AMS5 - Final
Thursday 18th March, 2010

READ THE INSTRUCTIONS CAREFULLY

1. Write your answers in a Blue Book. Write, *in ink*, your name, your student ID number, your section day/time and your TA's name on the front of your blue book.
2. Write the exam code (at the top right of this page) on the front of your blue book.
3. You should answer all the questions. Questions are not necessarily worth equal numbers of marks.
4. You are advised to read the questions carefully, and answer the question asked.
5. Begin your answer to each question on a new page.
6. You must show working or give explanations for all questions to get full marks.
7. A normal table and a χ^2-table can be found at the end of this exam. [They are not included in this practice exam, but will be included in the actual exam.]
8. Hand in this question paper with your answers.
9. The actual final will include some bonus questions. You can get full marks without answering the bonus questions. Correct answers to the bonus questions will earn you additional marks, but you cannot score more than 100%.

1. *(12 marks)* Read the summary of the article "An association between geomagnetic activity and dream bizarreness" printed at the end of this exam.

   (a) Was this an observational study or a controlled experiment? Explain briefly.

   (b) What is the hypothesis that the author was studying?

   (c) Formulate this as a null hypothesis.

   (d) What is the proposed causal link between geomagnetic activity (GMA) and dream bizarreness?

   (e) From the information in the summary we do not know whether the study was performed "blind".

   What would it mean in this case for the study to be "blind"? Be specific.

   Why would this be important?

   The dreams were rated on a scale of 1-5, "1 being completely representative of a potential waking life event, 5 being completely unrepresentative, with features impossible in waking life (e.g. presence of fictional characters or breaking of physical laws)."

   For periods of high GMA, the number of dreams in each bizarreness rating is given in the table below

bizarreness rating	# dreams
1	17
2	21
3	18
4	13
5	16

   (f) These measurements represent a sample of which population?

   (g) Does high GMA result in dreams that favor particular bizarreness ratings?

   For periods of low GMA, the number of dreams in each bizarreness rating is given in the table below

bizarreness rating	# dreams
1	4
2	10
3	19
4	21
5	15

   (h) Is dream bizarreness independent of GMA?

2. *(13 marks)* One of the pieces of information webCT records (and makes available to instructors) is the number of pages each student views. When I analyzed the data for last quarter, I found, for the 235 students who took AMS5, that the mean number of page views was 74.7, the median was 63 and the standard deviation was 53.8.

   (a) Sketch the distribution of the number of webCT page views. Label the axes.

   (b) Does the distribution follow the Normal Curve?

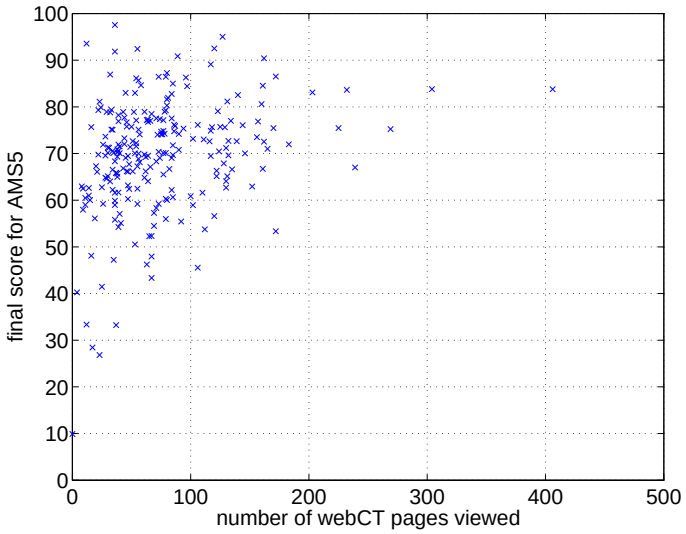
   (c) If we assume that last quarter's AMS5 students were like all AMS5 students, what is a 95% confidence interval for the mean number of webCT page views for all AMS5 students?

   (d) Does your answer to part b) affect the validity of your answer to part c)? Explain briefly.

   (e) Does your 95% confidence interval cover the true mean number of webCT page views?

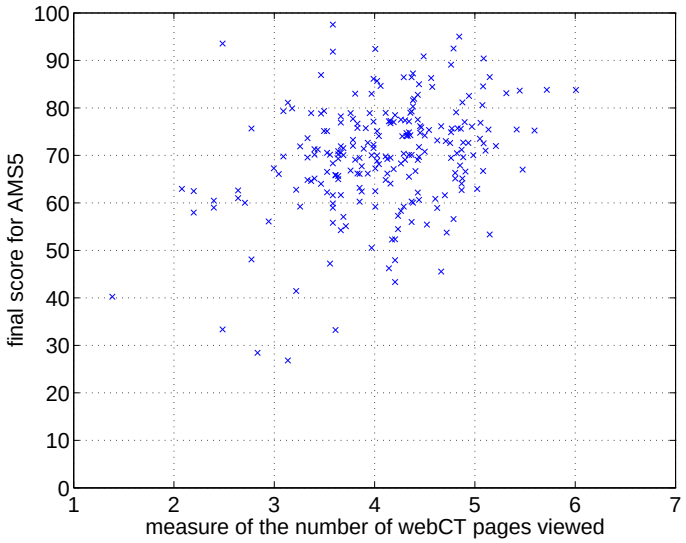
   Last quarter, the mean total score for the class was 69.6 and the standard deviation was 12.3. The distribution of total scores follows the Normal curve quite well.

   (f) The scatter diagram below shows total score vs number of webCT page views for the 235 students. The correlation coefficient is 0.27. Would it be reasonable to use regression to predict final score from the number of webCT pages accessed? Explain your answer.



[CONTINUED]

In the scatter diagram below I have plotted, for each student, their final score on the y-axis and a measure of their number of webCT page views on the x-axis[1]. The mean measure is 4.1 and the standard deviation of measures is 0.7. The correlation between final score and measure of the number of page views is 0.32.



(g) Students who looked at 150 webCT pages have a measure of approximately 5. What would you predict their final score to be?

(h) What would the RMS errors in these estimates be?

(i) What proportion of students who looked at 150 webCT pages would you expect to score 90 or more on the course?

[1]The measure is the logarithm of the number of page views, but that detail is not important for the rest of the question.

3. *(9 marks)* Instead of having sides marked with 1-6 spots, I have a set of four dice, where the sides are labelled as follows:

A	4	4	4	4	0	0
B	3	3	3	3	3	3
C	6	6	2	2	2	2
D	5	5	5	1	1	1

(a) I roll dice A and B. What is the chance that the number shown on die A is greater than the number shown on die B?

(b) I roll dice B and C. What is the chance that the number shown on die B is greater than the number shown on die C?

(c) I roll dice C and D. What is the chance that the number shown on die C is greater than the number shown on die D?

(d) I roll dice D and A. What is the chance that the number shown on die D is greater than the number shown on die A?

(e) I roll die C. You chose one of the other three dice at random. what is the chance that I roll a higher number than you?

(f) I chose a die and tell you it is die A. I roll it 20 times and tell you that the mean of the rolls is 2.4.

Do you have reason to doubt my claim that it is die A?

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An association between geomagnetic activity and dream bizarreness

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SUMMARY

Daily disturbances of the earth's magnetic field produce variations in geomagnetic activity (GMA) that are reportedly associated with widespread effects on human health and behaviour. Some of these effects could be mediated by an established influence of GMA on the secretion of melatonin. There is evidence from unrelated research that melatonin influences dream bizarreness, and it is hypothesised here that there is an association between GMA and dream bizarreness. Also reported is a preliminary test of this hypothesis, a case study in which the dreams recorded over 6.5 years by a young adult male were analysed. Reports of dreams from the second of two consecutive days of either low or high GMA (*K* index sum $\leqslant 6$ or $\geqslant 28$) were self-rated for bizarreness on a 1–5 scale. Dreams from low GMA periods ($n = 69$, median bizarreness = 4) were found to be significantly more bizarre than dreams from high GMA periods ($n = 85$, median bizarreness = 3; $p = 0.006$), supporting the hypothesised association between GMA and dream bizarreness. Studies with larger samples are needed to verify this association, and to determine the extent to which melatonin may be involved. Establishing that there is an association between GMA and dream bizarreness would have relevance for neurophysiological theories of dreaming, and for models of psychotic symptoms resembling bizarre dream events.

Introduction

> "I was stranded on a foreign coastline, with a monkey that spoke English and a woman that suddenly became small, almost doll-sized. Then I was at home..."
>
> –Author's dream, 22 May 1993

Bizarre dream experiences like this reflect events, characters, objects, thoughts, and feelings outside the conceivable expectations of waking life [1–3], and have been labelled "a distinctive property of the dreaming mental state" [4]. Dream bizarreness plays a key role in neurophysiological theories of dreaming (e.g. [5]), and is considered by some to be a useful model for certain neurological and psychotic symptoms [4,6–8]. Theories and models like these will be informed by identifying factors that influence dream bizarreness, one of which is hypothesised here to be geomagnetic activity (GMA).

The earth has a magnetic field, arising largely from motion within the planet's liquid core and commonly recognised as an aid to navigation. Probably less well known is that daily variations in GMA are produced by the solar wind, charged particles emanating from the sun, and which in extreme instances can disrupt power supply grids and radio communications [9]. Alterations in GMA can also have biological effects, not unexpectedly including a disturbance of the ability to navigate in animals that use the magnetic field for this purpose [10]. Of further interest are the reported associations between GMA and a vast array of human physiological and psychological variables, including blood pressure [11], immune functioning [12], epileptic seizures [13], hallucinatory experiences [14,15], depression [16], psychiatric hospital admissions [17,18], and suicide rates [19].

While the mechanisms are yet to be established, the hormone melatonin is potentially involved in many of the reported associations between GMA and human health and behaviour [13–16]; also see [20–22]. Melatonin is produced primarily by the pineal gland, and subserves a vast array of functions, most notably the regulation of bodily rhythms and the promotion of sleep. While melatonin secretion is regulated principally by the light/dark cycle, and typically maximal during the night [23], there is evidence for a supplementary influence of GMA, with more melatonin secreted when GMA is low than when GMA is high [24–28].

Arising from a widespread use of melatonin in attempts to treat insomnia [29] are anecdotal reports of this hormone producing weird or bizarre dreams (e.g. [30]). There is some scientific support for these claims, with melatonin found to alter the number of bizarre physical transformations of one thing into another in the dreams of young adults [31]. Considering this finding in relation to the influence of GMA on melatonin secretion leads to the hypothesis that there is an association between GMA and dream bizarreness.

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