CSC 309
ARTIFICIAL INTELLIGENCE
GROUP 3

PROBLEM SOLVING

- **Problem;** Cryptarithmetic
- **Problem Type;** Combinatorics, constraint satisfaction, solving subproblems

CRYPTOARITHMETIC

A puzzle where letters represent digits in an arithmetic equation.

Each letter has a unique digit, where the goal is to make the equation correct.

Example:

- SEND + MORE = MONEY

Importance:

- Develops logical thinking
- Uses constraints and search
- Applied in Computer Science and AI
- Introduces constraint-based problem solving

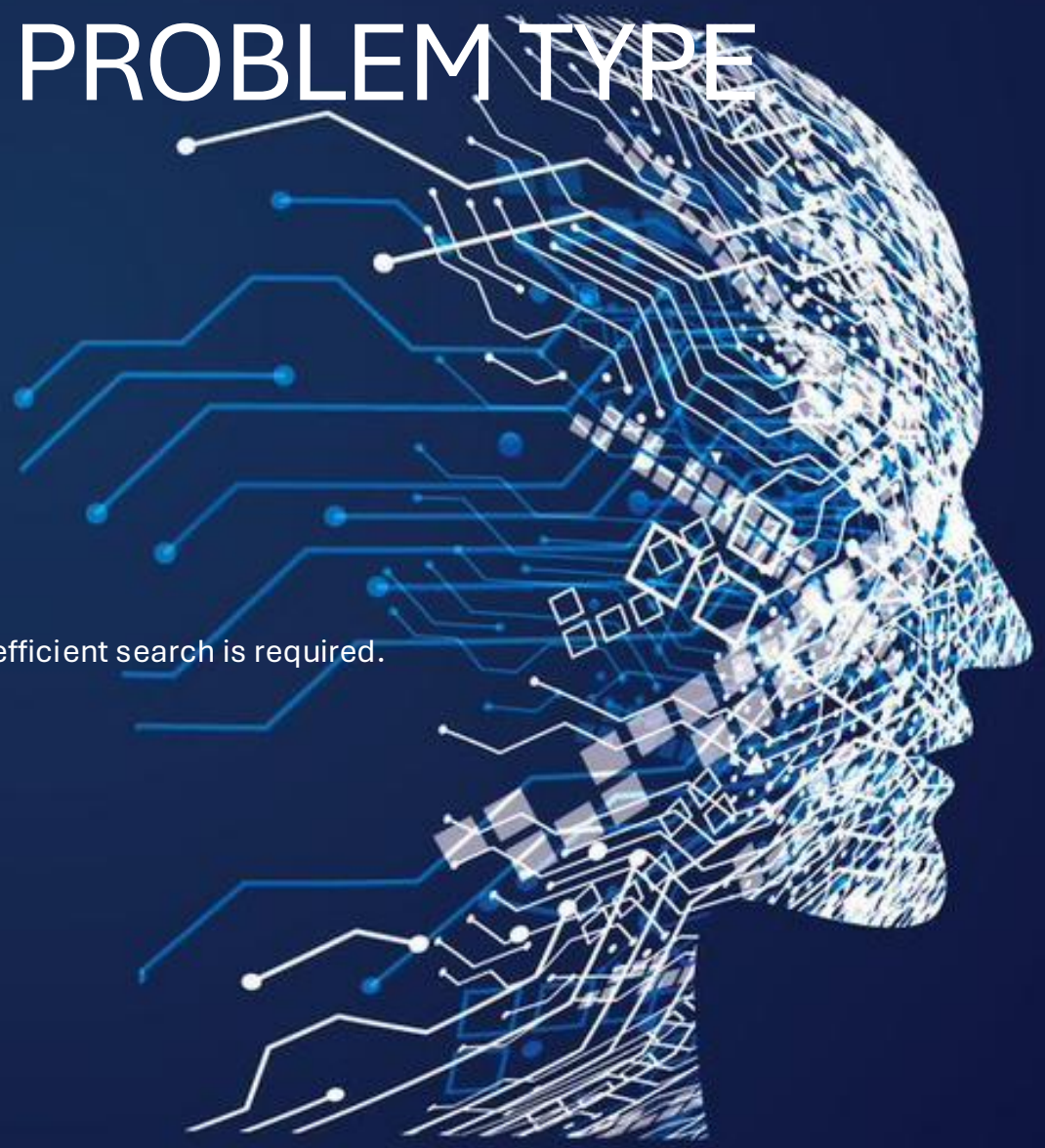
CRYPTOARITHMETIC AS A PROBLEM TYPE

Cryptoarithmetic can be seen as:

- A search problem (trying digit assignments)
- A constraint satisfaction problem (CSP) (rules must be satisfied)
- A combinatorial problem (many possible combinations)

Challenge:

- There are many possible digit assignments, but very few satisfy all constraints, so efficient search is required.



COMBINATORICS

The counting of possible ways to assign digits to letters

Example:

- there are 8 unique letters
- We choose 8 digits from
- Number of possibilities:
- * 10P8=10x9x8x...

Importance:

- Shows why brute force can be expensive
- Helps estimate search space size

CONSTRAINTS IN CRYPTOARITHMETIC

Constraints reduce the search space and make solving feasible.

Common constraints:

- Unique digits: No two letters can have the same digit.
- Leading letters ≠ 0: The first letter of a number cannot be zero (e.g., S ≠ 0, M ≠ 0).
- Arithmetic correctness: The equation must be mathematically valid.

Purpose:

- Ensures only valid solutions are considered.
- Helps solve the puzzle efficiently.

CONSTRAINT SATISFACTION PROBLEM (CSP)

A CSP is a problem where we assign values to variables while satisfying rules (constraints).

A CSP consist of:

- Variables Letters (S,EN,D,...)
- Domains Digits 0-9
- Constraints -> Rules

The goal is to find a valid assignment that satisfies all constraints

Purpose:

- Makes solving systematic
- Reduces trial-and-error by checking constraints

SOLVING AS SUBPROBLEMS

Break the problem into smaller parts to simplify solving:

- Column-by-column addition (start with units)
- Carry handling for next columns
- Partial assignments to check constraints early

Example:

- Solve units → tens → hundreds column step by step

Benefits:

- Faster solving
- Easier reasoning

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