**MA4605 Experimental Design**

**Experimental Design**

We are concerned with the analysis of data generated from an experiment. It is wise to take time and effort to organize the experiment properly to ensure that the right type of data, and enough of it, is available to answer the questions of interest as clearly and efficiently as possible. This process is called ***experimental design***.

The specific questions that the experiment is intended to answer must be clearly identified before carrying out the experiment. We should also attempt to identify known or expected sources of variability in the experimental units since one of the main aims of a designed experiment is to reduce the effect of these sources of variability on the answers to questions of interest. That is, we design the experiment in order to improve the precision of our answers. 

**Control**

Suppose a farmer wishes to evaluate a new fertilizer. She uses the new fertilizer on one field of crops (A), while using her current fertilizer on another field of crops (B). The irrigation system on field A has recently been repaired and provides adequate water to all of the crops, while the system on field B will not be repaired until next season. She concludes that the new fertilizer is far superior.

The problem with this experiment is that the farmer has neglected to ***control*** for the effect of the differences in irrigation. This leads to ***experimental bias***, the favouring of certain outcomes over others. To avoid this bias, the farmer should have tested the new fertilizer in identical conditions to the control group, which did not receive the treatment. Without controlling for outside variables, the farmer cannot conclude that it was the effect of the fertilizer, and not the irrigation system, that produced a better yield of crops.

Another type of bias that is most apparent in medical experiments is the ***placebo effect***. Since many patients are confident that a treatment will positively affect them, they react to a control treatment which actually has no physical affect at all, such as a sugar pill. For this reason, it is important to include control, or placebo, groups in medical experiments to evaluate the difference between the placebo effect and the actual effect of the treatment.

The simple existence of placebo groups is sometimes not sufficient for avoiding bias in experiments. If members of the placebo group have any knowledge (or suspicion) that they are not being given an actual treatment, then the effect of the treatment cannot be accurately assessed. For this reason, ***double-blind*** experiments are generally preferable. In this case, neither the experimenters nor the subjects are aware of the subjects' group status. This eliminates the possibility that the experimenters will treat the placebo group differently from the treatment group, further reducing experimental bias.