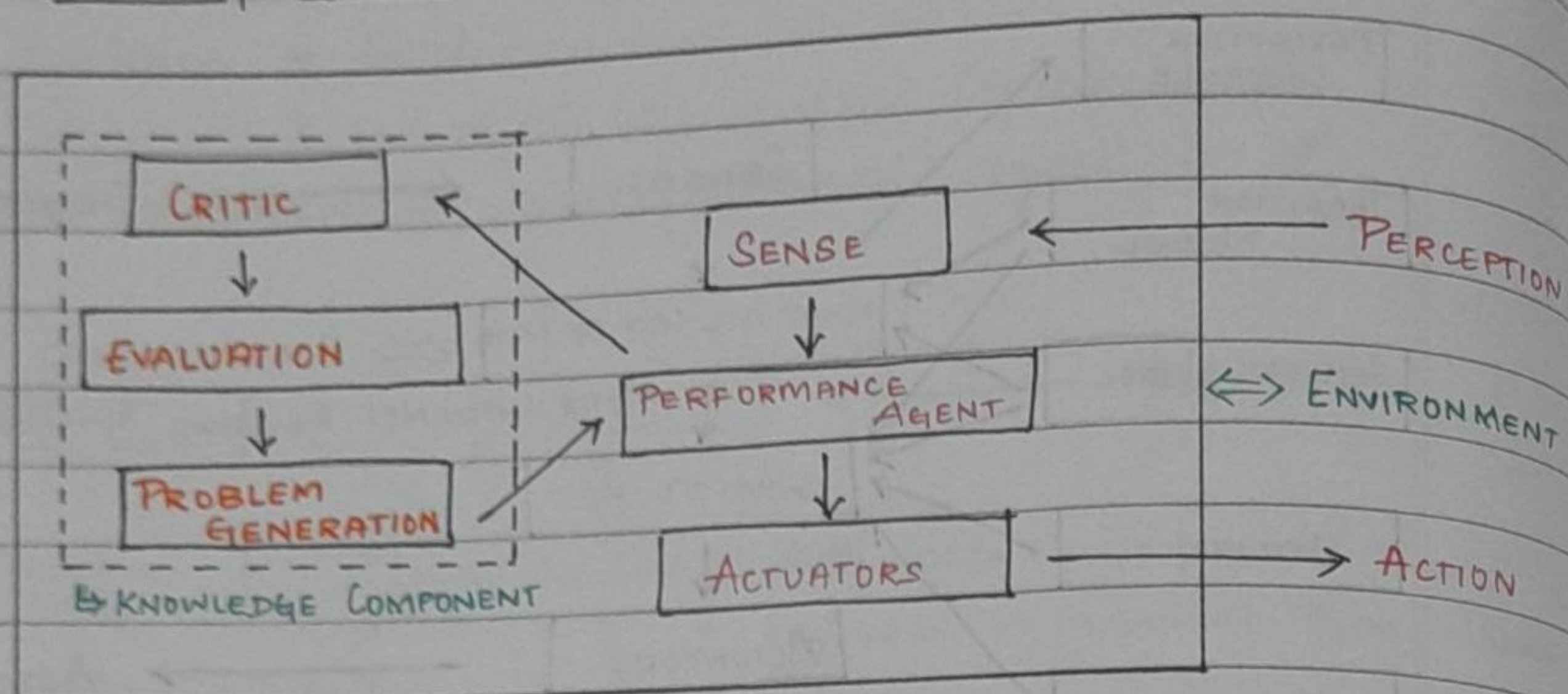

DISADVANTAGE :

* Doesn't Calculate the learning extent.
    ↳ (Learning)
* Doesn't know how far can be improved.
  (Delta, measure and time for improvement)

5. LEARNING BASED AGENT:

PERFORMANCE AGENT : (PERFORMANCE ELEMENT)

The performance Agent ⇒ Entire agent (utility Agent)
  (Contains Transition, Percept Sequence, Sensory, Goals and utility models)

CRITIC : Consists of a fixed performance standards.
  ↳ Evaluates the performance of the Agent.

PROBLEM GENERATION : Creates certain situations in which the agent starts to explore suboptimal as well as optimal actions to reach the goal in different ways
  ↳ Useful in a long Run.

→ **KNOWLEDGE COMPONENTS :** Helps to in Quantified Learning

Used to adapt itself ⇐ Gives Room for ↲
    accordingly.   learning.
                    (Not 100 % Quantified)

Learning Agent Consists of :
* Learning Element : Responsible for making Improvements
* Performance Element : Responsible for selecting external actions
  ↳ Uses Critic to judge.

6. ## MODEL FREE AGENTS :

★ These do not Come under Reflex Agents
★ Works Based on Reinforcement Learning.
GOAL : Works towards getting maximum Reward with minimum penalty.

MATHEMATICAL FORM : Bellman's Model
↳ Comes up with patterns across different models.
↳ Seen accross various entities instead of seeing accross models.

These agents are more intelligent than learning agent.

UTILITY : Used to reach maxima or not.
LEARNING : Much faster compared to conventional way of learning

*** Not all models free agents are based on Reinforcement learning and not all Reinforcement learning models are Model free. ***

⇒ There are also Reinforcement learning models with models and Rewards.

Enviroment Type	Observability			Agent		Behaviour		Performance		Perception		State Rep	Time Domain Behaviour			Knowledge	
	Full	Partial	Nill	Single	Multi	Determin-istic	Non Det	Stochastic	Non Det	Episodic	Continuous	Static	Dynamic	Discrete	Cont	Known	Unknown
Drone		✓		✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	
Cargo Truck		✓			✓	Partially Deterministic		✓	✓	✓			✓	✓		←	
Combat Games	✓	✓ →			✓	✓		✓			✓		✓		✓	←	
Tumour Detection Computer Vission	✓	✓		✓		✓		✓		→			✓	→		✓	
Chatbot		✓ ←	✓	✓			✓		✓	✓ ←			✓ ←			Mildly Known ←	✓ Unknown
Chess	→	✓		✓	✓	✓		✓		✓			✓	✓		✓	

NATURE OF THE ENVIRONMENT :

* OBSERVABILITY :
  * An environment becomes fully observable when environment completely exposes itself.
  * In a fully observable environment, the environment is made available to the agent in the locality.
    ↳ Agent becomes well equipped.
  * More comprises leads to a partial environment.

* AGENT :
  * Can be ~~Sigt~~ Single / Multiple.
  * Number of element involved.

* BEHAVIOUR :
  * As the perception Sequence becomes Stronger
    ↳ More deterministic Behaviour.
      ↳ Predefining the actions and making it prelearn certain things.
  Partially Observable environment is generally non deterministic

* PERFORMANCE :
  * ~~&~~ Based on predicting the Outcome
  * Types :
    1. Quantitative Predictions → Stochastic
    2. Not Accurate Predictions → Non deterministic

* PERCEPTION :
  * Generally environment evolves based on the Constraints and knowledge.
  * Types :
    1. Environment does not evolve → Episodic
    2. Environment evolves with ~~$~~Agent → Continuous.

* STATE REPRESENTATION :
  * Rational Element generally stays in Dynamic Environment.
  * Rational Element can not be in a static environment
  * Reflex Agent has a Static environment.
  * Types :
    1. Static
    2. Dynamic

* TIME DOMAIN BEHAVIOUR :
  * Similar to Perception with an extra dimension (Time)
  * Types :
    1. Discrete
    2. Continuous.

* KNOWLEDGE :
  * Depends on Observability of the Environment.
  * Types :
    1. Known
    2. Unknown