第二届 BNU 实验科学锦标赛通知

【2010-9-20】

参赛要求
北京师范大学管理学院系统科学系将于 2010 年 9 月 22 日至 11 月 10 日期间举办第二届“BNU 实验科学锦标赛”。参赛选手可以是本科生、研究生，甚至是老师，选手们自由组队，1~5 人一组。

参赛题目（有关这些题目的详细介绍，请参考本文件第 3 页之后的说明）
比赛题目分成物理学和社会科学两组，共 14 个题目（每组 7 个）:

物理组:
1. COMPLEX PENDULUM（复杂的单摆）;
2. FOUCAULT PENDULUM（傅科摆）;
3. ULTRA-SLOW FALL（超慢下落）
4. TURBULENCE IN WATER（水中的湍流）
5. BASKETBALL THROWER（投篮装备）
6. MOMENT OF INERTIA OF HUMAN BODY（人体的转动惯量）
7. ESCAPE EXPERIMENT WITH FISHES（鱼群的逃跑试验）

社会科学组:
1. CORRELATION OF DIVORCE AND SUICIDE（离婚与自杀的相关分析）
2. AUTOMOBILE TRAFFIC（汽车交通）
3. POPULATION PYRAMIDS OF CHINA（中国的人口金子塔）
4. EPIDEMICS OF 1918 AND 2003 IN CHINA（中国 1918 年和 2003 年的瘟疫大流行）
5. ECONOMIC VERSUS POLITICAL INFLUENCE（经济与政治的影响力）
6. ESCAPE EXPERIMENT WITH ANTS（蚂蚁的逃跑试验）
7. BABYBOOMS 9 MONTHS AFTER BLACKOUTS?（停电后 9 个月的生育高峰）

报名方法
请有意参加本次比赛的同学、老师于 2010 年 9 月 22 日之前将参赛成员名单、年级、联系方式（手机和 Email），以及参赛题目发送电子邮件给张江老师：zhangjiang@bnu.edu.cn。

评比方法
1. 每个参赛组要在 11 月 10 日之前提交一份试验说明报告；
2. 11 月 10 日晚（暂定）将举办一个“实验科学之夜”的现场试验展示，每个参赛组同学需要现场为老师和旁观同学展示你们的试验；
3. 11 月 12 日，每个组进行 15 分钟的答辩，并进行最终的评奖。
奖励办法
1、一等奖 1 名，奖金 2000 元
2、二等奖 2 名，奖金 1000 元
3、三等奖 3 名，奖金 500 元
4、纪念奖：所有参赛同学

如有关于此次比赛的疑问，请咨询 Roehner Bertrand 教授：
roehner@lpthe.jussieu.fr（英东楼 212 房间）或者张江老师：
zhangjiang@bnu.edu.cn（英东楼 215 房间），欢迎访问我们的网页：
http://ccr.bnu.edu.cn/zhangjiang/experiment/championship.htm

附加通知
对于参加本次比赛物理组的本科同学，部分题目也可被推荐参加北京市的物理实验竞赛，请有意者于 10 月 15 日报名，并参加 10 月 23 日北京师范大学的预赛。
具体详情，请参考教务处的通知：
http://jwc.bnu.edu.cn/showContent.asp?InfoId=923
SECOND BNU CHAMPIONSHIP
IN
EXPERIMENTAL SCIENCE (2010)

- The Championship is open to everybody, whether undergraduates, graduates or faculty members.
- In principle the participants should form teams of 2, 3 or 4, but it is also possible to take part alone.
- There are two sections: a physics section and a social science section. One of the objectives of the Championship is to convince the participants that the experimental methods which have proved successful in physics can also be used successfully in the social sciences.
- The best groups in each section will receive an award. Moreover, all groups who have taken part with determination will receive a certificate of participation and a souvenir-gift.
- Participants are encouraged to discuss with the organizers or with other faculty members, for instance if they do not know how to start or if they face an obstacle. Because, nobody (including the organizers) knows the solutions of the problems that are proposed, such discussions should not be seen as making the competition unfair. The overall objective is that both students and faculty team together to solve the problems.
- Toward the end of the Championship there will be a Night of Experimental Science to which all students who did not take part in the Championship are invited. The participants will show how their experiments work and will answer any questions. For the physics section, the experiments will be performed. For the social science section the participants will show on their computers how they have been able to find and select the data, how they analyzed them and what lead them to the conclusions they have drawn.
- At the end of the Championship each group will present its results in the form of a written report (in Chinese) and a lecture of about 15 mn (also in Chinese) given before the jury. The jury will be composed of faculty members and some students. After that, the jury will select the winners.

**Schedule**

15 September – 22 September: The participants select a topic
Around 10 November: Night of Experimental Science
Around 12 November: Presentation of the research to the Jury and session during which the prizes will be awarded.
COMPLEX PENDULUM

複杂的单摆

**Brief description:** You may think that a pendulum is a simple system. In fact it is a complicated system which can have very intricate trajectories (see picture). This research consists in recording such trajectories, then showing and explaining them to other students.

The explanations given on this page may be too short and not clear enough. You can get additional explanations by emailing or visiting one of the following two persons:

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- Prof. Jiang Zhang: zhangjiang@bnu.edu.cn, Ying Dong Building, office 215 (中文解释)
FOUCAULT PENDULUM

傅科摆

Brief description: The Foucault pendulum is just an ordinary pendulum except that one wants it to be more accurate than an ordinary pendulum.

Within several minutes of observation, one can see the plane of oscillation rotate. This rotation is related to the rotation of the Earth around its axis. This becomes fairly clear when we imagine such a pendulum at the North Pole for in this case the Earth will just rotate under the oscillating pendulum.

However, in its standard form this experiment has a low accuracy (hardly better than 5%). In this project we will firstly try to observe the Foucault effect, and secondly we will try to improve the accuracy of the experiment.

Foucault pendulum

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ULTRA-SLOW FALL

Brief description: A falling steel ball does not follow a straight vertical line. Due to the rotation of the Earth, it is deviated toward the East. This deviation is very small however: about 1.3 mm for a 20 meter fall in the air. Naturally, for such a small deviation the measurement has only a poor accuracy.

The theory of classical mechanics suggests that if, in some way, one can make the fall last longer the deviation will be larger. In other words, ultra-slow falls should provide a way to increase the deviation and therefore the accuracy of the measurement.

So, by making an object fall very slowly in a liquid we will try to observe the deviation due to the rotation of the earth.

Rotation of the earth around its axis

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**TURBULENCE IN WATER**

**Brief description:** When a metallic ball falls in water it is strongly deviated by the turbulent flow that it generates in its wake. The faster the fall, the larger the deviations. Turbulence, however, remains a fairly mysterious phenomenon. By measuring the deviation of objects which fall in water, we will try to better understand the main factors which govern turbulence.

![Image of a metallic ball falling in water]

**Turbulence (Reynolds number over 15,000)**

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BASKETBALL THROWER

Brief description: Is it possible to construct a device which would throw a basketball in the basket with a success rate close to 100%? In this project we will take up the challenge and try to build such a device.

Possible basketball thrower

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MOMENT OF INERTIA OF HUMAN BODY

人体的转动惯量

Brief description: For rotating objects the moment of inertia $I$ plays the same role as the mass in Newton’s law.

$$m \frac{d^2x}{dt^2} = \text{Forces} \leftrightarrow I \frac{d^2\theta}{dt^2} = \text{Moment of forces}$$

Whereas the mass can be measured easily with a weighing scale, the moment of inertia cannot be measured so easily.

In this project we will try to measure the 3 moments of inertia (around the center of gravity) of a person standing with his arms along his body. We will use two or three different methods in order to be able to check our results.

In can be noted that the body’s moments of inertia are of importance for the modeling of sport activities.

Measuring the moments of inertia

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ESCAPE EXPERIMENT WITH FISHES

鱼群的逃跑试验

Brief description:

Build a cell with two doors (A and B) located symmetrically with respect to the center of the cell. Put the cell in an aquarium. Put about 100 small fishes in the cell and wait. Progressively, the fishes will leave the cell. Probably, the numbers leaving through each door will be roughly the same. Now, repeat the same experiment but this time add into the cell a few drops of a chemical product that the fishes do not like. A similar experiment performed with ants has shown that in such an emergency a majority of the ants escape through the same door. We want to see if this result is special to social animals or if it also holds for non-social animals such as fishes.

If this asymmetry is also observed this raises many interesting questions. What is the influence of the density of fishes? What is the influence of the number of fishes? What will happen if we mix two (or more) species of fishes?

Such experiments will help us to better understand the determinants of this phenomenon. In this respect, the situation is the same as for a pendulum. We do not just watch it as it oscillates, we want to know what is the influence of factors such as the length or mass of the pendulum. Once we know the role of these factors, we say that we understand the phenomenon. We want to use the same procedure here.

Small fishes

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CORRELATION OF DIVORCE AND SUICIDE

Brief description:

From a network perspective divorce and suicide are two related phenomena. In divorce, it is the link between husband and wife which is cut. In suicide, all the ties which connect an individual to family and friends are cut. So, it is a natural question to wonder whether there is a statistical correlation between divorce and suicide rates.

In order to answer this question, one must find data for different provinces of the same country. Once this is done, the correlation can be easily computed. To make the evidence compelling this study must be repeated for as many countries as possible.

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AUTOMOBILE TRAFFIC

Brief description:
This is a topic which should be of interest for the students who prefer to work outside rather than in front of a computer screen.

First, one has to go to the border line between Beijing municipality and Hebei province. Then one will position oneself on the side of a road or a highway which crosses this border. One part of the team on one side of the road and the other on the other side. There will be two tasks.

- To record the numbers \( N_1, N_2 \) of Beijing and Hebei vehicles (that is to say cars and also trucks with the plate of Beijing or Hebei) which go in each of the two directions.
- The second task (to be performed in parallel with the first one) is to record the time interval between two successive vehicles. Once this is done, we will show you how to interpret these data.

For instance, one can compute the “social temperatures” of Beijing and Hebei. This is based on the following formula from the kinetic theory of gases:

\[
T_1 \sim \frac{p_1}{\rho_1}, \quad T_2 \sim \frac{p_2}{\rho_2}
\]

where \( \rho_1, \rho_2 \) are the density of population in Beijing and Hebei respectively and \( p_1 \sim N_1, p_2 \sim N_2 \).

Traffic on a highway

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There have been early Chinese censuses in 1909-1911, 1912, 1928, 1953, 1964. The first step of this project is to collect data from these censuses for instance at the National Library of China. The final objective is to build the population pyramids (by single year of age) for all provinces for which the information is available.

Population pyramid of Shanghai in 1982

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EPIDEMICS OF 1918 AND 2003 IN CHINA

Brief description:

In the fall of 1918 there has been a world-wide epidemic of influenza which caused millions of deaths especially among young adults. In 2003 there has also been an influenza epidemic (SARS). The objective of this research is to compare these two epidemics in China.

First of all this requires to collect as much information as possible about these events. For instance, one would like to know the number of deaths by age and by province.

In a second step we would like to draw some meaningful conclusions.

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ECONOMIC VERSUS POLITICAL INFLUENCE
经济与政治的影响力

Brief description:
If a country $A$ is dependent upon a country $B$ for its foreign trade (either exports or imports) does this imply a political influence of country $B$ on country $A$?

Whereas the economic link is fairly easy to define and to quantify by using foreign trade data, it is much more difficult to identify and measure the degree of political influence. This is one of the main challenges of this project.

Of course, the research should rely on the analysis of several (as many as possible) real cases. One will have to select these cases cleverly so that the effect becomes clearly visible.

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ESCAPE EXPERIMENT WITH ANTS

蚂蚱的逃跑试验

Brief description:

Build a cell with two doors (A and B) located symmetrically with respect to the center of the cell. Put about 100 ants in the cell and wait. Progressively, the ants will leave the cell. Probably, the numbers leaving through each door will be roughly the same.

Now, repeat the same experiment, but this time add in the cell a small quantity of a chemical product that the ants do not like. Observation shows that a large percentage of them (around 70% on average) will leave the cell through the same door.

Ants escaping from the cell

Naturally, such an experiment raises many interesting questions. What is the influence of the density of ants? What is the influence of the number of ants? What will happen if we mix two (or more) species of ants?

Such experiments will help us to better understand the determinants of this phenomenon. In this respect, the situation is the same as for a pendulum. We do not just want to measure the period of one pendulum we want to know what is the influence of factors such as the length or mass of the pendulum, in other words we want to know the behavior of all pendulums. Once we know the role of these factors, we can consider that we understand the phenomenon. The same approach will be used here.

Why is this effect likely to be is more “social” than the similar experiment with small fishes which is proposed in the physics section? In contrast to fishes, ants are social animals. Will this make a difference in their behavior during an emergency? We do not know yet. This is one of the points we would like to understand.

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BABYBOOMS 9 MONTHS AFTER BLACKOUTS?

停电后9个月的生育高峰

Brief description:

It has been said in US newspapers that 9 months after the great electrical blackout of 1965 (which means no light nor electricity for several hours) in the Northeast of the United States there was a peak in births in the areas which were affected. Is this really true? And, if true, how big was the effect? In order to answer these questions, one must find monthly birth data for the affected areas. Of course, this was by no means the only blackout. Wikipedia (article “List of power outages”) gives a long list of blackouts in various countries. This enables us to test the babyboom effect not just on one case but on a great number of cases.

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