外国語科目 (数理・計算科学専攻)

22　大修

英語

時間　午後2時 – 午後3時

注意事項

1. つぎの3問中2問を選択し解答せよ.
2. 解答は1問ごとに別々の解答用紙に記入せよ.
3. 解答用紙ごとに必ず問題番号および受験番号を記入せよ.
4. 2問を超えて解答した場合は採点されない可能性がある.

問 1

次の英文を読んで，下の設問に日本語で答えよ．

One of Einstein's most famous sayings was: "The most incomprehensible thing about the universe is that it is comprehensible." Stated another way, although many aspects of the physical world can be encapsulated in simple laws or in a concise mathematical description, what we do not know is why that should be the case. Even more difficult to explain is the almost magical way that certain mathematical notions that seem to spring out of sheer invention from creative minds turn out to be exactly the tools that are needed to describe the physical world. This phenomenon has been described by the eminent twentieth-century physicist Eugene Wigner as "the unreasonable effectiveness of mathematics in the natural sciences." A striking example is the theory of conic sections—the ellipse, parabola, and hyperbola—first studied for no apparent practical reason by Greek mathematicians around 400 B.C. That theory did not find an application in science until two thousand years later when Kepler realized that the shape of a planet's orbit around the sun is an ellipse. Kepler's discovery was further elaborated by Newton to include comets and other objects entering the solar system, whose orbits could be an ellipse, parabola, or hyperbola. Newton also showed that the shape of the earth itself was ellipsoidal rather than spherical.

(出典 "Poetry of the universe" by Robert Osserman, 1995)

- conic section: 円錐の切断面
- ellipse: 楕円
- parabola: 放物線
- hyperbola: 双曲線
- ellipsoidal: 楕円体の

(1) 枠で囲まれた部分を和訳せよ．

(2) 本文に述べられている Newton の貢献は何か？

問 2

次の文章は，米国統計学会会長講演の一部である．これを読み，下の設問に日本語で答えよ．

A field like statistics has both an inside and an outside. The outside part faces our clients, the people who need answers to pressing statistical questions. My examples tonight concerned outside relationships with physicists, microbiologists, and brain researchers. One of the encouraging trends in statistics has been our increasing engagement with front-line science. • • •

中略

I find the microarray story particularly encouraging. First of all, biologists did come to us for answers to their difficult new inference problems. • • •

中略

Microbiologists talk with other information scientists too, such as data miners, neural networkers, and bioinformatics people. It's human nature to worry about competition like this. A In fact, however, we have a positive regression coefficient with these "rival" fields. Their enthusiastic energy is refreshing and contagious. They bring new data-analytic ideas into our field, ideas that statisticians can then understand and explain in terms of basic inferential theory. Many scientists are excellent probabilists, but in my experience only statisticians are trained in the kind of reverse thinking, from observed data back to possible models, necessary for inference. B In other words, don't worry about statistics going out of business from outside competition.

If you do feel the need to worry, a better subject is our own production of useful new ideas. This relates to the "inside" of the statistics profession, the side that worries about the structure of statistical inference and how it can be extended. New ideas are the coin of the realm for an intellectual discipline. Without them a field hollows out, no matter how successful it may be in terms of funding or public recognition. C Too much "inside" can be deadly for a field, cutting it off from the bigger world of science, as happened to mathematics in the twentieth century.

(Bradley Efron, "Bayesians, Frequentists, and Scientists," *Journal of the American Statistical Association*, Vol. 100, pp.1-5, 2005 より)

- statistics: 統計学
- microbiologists: 微生物学者
- front-line: 最前線の
- microarray: マイクロアレイ（細胞内の遺伝子発現量を測定する器具）
- data miner: データマイニングの専門家
- neural networker: ニューラルネットワークの専門家
- bioinformatics: 生命情報学
- regression coefficient: 回帰係数
- coin of the realm: 法貨

（1）下線部Aの指す内容を説明せよ.

（2）下線部Bを和訳せよ.

（3）下線部Cを和訳せよ.

問 3

次の文章は，本のまえがきの一部である．これを読み，下の設問に日本語で答えよ．

Communication

The need for communication arises whenever two or more computers, components, systems, or humans (in general, "parties") need to jointly perform a task that none of them can perform alone. A This may arise, for example, due to the lack of resources of any single party or due to the lack of data available to any single party.

In many cases, the need for communication is explicit: When we search files on a remote computer it is clear that the requests and answers are actually communicated (via electrical wires, optical cables, radio signals, etc.). In other cases, the communication taking place is more implicit: When a single computer runs a program there is some communication between the different parts of the computer, for example, between the CPU and the memory, or even among different parts of the CPU. In yet other cases, there is no real communication going on but it is still a useful abstraction. B For a problem whose solution relies on several pieces of data, we can imagine that these *pieces of data* need to communicate with each other in order to solve the problem; in reality, of course, this communication will be achieved by a processor accessing them all.

Complexity

The notion of complexity is becoming more and more central in many branches of science and in particular in the study of various types of computation. In the field of *computational complexity* the central question is always "how complicated" a given problem is, rather than "what is a solution" to the problem.

The problems we will be dealing with here can all be solved trivially if unlimited communication is allowed. What we will be studying is *how much* communication is necessary to solve a given problem. The amount of communication needed is what we will call the communication complexity of the problem. We should emphasize: Communication complexity is an inherent property of a *problem*, not of any particular solution for the problem. We may design many solutions for any given problem, solutions whose efficiency may vary widely. The communication complexity is the cost of the most efficient solution for the problem.

(Hushilevitz and Nisan, "Communication Complexity" (1997) より)

・complexity: 複雑さ

(1) 下線部 A を和訳せよ．

(2) 下線部 B に該当する例を本文に即して挙げよ．

(3) "computational complexity" と "communication complexity" とは何であるか．
本文に即して，あわせて 100 字程度で説明せよ．