be used for celestial navigation and that the positioning accuracy with it is good. In fact, we have obtained similar results in all other tests.[2,3]

4. CONCLUSION. The optimal estimating method described in this paper could make accurate celestial positioning possible in real time. If it is applied to a sextant which can obtain GMT and an altitude reading by pushing one or two buttons, a navigator who requires his position need only push the buttons when he observes the height of a celestial body and he will be able to get his position in a few seconds. In this way, celestial navigation will be more convenient, accurate, easy and reliable.

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## KEY WORDS

1. Astro. 2. Computers.

# The Cocked Hat

J. E. D. Williams

There is a BBC Open University statistics programme devoted to the 'Cocked Hat', which is long on legerdemain and shots of ladies with bearing compasses in a little boat,

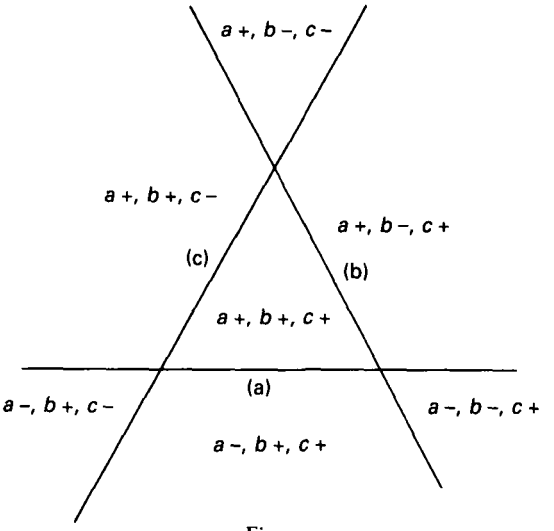


Fig. 1

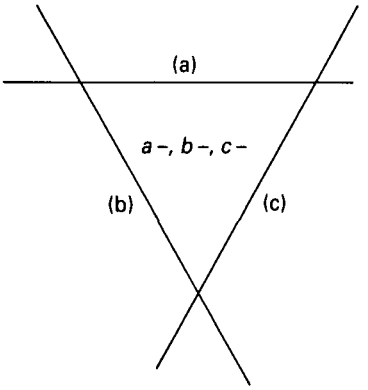


Fig. 2

| p | q | r |
|---|---|---|
| + | + | + |
| + | + | − |
| + | − | + |
| + | − | − |

Fig. 3

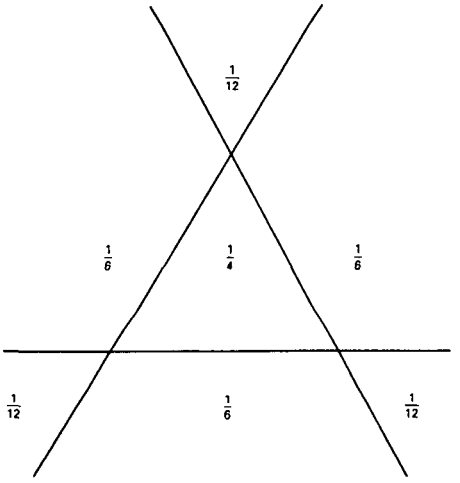


Fig. 4

but short on analysis. Viewers are told that mathematicians know that the probability of being within a cocked hat is only 25 percent, but that navigators believe they are usually within the cocked hat. That's funny: nearly half a century ago, when I was struggling to earn the appellation of navigator, my position always seemed to be outside the cocked hat and no-one was surprised. I soothed myself with something like the following, which I have never seen in print. It may edify the Open University and, despite the sad lack of ladies and boats, amuse readers of the Journal, all of whom have always known that their position is usually outside the cocked hat.

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If there is no information on the distribution of probable error, a position line of any shape simply divides the Earth's surface into two domains and the position is as likely to be in one as in the other. We may arbitrarily denominate them the + domain and the − domain. The three position lines in Fig. 1 divide the surface of the Earth into seven zones. We follow the convention that the triangle itself is the 3+ zone; every zone bounded by a side of the triangle is thus a 2+, 1− zone and each zone at a vertex of the triangle is a 1+, 2− zone.

The 3− zone is conspicuous by its absence. If the true position were in the minus zone of each and every position line as they have severally been labelled, the cocked hat would necessarily be shaped as in Fig. 2 and the position would be within it. The fact that the cocked hat has taken the form of Fig. 1 and not that of Fig. 2 tells us that, by our convention, the position is in the + domain of at least one position line. Given that we are in the + domain of one position line ($p$), and may equally be in either the + domain or the − domain of two other position lines ($q$, $r$), the four possibilities are shown in Fig. 3, but we have no idea which position lines correspond to $p$, $q$, $r$. Out of four, there is one chance that the position is in the 3+ zone, two chances that it is in a 2+, 1− zone, one chance that it is in a 1+, 2− zone and no chance that it is in a 3− zone. The probability of being in each zone is shown in Fig. 4.

KEY WORDS

1. Errors. 2. Statistics.

# Seamen's Accidental Deaths and Injuries Worldwide: A Methodology and Some Estimates

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1. INTRODUCTION. For many years Lloyd's Register of Shipping has published data on those deaths of seamen (and ships' passengers) reported to the Corporation of Lloyds as having occurred in total losses of ships. Apart from any under-reporting and errors that may have occurred (probably minimal), there is no coverage of other accidental deaths of seamen (for example, when their ships do not become total losses), and none of injuries. Lloyd's Register do, however, produce complete data on ship losses. The UK Department of Transport also produces full data of accidental deaths and injuries to seamen on UK-registered ships, as well as of the losses of ships in the relevant fleet. Both of these sources are regarded as thoroughly reliable. The ship loss data has been widely, if tacitly, used as a proxy for human casualties.

This brief paper uses these sources (see Table 1) to estimate seamen's accidental deaths and injuries worldwide and presents the preliminary results for discussion. Proposals are made to improve the results shown.

Accordingly, section 2 describes the methods used, section 3 presents the results using them and a final section draws conclusions and makes some suggestions for improving the estimates. Table 1 displays the raw data and sources employed.