２０１８年度 早稲田大学大学院教育学研究科
博士後期課程 一般・外国学生入学試験問題　資料解読
【教科教育学専攻（数学科教育学・数学科内容学）】

解答上の注意

１. 教育基礎学専攻（数学科教育学・数学科内容学）の入学試験問題は、出願時に届け出た指導教員の欄に従い、下記の表の解答すべき問題を解答しなさい。

志願票に記入した研究指導名	志願票に記入した指導教員名	解答すべき問題・ページ
数学科教育学研究指導	瀧澤　武信	問題 Ⅰ（P.2）
数学科内容学研究指導	広中　由美子	問題 Ⅱ（P.3）
数学科内容学研究指導	小森　洋平	
数学科内容学研究指導	横森　　貴	
数学科内容学研究指導	小柴　健史	
数学科内容学研究指導	谷山　公規	

２. 解答用紙の所定欄に、「問題番号」（例：「Ⅰ」・「Ⅱ」など）を必ず記入すること。
また、全ての解答用紙の所定欄に研究指導名・指導教員名・受験番号・氏名を必ず記入すること。

３. 解答すべき問題以外を解答した場合、当該解答は「０点」となります。

４. 解答用紙が複数枚配付された場合、ホッチキスははずさないこと。また、無解答の解答用紙でも提出すること。

５. 問題用紙は「３枚」（本ページ含む）、解答用紙は「１枚」です。必ず枚数を確認すること。

以　上

２０１８年度
早稲田大学大学院教育学研究科博士後期課程入学試験問題

科目名　資料解読（数学科教育学・数学科内容学）

問題 I

（1）下の英文を和訳せよ.
（2）このテキストの方法で，１ ≧ １ を確認せよ.

出典：
J. H. Conway: "On Numbers and Games", Academic Press, 1976.

※この問題は、著作権の関係により掲載ができません。

２０１８年度
早稲田大学大学院教育学研究科博士後期課程入学試験問題

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問題 II

First, summarize the following within 150 words. Next, give your idea on the possibility of quantum computers.

One of the great scientific and engineering questions of our time is : are quantum computers possible? We can build computers out of mechanical gears and levers, out of electric relays, out of vacuum tubes, out of discrete transistors, and finally today out of integrated circuits that contain thousands of millions of individual transistors. In the future, it may be possible to build computers out of other types of devices — who knows.

All of these computers, from mechanical to integrated-circuit-based ones, are called *classical*. They are all classical in that they implemented the same type of computer, albeit as the technology gets more sophisticated the computers become faster, smaller, and more reliable. But they all behave in the same way, and they all operate in a non-quantum regime.

What distinguishes these devices is that information in manipulated as *bits*, which already have determinate values of 0 or 1. Ironically, the key components of today's computers are quantum devices. Both the transistor and its potential replacement, the Josephson junction, won a Nobel Prize for the quantum theory of their operation. So why is their regime non-quantum? The reason is that the regime reckons information as bits.

By contrast, quantum computation operates on *qubits*, which are based on complex-number values, not just 0 and 1. They can be read only by *measuring*, and the readout is in classical bits. To skirt the commonly bandied notion of observers interfering which quantum systems and postpone the discussion of measurement as an operation, we offer the metaphor that a bit is what you get by "cooking" a qubit. From this standpoint, doing a classical computation on bits is like cooking the ingredients of a pie individually before baking them together in the pie. The quantum argument is that it's more expedient to let the filling bubble in its natural state while cooking everything at once. The engineering problem is whether the filling can stay *coherent* long enough for this to work.

The central question is whether it is possible to build computers that are inherently quantum. Such computers would exploit the power and wonder of nature to create systems that can effectively be in the multiple states at once. They open a world with apparent actions at a distance that the great Albert Einstein never believed but that actually happens — a world with other strange and counter-intuitive effects. To be sure, this is the world we live in, so the question becomes how much of this world our computers can enact.

The question is yet to be resolved. Many believe that such machines will be built one day. Some others have fundamental doubts and believe there are physical limits that make quantum computers impossible. It is currently unclear who is right, but whatever happens will be interesting: a world with quantum computers would allow us to solve hard problems, while a barrier to them might shed light on deep questions of physics and information.

出典："Quantum Algorithms via Linear Algebra", R. J. Lipton and K. W. Regan, MIT Press

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