2. Answer the following questions:

(a) What is measurement bias?

For example, consider a researcher who wants to determine if optimization O is beneficial for system S. If she measures S and S + O in an experimental setup that favors S + O, she may overstate the effect of O or even conclude that O is beneficial even when it is not. This phenomenon is called ***measurement bias*** in the natural and social sciences.

(b) Why can changing the UNIX environment size change program performance?

This phenomenon occurs because the UNIX environment is loaded into memory before the call stack. Thus, changing the UNIX environment size changes the location of the call stack which in turn affects the alignment of local variables in various hardware structures.

(c) What are two of the suggested ways that can be used to avoid measurement bias?

The first technique***, experimental setup randomization*** (or setup randomization for short), runs each experiment in many different experimental setups; these experiments result in a distribution of observations which we summarize using statistical methods to eliminate or reduce measurement bias. The second technique, ***causal analysis*** [16], establishes confidence that the outcome of the performance analysis is valid even in the presence of measurement bias.

(d) Did you see any measurement bias with regard to link order in Homework 1?

Yes, the paper consider two sources of measurement bias, the second one is link order which affects code and data layout. To generalize these results, the median difference between the minimum and maximum points is 0.02 while on the Pentium 4 the median difference is 0.08. Thus, the measurement bias due to link order is significant: we can arrive at significantly different (on average 2% for Core 2 and 8% for Pentium 4, depending on our experimental setup.