

筑波大学 情報学群 情報メディア創成学類

平成29年度 個別学力検査（後期日程）

### 小論文問題

#### 【注意事項】

1. 試験開始の合図があるまで、この冊子の中を見てはいけません。
2. この冊子は、表紙と白紙を除いて全部で9ページです。解答用紙は、計4枚です。解答用紙の後ろにある白紙の紙は下書き用紙で、4枚あります。落丁、乱丁、印刷不備があったら申し出なさい。
3. 解答用紙の所定欄に、氏名、受験番号を記入しなさい。
4. 問題は **I** と **II** の2題で、問題 **I** には設問1～6、問題 **II** には設問7～10が含まれます。  
設問1～3の解答を1枚目の解答用紙、設問4～6の解答を2枚目の解答用紙、設問7～9の解答を3枚目の解答用紙、設問10の解答を4枚目の解答用紙に記入しなさい。
5. 解答は各解答用紙の表側の面にだけ記入し、裏面には記入しないこと。
6. 解答用紙は、記入の有無にかかわらず、持ち帰ってはいけません。
7. この問題冊子と下書き用紙は持ち帰ってかまいません。

**I** 集合の定義に関する次の英文を読んで、5 ページの【設問】1~6 に答えなさい。右肩に \* 印のついた語句に関しては5 ページの【注】を参考にしなさい。なお、文中の  $\mathbb{N}$  は0以上の整数の集合  $\mathbb{N} = \{0, 1, 2, \dots\}$  である。また、◀ は、そこで **Example** が終了することを示している。

When we write down an inductive definition such as  $S = \{0, 1, 2, 3, \dots\}$ , most of us will agree that we mean the set  $S = \{x \in \mathbb{N} : x < 10\}$ . Another way to describe it is to observe that  $0 \in S$  and whenever  $x \in S$ , then  $x+1 \in S$ , and that ◀ the only way an element gets to  $S$  is by the previous two steps. This description has three ingredients, which we'll now introduce as follows:

1. There is a starting element  $0$  in the set.
2. There is a construction operation to build new elements from existing elements (adding  $1$  in this case).
3. There is a statement that no other elements are in the set.

This process is an example of an inductive definition of a set. The set of objects defined is called an inductive set. An inductive set consists of objects that are constructed, in some way, from objects that are already in the set. Its building can be constructed unless there is at least one object in the set to start the process. Inductive sets are important in computer science because the objects can be used to represent information, and the construction rules can often be programmed. We give the following formal definition:

An inductive definition of a set  $S$  consists of three steps:

**Base:** List some specific elements of  $S$  (at least one element must be listed).

**Induction:** Give one or more rules to construct new elements of  $S$  from existing elements of  $S$ .

**Closure:** State that  $S$  contains exactly all the elements obtained by the base and induction steps. This step is usually assumed rather than stated explicitly.

The closure step is a very important part of the definition. Without it, there could be lots of sets satisfying the first two steps of an inductive definition. For example, the two sets  $\mathbb{N}$  and  $\{0, 1, 2, \dots\}$  both contain the number  $0$ , and  $x+1$  is in either set, then so is  $x+2$ . If the closure statement that tells us that the only set defined by the base and induction steps is  $\{0, 1, 2, \dots\}$ .

In the chosen statement sets as that we're defining exactly one set, namely, the smallest set satisfying the basic and inductive steps. We'll always call the specific members of chosen to our inductive definitions.

The construction of an inductive set are the basic elements and the rules for constructing new elements. For example, the inductive set  $\{2, 4, 6, 8, \dots\}$  has two constructions, the number 2 and the operation of adding 2 to a number.

**Example 1** Is the following an inductive?

$$S = \{2, 4, 6, 8, 10, 12, 14, \dots\}$$

It might be easier if we think of it as the union of the two sets  $B = \{2, 4, 6, 8, 10, \dots\}$  and  $C = \{4, 6, 8, 10, 12, \dots\}$ . Both these sets are inductive. The construction of  $B$  are the number 2 and the operation of multiplying by 2. The construction of  $C$  are the number 4 and the operation of adding by 4. We can combine these definitions to give an inductive definition of  $S$ .

**Basic:**  $2, 4 \in S$

**Inductive:** Let  $x \in S$ . If  $x$  is odd, then  $(2x) \in S$  else  $(x+4) \in S$ .

This example shows that there can be more than one basic element, and the inductive step can include rules. ■

Suppose we want to give an inductive definition for a set of strings<sup>1</sup>. To do so, we need to have some way to construct strings. For strings the construction are „the empty string“ together with the operation of appending a letter to the left end of a string to „prepend“<sup>2</sup>. We'll denote<sup>3</sup> the append operation by the dot operator. For example, to append the letter  $a$  to the string  $x$ , we'll use the following notation<sup>4</sup>:

$$x \cdot a$$

For example,  $ab \cdot c = abc$ , then the evaluation<sup>5</sup> of the expression  $x \cdot a$  is given by

$$x \cdot a = a \cdot x = ax$$

When a letter is appended to the empty string, the result is the letter. In other words, for any letter  $a$  we have

$$a \cdot \epsilon = \epsilon \cdot a = a$$

To get along without parentheses, we'll agree that appending is right-associated. For example,  $a \circ b \circ c$  means  $a \circ (b \circ c)$ .

Now we have the tools to give inductive definitions for some sets of strings. For example, if  $\Sigma$  is an alphabet, then an inductive definition of a set of strings of  $\Sigma$  can be written as follows:

**Base:**  $\epsilon \in S$ .

**Induction:** If  $x$  is a string of  $\Sigma$ , then  $ax \in S$ .

For example, if  $\Sigma = \{a, b\}$ , then the set of strings can be constructed by the following sequence:

$$\begin{aligned} S &= \{ \epsilon, a, b \} \Rightarrow S = \{ \epsilon, a, b, ab \} \\ &\Rightarrow S = \{ \epsilon, a, b, ab, aab \} \\ &\Rightarrow S = \{ \epsilon, a, b, ab, aab, abab \} \\ &\Rightarrow \dots \end{aligned}$$

**Example 2** Suppose that  $\Sigma = \{0, 1\}$  and we want to define the set of strings  $S$  such that each string in  $S$  contains exactly one occurrence of 0 on the right. For example,  $S$  should contain strings like

$$\{ \epsilon, 01, 101, 110, \dots \}$$

Can we define  $S$  inductively? Yes. Let the digit 0 be the base element of  $S$ . If  $x$  is an element of  $S$ , then we can construct a new element of  $S$  by appending the digit 1 to  $x$ . Then the inductive definition of  $S$  can be written as follows:

**Base:**  $0 \in S$ .

**Induction:** If  $x \in S$ , then  $1x \in S$ .

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**Example 3** (Appending on the Right) Let  $\Sigma = \{0, 1\}$ , and suppose that  $S$  is the set of strings over  $\Sigma$  with the following property: the string contains a leading one except if itself. Then  $S$  should contain strings like

$$S = \{ 0, 1, 01, 10, 110, 101, 1101, \dots \}$$

If we let 0 and 1 be the base elements of  $S$ , then we can append 1 to each of these strings to obtain the strings  $01$  and  $11$ . Similarly, by appending 1 to each of these latter strings we obtain the strings  $011$  and  $111$ . But then we can construct the two strings  $101$  and  $110$ .



【注】(ABC 順)

alphabet	生成のために用いる文字の集合
denote	を意味する, 示す
English alphabet	英語の文字全体の集合
evaluation	(式の値を) 計算した結果
inductive	帰納法で定義可能な
juxtaposition	横に並べて置くこと
notation	表記法
odd	奇数
parentheses	括弧 (parenthesis) の複数形
right associative	右結合 (右側の演算を先に行うこと)
set	集合
string	文字列

【設問】

1. (A)～(H) に当てはまる式や値を示しなさい。
2. 下線部 (a) がないとどのような問題が生じるのか。本文中で示された例を用いて, 問題が生じる理由を説明しなさい。
3. 下線部 (b) の  $\Lambda$  はどのような文字列であるかを説明しなさい。
4. 下線部 (c) が指し示しているものは何かを説明しなさい。
5. 下線部 (d) において, 100 と 101 の作成について述べているが, それまでに説明した方法では何が問題であるのか説明しなさい。
6. 下線部 (e) の問題を解きなさい。









【設問】

7. 新井氏は、「AI はどのように仕事を奪い、仕事を生み出し、社会を変えるのか。」という問題を検証する方法の一つとして、下線部①のように大学受験をさせることを考えた。AI に大学受験をさせることと、AI が仕事を奪うことの関係について、氏の考えを 70 字以内で説明しなさい。
8. 下線部②について、AI が、意味は分かっていないにも関わらず、数学の問題を解いたり、雑談につきあったり、珍しい白血病を言い当てることができるのはどのような方法によると考えられるか、二つの記事を読んだ上で、100 字以内で説明しなさい。
9. 新井氏の考えでは、AI はどのような仕事を人間から奪い、どのような仕事を人間に残す（あるいは生み出す）か、説明しなさい。
  - i. 人間から奪う仕事：(1 行以内)
  - ii. 人間に残す（あるいは生み出す）仕事：(2 行以内)
10. 全体を通して、「東ロボくん」プロジェクトから新井氏はどのような危機感を持ち、その危機を回避するために何が必要であると考えているか、220 字以内で説明しなさい。