小熊樂園资格考试

Bear Resort Qualification Examination

2025 年有效 / Effective in 2025

个人信息 / **Personal Information**

姓名 / Name: _____   小熊樂園编号 / Bear Resort ID: _____

诚信声明: 我承诺在考试中没有接受外部协助，遵守考试规定，且我的答案能最佳反应我的实力。
Integrity Statement: I certify that I have completed the exam without external help, abode the exam instructions, and my answers reflect my capabilities at the best extent.

签字 / Signature: _____   日期 / Date: _____

考试说明 / **Instructions**

小熊樂園资格考试将评估准成员的综合素养，资格考通过的分数将远低于卷面总分。考察的方面包含且不限于小熊樂園基本信息、语言能力、文学素养、数学逻辑、理化基础、计算机运用和生活常识，应试者仅需选择自己擅长的方向进行回答，可以跳过不擅长的领域。

The Bear Resort Qualification Examination aims to evaluate the general capabilities of pre-members, note that the marks to qualify is much lower than the full marks on the paper. The evaluation focuses on (but not limited to) Bear Resort information, language skills, literature capabilities, mathematical logics, physics/chemistry capabilities, computer usages, and commonsense; therefore, competitors should select questions that they are comfortable with and skip the unfamiliar topics.

- 考试中严禁接受外部协助。完成作答后请扫描提交至 DK4KY3 的 Gradescope。
  Complete the exam without external help. Submit scanned solution to DK4KY3 on Gradescope.

- 对于选择题，请清晰指明选项；对于简答题，请列出过程，无支持的答案不会得分。
  For multiple choices, please clearly indicate your choice; for short answer questions, please show your process, unsupported answers will not receive credits.

第一部分：单项选择题。请选择下列选项中最适合的答案，答对得 4 分，不答得 1 分，答错不得分。

Part I: Multiple Choice Questions. Please select the most suitable choice. 4 points for the correct answer, 1 point for no answer, and no points for incorrect answer.

1. 小熊樂園成立于何时？

   When is the Bear Resort established?

   ○ 2022 秋 / Fall 2022

   ○ 2023 春 / Spring 2023

   ○ 2023 秋 / Fall 2023

   ○ 2024 春 / Spring 2024

2. 哪座城市与小熊樂園的创立无关？

   Which city is irrelevant to the establishment of Bear Resort?

   ○ 香港 / Hong Kong

   ○ 巴尔的摩 / Baltimore

   ○ 北京 / Beijing

   ○ 圣·胡安 / San Huan

3. 小小熊和小熊的关系是?

   What is the relationship between Little Bear and Beary?

   ○ 父和子 / Father and son

   ○ 子和父 / Son and father

   ○ 朋友 / Friends

   ○ 无关系 / No relationship

(Questions 4 to 6 are for candidates who understand Chinese; if you are not, please skip to Question 7.)

根据以下材料，回答第 4 至 6 题。

> 机器学习是人工智能的一个分支。人工智能的研究历史有着一条从以"推理"为重点，到以"知识"为重点，再到以"学习"为重点的自然、清晰的脉络。显然，机器学习是实现人工智能的一个途径之一，即以机器学习为手段，解决人工智能中的部分问题。机器学习在近 30 多年已发展为一门多领域科际整合，涉及概率论、统计学、逼近论、凸分析、计算复杂性理论等多门学科。 　　　　　　　　　　　　　　　　　－－节选自维基百科

4. 根据节选片段，机器学习的目的是?

   ○ 成为人工智能的分支。

   ○ 整合各个学科和领域。

   ○ 将研究重点移至学习。

   ○ 解决人工智能的不足。

5. 以下学科领域由中文翻译为英文不正确的是?

    ○ 概率论 $\implies$ Probability Theory.

    ○ 统计学 $\implies$ Statistics.

    ○ 逼近论 $\implies$ Approximation Theory.

    ○ 凸分析 $\implies$ Concave Analysis.

6. 文中划线的<u>显然</u>最能表现作者的何种态度?

    ○ 将后方的结论留作读者的练习。

    ○ 用简易的证据即可同意作者观点。

    ○ 转折前方论点,开启新的观点。

    ○ 暗示文章将反驳另一个论点。

(题目 7 至 9 是为理解英文的考生准备,如果你不理解英文,请移步至第 10 题。)

Refer to the following paragraph, answer Questions 7 to 9.

> Machine learning algorithms are increasingly used in various domains, including healthcare, finance, criminal justice, and education. These algorithms have the power to make decisions that, without human judgment, can have significant consequences for individuals and communities. <u>Therefore</u>, it is crucial to consider the ethical dimensions of machine learning to prevent potential harm and ensure that the data created by these systems are used responsibly.   – – Selected in Vation.

7. Which field is not mentioned in the paragraph, where there is increasing use of machine learning algorithms?

    ○ Medical and emergency services.

    ○ Banking and investment companies.

    ○ Education for imprisonments.

    ○ Software developments for trading.

8. What is the purpose of the underlined word <u>Therefore</u> in the paragraph?

    ○ The next argument qualifies the previous argument.

    ○ It elaborates the statements in the previous sentence.

    ○ It gives reasoning to an argument that the author disagrees with.

    ○ It suggests a new point for future of machine learning ethics.

9. How does the paragraph develops?

    ○ The author first introduced the usage of machine learning, then they transits to the issues of machine learning.

    ○ The author proposes two conflicting arguments on machine learning and adapted the latter one.

○ The author disagrees with a popular claim by the public and then explains why their claim is right.

○ The author discusses the benefits of machine learning and leaves its limitations as an open question.

10. 令集合 $F = \{(a,b) : a \in \mathbb{Q} \cap [0,1] \text{ 或 } b \in \mathbb{Q} \cap [0,1]\}$，以下对于 F 描述正确的有几项？

Let set $F = \{(a,b) : a \in \mathbb{Q} \cap [0,1] \text{ or } b \in \mathbb{Q} \cap [0,1]\}$, how many of the following statements on F are correct?

- F 是紧集。/ F is compact.
- F 是连通集。/ F is connected.
- F 是开集。/ F is open.
- F 是可数集。/ F is countable.
- F 在 $\mathbb{R}^2$ 的勒贝格测度不为 0。/ The Lebesgue measure for $\mathbb{R}^2$ of F is non-zero.

○ 1.

○ 2.

○ 3.

○ 4.

11. 以下在域范畴内，同构表达不正确的是？

Which of the following isomorphism is incorrect in the category of field?

○ $\mathbb{R}(i) \cong \mathbb{C}$.

○ $\mathbb{Q}(\sqrt{2}, \sqrt{3}) \cong \mathbb{Q}(\sqrt{2} + \sqrt{3})$.

○ $\mathbb{F}_2[t]/(t^2 + t + 1) \cong \mathbb{F}_4$.

○ $(\mathbb{Z}/2\mathbb{Z})^2 \cong \mathbb{Z}/4\mathbb{Z}$.

对于选项 4，假设 $(\mathbb{Z}/2\mathbb{Z})^2$ 的乘法定义为：对于任意 $(a,b),(c,d) \in (\mathbb{Z}/2\mathbb{Z})^2$，令 $(a,b) \cdot (c,d) = (a \cdot c, b \cdot d)$.

For choice 4, assume that multiplication in $(\mathbb{Z}/2\mathbb{Z})^2$ is defined as: for any $(a,b),(c,d) \in (\mathbb{Z}/2\mathbb{Z})^2$, let $(a,b) \cdot (c,d) = (a \cdot c, b \cdot d)$.

12. 考虑积分 $\int_{-\infty}^{\infty} x\,dx$，以下说法正确的是？

Consider the integral $\int_{-\infty}^{\infty} x\,dx$, which of the following is correct?

○ x 在 $\mathbb{R}$ 黎曼可积。/ x is Riemann integrable on $\mathbb{R}$.

○ x 在 $\mathbb{R}$ 勒贝格可积，且积分的结果为 0。/ x is integrable on $\mathbb{R}$, and the integral evaluates to 0.

○ x 在 $\mathbb{R}$ 勒贝格可积，且积分的结果为正。/ x is integrable on $\mathbb{R}$, and the integral evaluates to a positive number.

○ x 在 $\mathbb{R}$ 勒贝格不可积。/ x is not Lebesgue integrable on $\mathbb{R}$.

13. 令 $\mathbb{F}$ 为任意域，R 为任意环，G 为任意群。以下陈述中，正确的有几项？

Let $\mathbb{F}$ be any field, R be any ring, and G be any group. How many of the following statements are correct?

- 有且仅有两个理想的 R 是域。/ R with exactly two ideals is field.
- 若 $\mathbb{F}$ 是域扩张 F/K 的中间域，则其伽罗瓦对应群 G 是 $\text{Aut}_F(K)$ 的子群。/ If $\mathbb{F}$ is the intermediate field of the field extension F/K, then its Galois correspondence group G is a subgroup of $\text{Aut}_F(K)$.
- $\mathbb{F}$ 上的模是一个 $\mathbb{F}$ 的向量空间。/ Modules over $\mathbb{F}$ is a $\mathbb{F}$-vector space.
- 若 $\mathbb{F}$ 的势是无限，则 $\mathbb{Q} \subset \mathbb{F}$。/ If $\mathbb{F}$ has an infinite cardinality, then $\mathbb{Q} \subset \mathbb{F}$.
- 令 G 为所有行列式不为 0 的 3×3 矩阵，运算符 $\cdot$ 的定义可以是矩阵的元素相加，而不能是矩阵相乘。/ Let G be all 3-by-3 matrices with non-zero determinant. The operator $\cdot$ could only be addition by entries, but not matrix multiplications.

○ 1.

○ 2.

○ 3.

○ 4.

14. 咖啡因是早八课同学的福音，其结构式如下：

Caffeine is precious things to students with 8am class, its structure diagram is as follows:
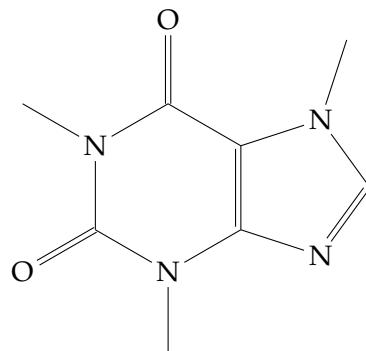
咖啡因分子的相对质量是？

What is the relative mass for a caffeine molecule?

相对原子质量参考 / Relative atomic mass:
C – 12, O – 16, H – 1, N – 14.

○ 88.

○ 148.

○ 151.

○ 194.

15. 以下对同分异构物关系的表达中，正确的有几项？

    For the following statements about isomerism, how many of the them are correct?

    - 立体异构物是又空间上分子中的原子分布差距造成的。/ Stereoisomerism incurs different spacial arrangements of atoms in a molecule.
    - 结构式异构物与离子键有关。/ Configurational isomerism is related to ionic bond.
    - 1,2-二甲基环丙烷需要以顺反区分。/ 1,2-dimethylcyclopropane needs to be identified by *cis* or *trans*.
    - 顺反异构中必须存在双键。/ There must be a double bound in *cis-trans* isomerism.

    ○ 0.

    ○ 1.

    ○ 2.

    ○ 3.

16. 波是物理中一个重要的概念，通常上波的传播公式可以写作：

    Wave is an important concept in physics, and its propagation can be typically represented as:

    $$\begin{cases} \text{关系/Relationship:} & u_{tt} - c^2 u_{xx} = 0, x \in (0, L); \\ \text{起始条件/Initial Condition:} & u(x, 0) = g(x), \qquad u_t(x, 0) = h(x), x \in [0, L], \\ \text{边界条件/Boundary Condition:} & u(0, t) = u(L, t) = 0, t \geq 0. \end{cases}$$

    以下对于公式描述错误的是？

    Which of the following is an incorrect description to the equation?

    ○ t 表示时间，x 表示位移，$[0, L]$ 为长度区间。/ t represents time, x represents displacement, and $[0, L]$ is the interval concerned.

    ○ 公式的边界条件为狄利克雷条件。/ The function is using the Dirichlet's boundary condition.

    ○ 介质的两端是不固定的。/ The ends of the medium is free.

    ○ c 可以表示光速。/ c can represent the speed of light.

17. 相对论的许多结论和经典力学的条件相互违背。以下假设在经典力学中为真而相对论中为假的有几个？

    Relativity has many conclusions that are contradicting the classical mechanics. How many of the following assumptions are true in classical mechanics but not in special relativity?

    - 真空中光速是常数。/ Speed of light in vacuum is constant.
    - 高速运动的物体时间流速更慢。/ Time is slower for higher speed objects.
    - 物体的速度可以超过光速。/ An object can move faster than the speed of light.
    - 物体高速运动时能量增加而质量不变。/ When an object is moving quickly, it has higher energy but not larger mass.

○ 0.

○ 1.

○ 2.

○ 3.

18. 粒子是组成世界的部分，以下关于粒子的描述正确的是？

    Particles are composing the world, which of the following particle is correct?

    ○ 光子是唯一质量为零的粒子。/ Photon is the only particle with mass zero.

    ○ 胶子在强作用力中被交换。/ Gluons are exchanged during strong interactions.

    ○ 引力子是四大基本力中第一个被发现的粒子。/ Graviton is the first observed particle for the 4 fundamental forces.

    ○ 粒子包含电量的最小单位是 1。/ The smallest unit of charge for particles is 1.

19. 下图为一张神经网络结构。

    Below is a structure of a neural network.
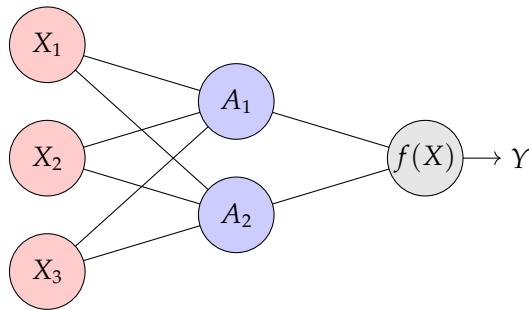
    下列说法正确的是？

    Which of the following statement is correct?

    ○ Dropout 指移除一些分析点，是一种正则化的方式。/ Dropout means removing certain nodes, and is a method for regularization.

    ○ 这个神经网络包含 3 个输入，第二层有两个输出，第三层有一个输出，最终的结果层有一个结果。/ This neural network has 3 input features, a second layer with 2 outputs, a third layer with 1 output, and the final outcome layer with 1 outcome.

    ○ 一个常用的激活公式 `ReLU` 为 / A typical activation function `ReLU` is
    $$\text{ReLU}(v) = \frac{1}{1 + e^v}.$$

    ○ 数据增强增加了未经核实的数据，所以在应用中需要避免。/ Data augmentation adds unverified data, hence it should be avoided in practice.

20. 哈希表是一种常见的数据结构，以下关于该数据结构描述正确的是：

    Hash table is a typical data structure, which of the following descriptions is correct?

    ○ 哈希表各个功能的最差情况用时 $\mathcal{O}(1)$。/ The worst case runtime for hash table is $\mathcal{O}(1)$.

○ 哈希公式的本质确保了哈希值不会撞车。/ The nature of hash function guarantees that there will not be collisions of hash values.

○ 哈希表的大小必须是质数。/ The size of a hash table has to be prime.

○ 良好的哈希公式需要时间 $\mathcal{O}(1)$。/ A good hash function should have runtime $\mathcal{O}(1)$.

21. 双浮点数的表达方式如下：

The double precision floating points is represented as follows:

符号位 / sign bit	`#e` 指数位 / exponent bits	`#f` 52 假数位 / Mantissa bits
1	11	52

最小的可表达的正数浮点数是？

What is the smallest positive machine representable number?

○ 最小可表达的正浮点数可无限接近 0。/ The smallest positive machine representable number can be arbitrarily close to 0.

○ 2^{-1023}.

○ 2^{-52}.

○ 2^{-11}.

22. 面对对象编程是许多编程语言的基础。以下对于面对对象编程描述中错误的是？

Object orientated programming is the bases of many programming language. Which of the following is incorrect with its description?

○ 多态的本质是提供对于不同类别的统一化。/ Polymorphism is fundamentally providing a uniformed standard for different classes.

○ `C` 语言不是面对对象编程语言，其 `struct` 的环境是一种不完全的替代。/ C language is not object orientated programming language, its `struct` is a weak alternative.

○ 面对对象编程的类在内存中储存在临近的位置。/ The storage of a class in object orientated programming is adjacent.

○ 面对对象编程的继承中，继承对象一定会使用被继承的函数。/ In object orientated programming, the extended class will always use the functions from their parents.

23. 牛顿-拉弗森方法是一种算法，在计算机科学中有广泛的应用。下列关牛顿-拉弗森方法于描述正确的是？

Newton-Raphson Method is an algorithm, it has extensive applications in computer science. Which of the following description is correct for the Newton-Raphson Method?

○ 牛顿-拉弗森方法仅限二维数据 (x, y)。/ Newton-Raphson Method can only be applied to 2-D data (x, y).

○ 牛顿-拉弗森方法可以用于寻找凸方程的最大值。/ Newton-Raphson Method can be used to find maximum of a convex function.

○ 牛顿-拉弗森方法的拟合率越大，则拟合越快。/ The larfer the learning rate for Newton-Raphson Method, the faster the function find a zero.

○ 阿贝尔-鲁菲尼定理指出五次或更高多项式没有一般的求根公式，所以牛顿-拉弗森方法只能运用在四次或以下的多项式上。/ By Abel-Ruffini theorem, polynomials of degree 5 or higher has no general solutions with radicals, so Newton-Raphson Method can only be applied to polynomials of degree 4 or less.

24. 在照明不良的条件下走路，以下表达正确的有几项？

When walking during poor illumination, how many of the following are correct?

- 应该避免走向有反光的区域。/ One should avoid walking towards bright or reflecting areas.
- 应该避免走向灰色的区域。/ One should avoid walking towards gray light areas.
- 应该避免走向有黑色的区域。/ One should avoid walking towards dark areas.

○ 0.

○ 1.

○ 2.

○ 3.

25. 问号处最应该填入什么？

Which of the following fits the best at the question mark?
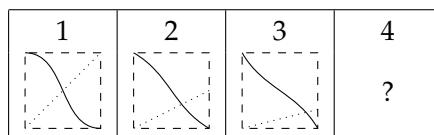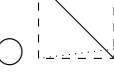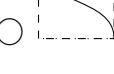
这是第一部分：选择题的结尾。

This is the end of Part I: Multiple Choice Questions.

第二部分：简答题。请提供详细的步骤，未经验证的答案可能会导致失分。每题满分 10 分，部分正确的答案会获得部分得分，选择不作答得 2 分，完全错误的答案得 0 分。

Part II: Short Answer Questions. Please provide detailed processes, unverified answers might result in reduction of points. 10 points for fully correct response, partial credits will be awarded, 2 points for not answering, and 0 points for fully incorrect attempt.

1. 小熊樂園成立之初，创立人们将动物伦理纳入了基础逻辑。请从简要分析动物伦理的意义与价值。

   When Bear Resort was established, the founders included animal ethics in the basic logics. Please briefly evaluate the values of animal ethics.

   ○ 不作答（2 分）/ Not answering (2 points)

2. 小熊樂園推崇多语言学习，请用中文和英文以外的语言翻译下方段落。

   The Bear Resort encourages multi-lingual studying, please translate the following paragraph in languages other than Chinese or English.

   - 蒂娜动物园将于香港中环地区附近建设。建设以后将成为香港乃至全世界的旅游胜地。
     Tina's Zoo will be built around Central area in Hong Kong. After establishment, it is expected to be one of the largest tourism interests in Hong Kong, as well as around the world.

   ○ 不作答（2 分）/ Not answering (2 points)

3. 熊类在文学作品中都有出现，请描述一本文学作品和熊类在其中的形象。

Bears appear in many literature works. Please describe such a literature work and the figure of bears.

○ 不作答（2 分）/ Not answering (2 points)

4. 令 $F \subset \mathbb{R}^n$ 为欧几里得空间内的一个子集，对 F 的 s 维豪斯多夫外测度（s 为非负实数）定义如下：

Let $F \subset \mathbb{R}^n$ be a subset of Euclidean space, the s-dimensional Hausdorff measure of F (where s is non-negative real number) is defined as:

$$\mathcal{H}^s(F) = \lim_{\delta \to 0} \left[\inf \left\{ \sum_i \big(\operatorname{diam}(U_i) \big)^s : \operatorname{diam}(U_i) < \delta \wedge \bigcup_i U_i \supset F \right\} \right].$$

证明：若 $E \subset \mathbb{R}^n$ 满足 $\mathcal{H}^s(E) < \infty$，则对于所有 $t > s$ 有 $\mathcal{H}^t(E) = 0$.

Prove that if $E \subset \mathbb{R}^n$ satisfies that $\mathcal{H}^s(E) < \infty$, then for all $t > s$, there is $\mathcal{H}^t(E) = 0$.

○ 不作答（2 分）/ Not answering (2 points)

5. 我们将 $(a_1 \ a_2 \ \cdots \ a_m)$ 记为交换，即将 a_1 变为 a_2，a_2 变为 a_3，等等，a_m 变为 a_1。证明：任何交换可被写为单个交换（即 $(a_i \ a_j)$）的组合。

We denote $(a_1 \ a_2 \ \cdots \ a_m)$ as a permutation, that is making a_1 into a_2, a_2 to a_3, etc., until a_m to a_1.

Prove that every permutation can be written as compositions of transpositions (that is $(a_i \ a_j)$).

○ 不作答（2 分）/ Not answering (2 points)

6. 设 $y(x)$ 满足下列常微分方程：

Let $y(x)$ satisfying the following ordinary differential equations:

$$\begin{cases} \dfrac{d^2 y}{dx^2} + \cos(1-x)y = x^2 - 2x + 1, \\ y(1) = 1, \qquad \dfrac{dy}{dx}(1) = 0. \end{cases}$$

证明：$y(x)$ 关于 $x = 1$ 对称。

Prove that $y(x)$ is symmetric about $x = 1$.

○ 不作答（2 分）/ Not answering (2 points)

7. 考虑下方的氢气在氧气中燃烧反应:

Consider the following chemical equation of hydrogen gas combustion in oxygen gas:

$$2H_2 + O_2 \xrightarrow{f} 2H_2O.$$
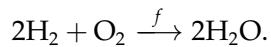
我们可以用图的形式表示。

We may represent it from a graphical representation.
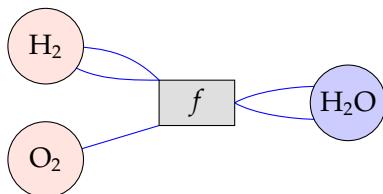
如果我们有多个化学反应式，我们可以将他们进行组合。请用图的形式表达下方的两个反应：

In case we have multiple chemical reactions, we can compose them accordingly. Please use the graphing to represent the following two reactions:

$$C_2H_4 + H_2O \xrightarrow{f} ???,$$

$$??? + O_2 \xrightarrow{g} CO_2 + H_2O.$$
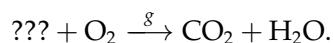
○ 不作答（2 分）/ Not answering (2 points)

8. 我们要分析热在一个圆环上的传导，假设圆环不会向外散热且是完美导体。通常，我们可以考虑将圆环转化为一段导体。

   We are analyzing the dispersion of heat on a ring, suppose that the ring will not disperse heat to outside and perfectly conductive. Typically, we can consider the ring as a segment.
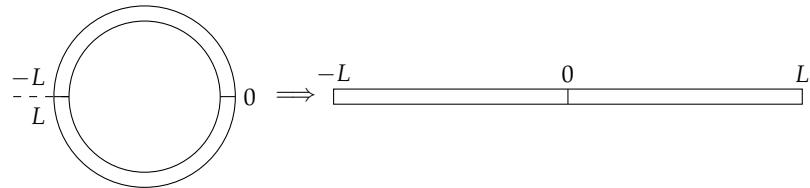
   假设热传导率为 κ，圆环初始温度为 $\gamma(x)$ 在 $x \in [-L, L]$，列出关系的公式并写出完整解（无需过程）。

   Suppose the heat conductivity rate is κ, the initial temperature of the ring is $\gamma(x)$ for $x \in [-L, L]$. Write down the relationships of the system and the complete solution (no process needed).

   ○ 不作答（2分）/ Not answering (2 points)

9. 将一个 `array` 排序是计算机科学的基础。请选择一个计算机语言，并选择一种排序方法，整理一组不同的整数。

   Sorting an `array` is a foundation in computer science. Please select a computer language and a sorting algorithm to sort a set of distinct numbers.

   注意：不使用 $\mathcal{O}(n \log n)$ 的排序算法会获得 20% 的扣分。

   Note: Not using a $\mathcal{O}(n \log n)$ sorting method would result in 20% of deduction of point.

○ 不作答（2 分）/ Not answering (2 points)

语言 / Language: ○ C   ○ C++   ○ JAVA   ○ Python   ○ Others: _____

排序方式 / Sorting Method: ○ 冒泡 / Bubble   ○ 归并 / Merge   ○ 快速 / Quick

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10. 证明或反驳以下观点:

Prove or disprove the following statement:

如果 f 是一个不几乎处处为 0,则 $f \in \mathcal{O}(1)$,即 f 为常数运行时间。

If f is not 0 almost everywhere, then $f \in \mathcal{O}(1)$, in other words, f has constant runtime.

○ 不作答(2 分)/ Not answering (2 points)
○ 证明 / Prove   ○ 证伪 / Disprove

这是第二部分:简答题的结尾。

This is the end of Part II: Short Answer Questions.

此页留白是有意的。
不要在本页书写。

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Do not write on this page.