Morning

Formal Language And Automata

- Languages
- Automata
- Computation

Language

What is a language ?

This is a sentence.

This is also a sentence.

● ● ● ● ● ●

So we have

{ sentence 1, sentence 2, sentence 3, ….. }

the set of sentences ⇔ Language

Sentence and Alphabet

- sentence/string = sequence of symbols chosen

  from the alphabet Σ

  example : Mouse love rice.

- alphabet = set of symbols

  example : ASCII, 中文国标, $\Sigma = \{0,1\}$

  symbols ⇒ sentences ⇒ language

Rules/Grammar

- rules = by which sentence is generated

  example : rules for English

  <sentence> → <noun-phrase><predicate>

  <noun-phrase> → <article><noun>

  <predicate> → <verb>

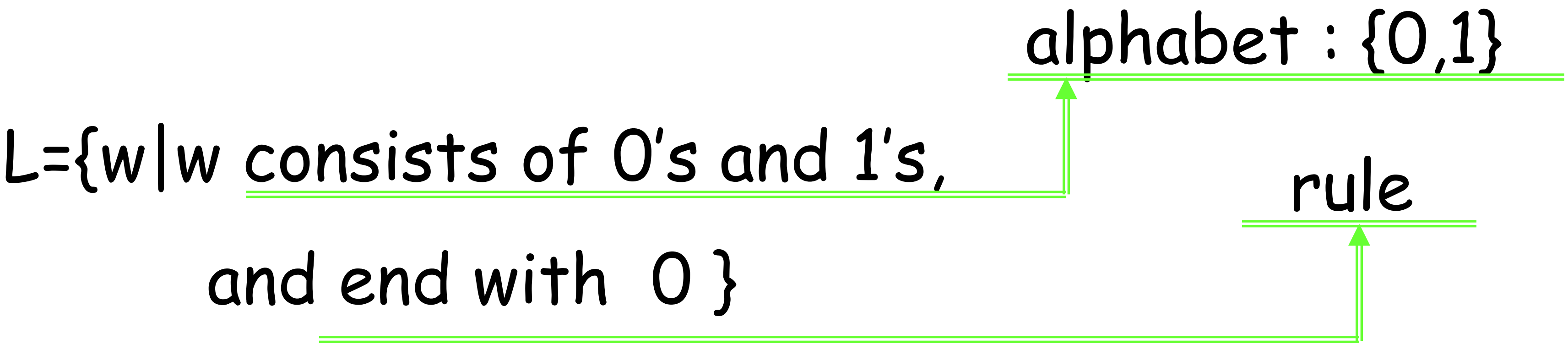
  <article> → a|an|the

  <noun> → wolf|sheep

  <verb> → love|eat

Examples of language

example 1.1



L={w|w consists of 0's and 1's,

and end with 0 }

alphabet : {0,1}

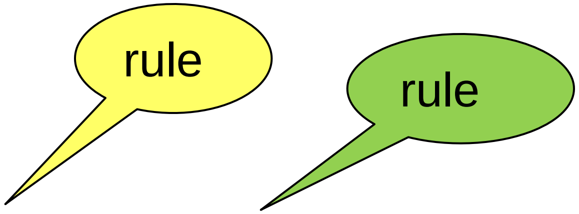
rule

L={ 0,00,10,000,010,100,110,0000,……}

11111100$\in$L, 1$\notin$L, 0001$\notin$L, 20$\notin$L

Examples of language

example 1.2



rule

rule

$L=\{\ 0^n1^n \mid n \geq 0\ \}$

alphabet = {0,1}

$L=\{\varepsilon, 01, 0011, 000111, 00001111, 0000011111, \ldots\ldots\}$

example 1.3 The empty language

$$L = \{\ \} = \phi$$

L : contains no string

example 1.4

L={ w| w is a sentence in English }

Bolt won two gold medals in Daegu. √

The sheep eats grass . √

The grass eats sheep . ?

♣ Formal language focus on form, not meaning

String operations

$w=a_1a_2......a_n$ abba

$v=b_1b_2......b_n$ bbbaaa

Concatenation

$wv=a_1a_2......a_nb_1b_2......bn$ abbabbbaaa

Reverse

$w^R=a_na_{n-1}......a_1$

Another operation

$$w^n = \underbrace{w\ w\ \ldots\ldots\ w}_{n}$$

- $w = abb \Rightarrow w^2 = abbabb,\ w^3 = abbabbabb$
- definition : $w^0 = \varepsilon$

Operations on languages

- The usual set operations

$$L_1 \cup L_2 = \{ w \mid w \in L_1 \text{ or } w \in L_2 \}$$

$$L_1 \cap L_2 = \{ w \mid w \in L_1 \text{ and } w \in L_2 \}$$

$$L_1 - L_2 = \{ w \mid w \in L_1 \text{ and } w \notin L_2 \}$$

- Reverse

$$L^R = \{ w^R \mid w \in L \}$$

Example $L = \{ a^n b^n \mid n \geq 1 \} \Rightarrow L^R = \{ b^n a^n \mid n \geq 1 \}$

Operations on languages

- Concatenation

$$L_1L_2 = \{ wv \mid w \in L_1 \text{ and } v \in L_2 \}$$

Example $L = \{ a^n b^n \mid n \geq 1 \}$, $K = \{ b^n a^n \mid n \geq 1 \}$

$LK = \{a^n b^n b^n a^n \mid n \geq 1 \}$ ✗

$LK = \{a^n b^n b^m a^m \mid n \geq 1 , m \geq 1 \}$

$L^2 = ?$

example 1.5

$L = \{ w \in \{0, 1\}^* \mid \text{all 0's precede all 1's in } w \}$

$L = \{ \varepsilon, 0, 1, 00, 01, 11, 000, 001, 011, 111, \ldots\ldots \}$

example 1.6

L_1={w$\in${0,1}*| no prefix of w contains 1}

={ε, 0, 00, 000, 0000, 00000, 000000, ……}

L_2={w$\in${0,1}*| no prefix of w starts with 1}

={ε, 0,00,01,000,001,010,011,0000,0001, ……}

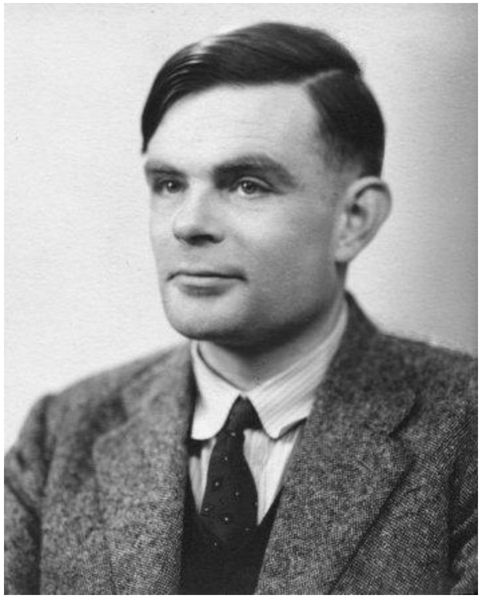
={w$\in${0,1}*| the first character of w is 0 } $\cup$ {ε}

L_3={w$\in${0,1}*| every prefix of w starts with 1}

= ϕ

Automata

- Alan MarthisonTuring
  - On Computable Numbers With an Application to the Entscheidungs Problem
  - Turing Machine

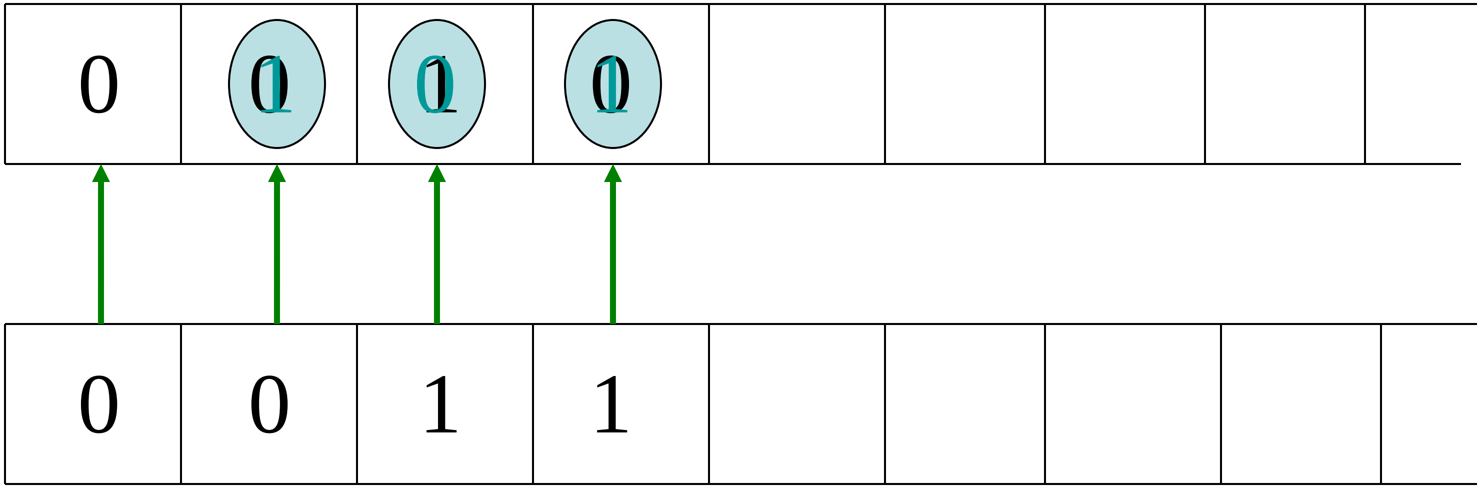


Automata

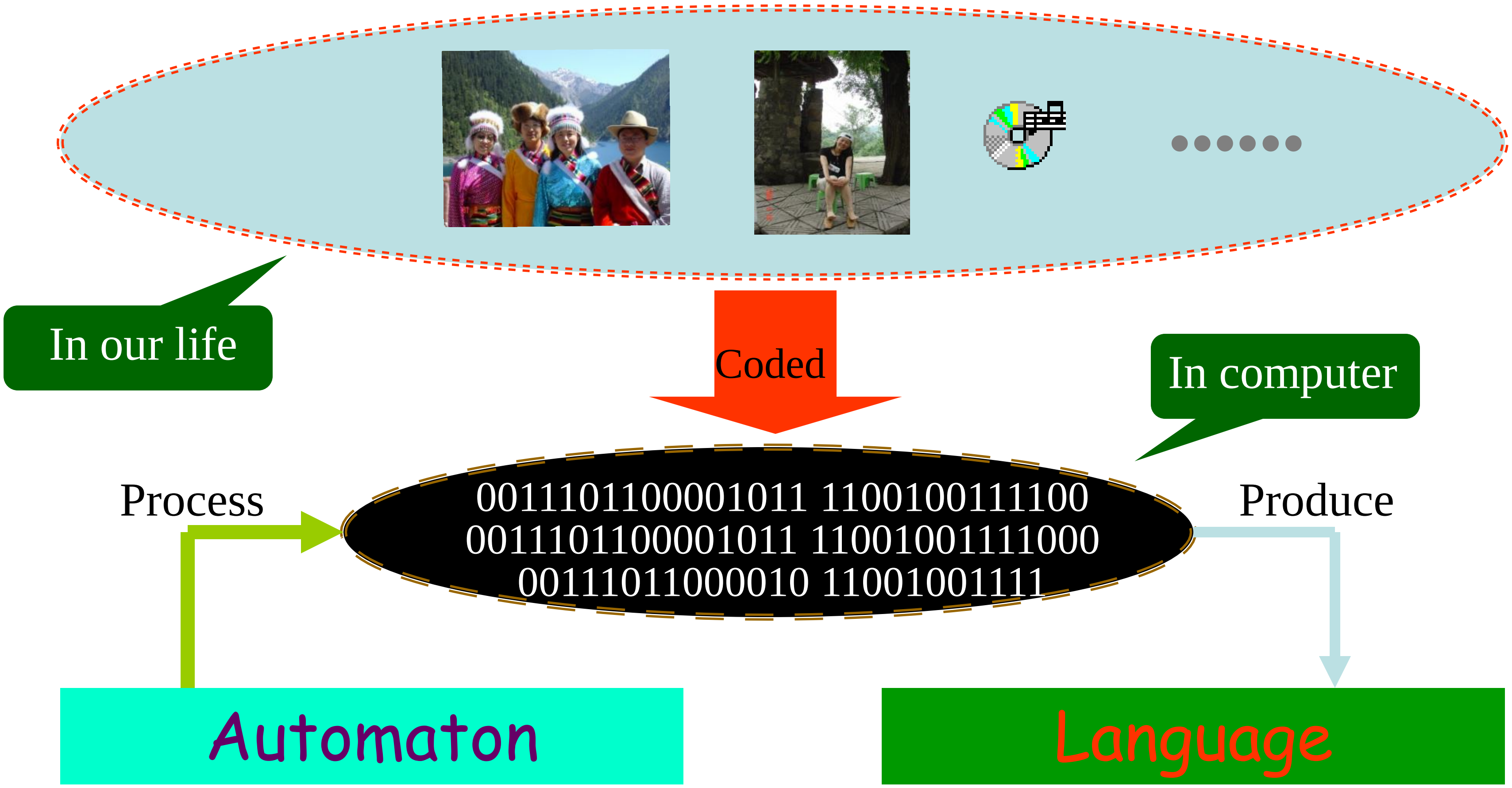
- Finite Automata
    - Deterministic Finite Automata
    - Non-deterministic Finite Automata
- Push Down Automata
- Turing Mashine

Computation

$$\begin{array}{rr} & 2 \\ + & 3 \\ \hline & 5 \end{array} \qquad \begin{array}{rr} & 0\,0\,1\,0 \\ + & 0\,0\,1\,1 \\ \hline & 0\,1\,0\,1 \end{array}$$



Computation for computer



In our life

●●●●●●

Coded

In computer

Process

0011101100001011 1100100111100
0011101100001011 11001001111000
001110110000010 11001001111

Produce

Automaton

Language

(formal description)

(set of strings)

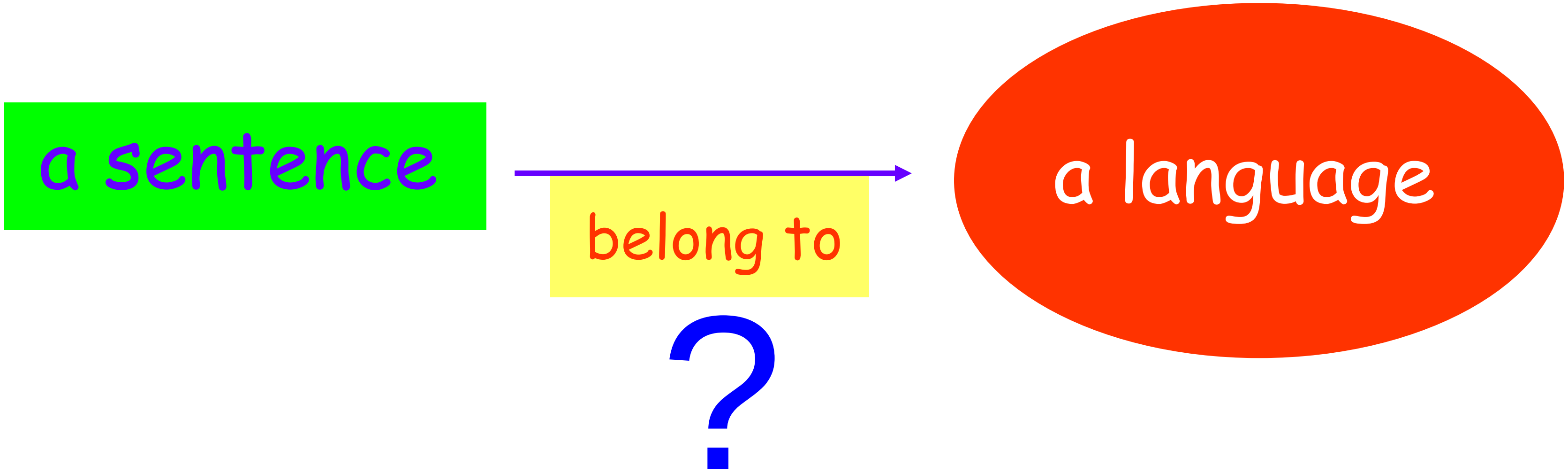
Computation

- Computable Problems
  - write a program to solve
- Intractable Problems
  - find someway to work around

Undecidable Problem

```
main ( )
{
    Int n, total, x, y, z ;
    scanf(“%d”, &n);
    total=3;
    while(1){
        for(x=1;x<=total-2;x++)
            for(y=1;y<=total-x-1;y++){
                z=total-x-y;
                if(exp(x,n)+exp(y,n)==exp(z,n))
                     printf(“hello,world\n”);
             }
        total++;
     }
}
```

Undecidable Problem



a sentence

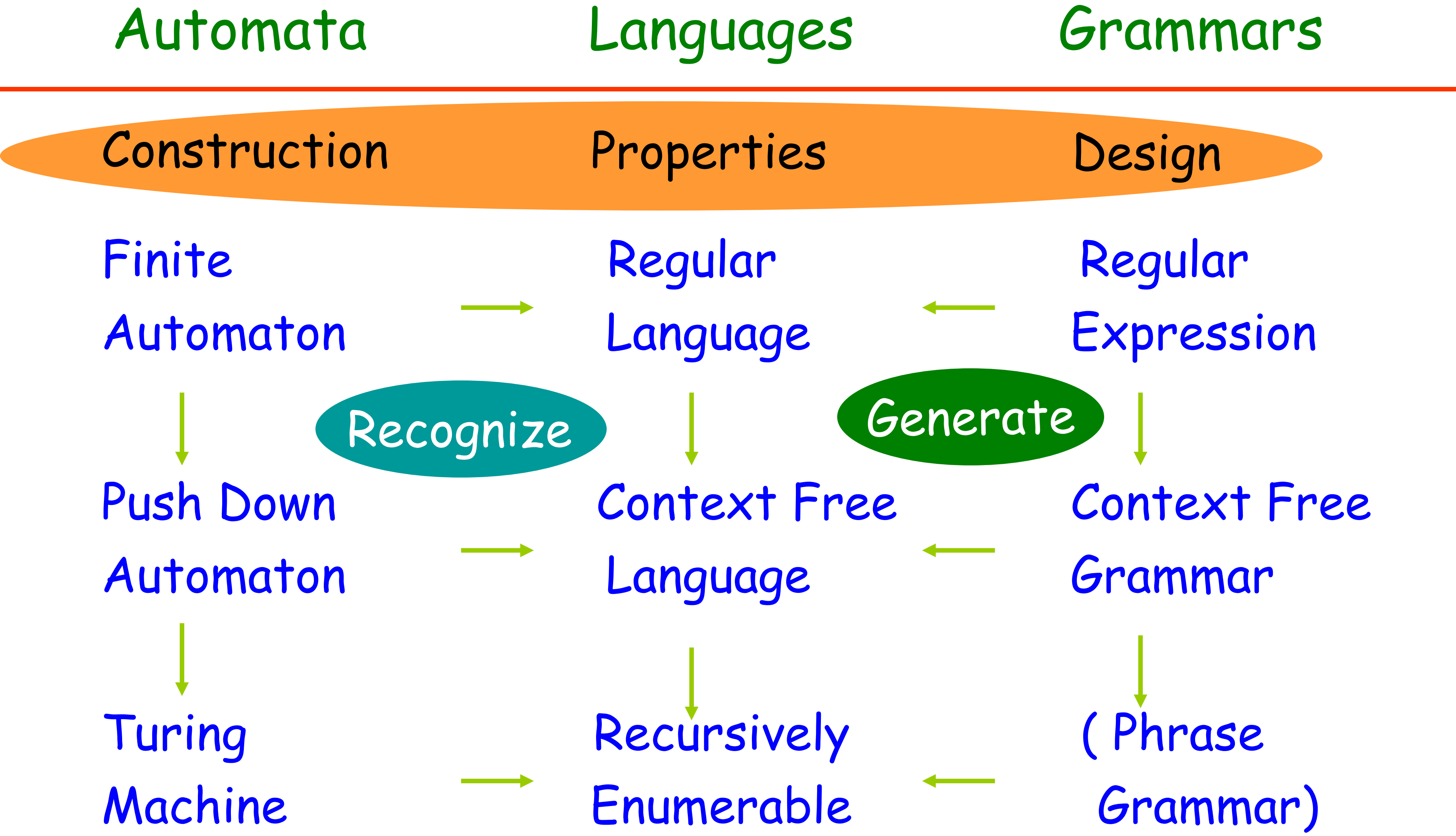
belong to

?

a language

automaton

Content



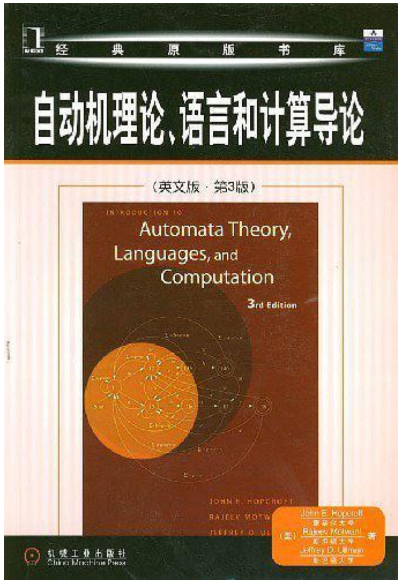
Automata	Languages	Grammars
Construction	Properties	Design
Finite Automaton	Regular Language	Regular Expression
Push Down Automaton	Context Free Language	Context Free Grammar
Turing Machine	Recursively Enumerable	(Phrase Grammar)

Recognize

Generate

Text book

1. Introduction to Automata Theory , Languages , and Computation (Third Edition)



—— John E. Hopcroft

Rajeev Motwani

Jeffrey D. Ullman

Text book

2. An Introduction to Formal Languages and Automata (Third Edition)

—— Peter Linz

Goal

1. Understanding “theoretical“ concepts

------ method of formal description

2. Get a sense of how to reason formally

3. Improving reading ability in English

Homework

- All exercises listed on qq-group
- Submit on random ID
- Check by free talk
- Discussions in group

Honor and Collaboration

- Collaboration is strongly encouraged
- Solutions must be written independently
- Responsible for Understanding and explaining

Exam

- Only final exam

- Open exam

  You are allowed to refer to text-book, class handouts, and notes during the exam

- Closed exam

  Nothing allowed except one pen

Grading Policy

- Homework : 20%
- Final exam : 80%

Instructor

- Name： 孙大烈
- Office：综合楼 220
- Mobile：13936169569
- E-mail： sdl@hit.edu.cn
- 课程群： 自动机/104804608（qq）

群名称:自动机
群 号:104804608

Good good study

day day up !