Lecture 01.02 Operationalism, conventionalism, and realism

Mathematical measurement theory developed alongside another dimension of the study of measurement. This dimension is mostly concerned with the "reality" and meaning of measurement.

01.02.1 Operationalism

Most operationalists hold that the terms we apply to quantities—for instance, "duration" or "length"—depend essentially on the operations we use to measure them. In fact, one operationalist goes so far as to claim that

> *we mean by any concept nothing more than a set of operations; the concept is synonymous with the corresponding set of operations. (Tal, 2017)*

Implications include that using two different instruments—say a ruler and calipers—to measure what we would typically consider to be the "length" of the same object would, in fact, need to be described as two different quantity-terms such as "length-ruler" and "length-calipers."

logical positivism

Logical positivism—a now-defunct philosophical school popular in the 1920s and 1930s in Europe, the central thesis of which is the theory that only those statements that are empirically verifiable are meaningful[4]—initially embraced this view. However, as with positivism, operationalism was found to have many issues, including (Tal, 2017):

- operationalism seems to imply that a measurement is automatically reliable,
- meaning seems to apply beyond the strict criteria of operationalism,
- operational definitions cannot be applied to some useful theoretical concepts, and
- the concept of operation itself is ambiguous.

For these reasons and others, operationalism was outpaced by the approach we turn to next.

[4] This theory is called *verificationism* and is still to be found in public discourse. This is unfortunate because philsophers have long since abandoned it along with positivism.

01.02.2 Conventionalism

A sort of operationalism-lite, *conventionalism* says that many of the quantities we define, such as temperature, are conventional. Ernst Mach, for instance, claimed that there is no possible truth or falsity to the question of which thermometric fluid expands more uniformly because temperature intervals are defined in terms of the expansion of a thermometric fluid (Tal, 2017). This is called the *principle of coordination*.

principle of coordination

Logical positivists Hans Reichenbach and Rudolf Carnap used conventionalism alongside their verificationism (unverifiable statements are neither true nor false). A *coordinative definition* of an unverifiable statement like "a meter is the length of a standard rod in Paris" (Fieser and Dowden, 2017)—this is actually how the SI system used to define a meter. (Now the SI uses the definition: "the length of the path travelled by light in vacuum during a time interval of $1/299,792,458$ of a second" (The International System of Units, 1984).) These sorts of conventional definitions were used to supplement explicit definitions.

coordinative definition

01.02.3 Realism

Most realists argue that, independent of convention or belief or measurement instrument—that is, *objectively*—objects have some real measureable properties. These properies can include those that are psychologically measureable (i.e. some subjective experiences can be measured). They are typically considered to be *estimated* by a measurement process.

estimation

We find that ordering objects by length is a very repeatable process. Similarly, we find that concatenating objects "lengthwise" yields a repeatable composite length, regardless of the ordering. Realism posits that the best explanation of these phenomena is that some objects have the property that they can relate to other objects with the relations "longer than" and "is the sum of."

Note that this means that lengths share a structure with real numbers, which can be related to each other by the relations "larger than" and "is the sum of." Some realists even go so far as to claim that we can define numbers themselves as ratios of quantities.

It is difficult to describe how the concepts of measurement *accuracy* and *error* without some form of realism (looking at you, operationalists and conventionalists). For the realist, the error is easy to define: it's the difference between the estimate and the real quantity.

Mathematical measurement theory is generally palatable to realists. However, measurement theorists have largely ignored the realists (Tal, 2017).

Example 01.02-1 which ism?

Decide which of school of thought might affirm each statement.

1. "There is no such thing as an objective property, only measurement processes."
2. "Measuring is estimating."
3. "A watch and an atomic clock measure different quantities."
4. "It is customary to define pressure as corresponding height of a column of mercury, which is precisely what pressure is."
5. "Whereof one cannot speak, thereof one must be silent."
6. "Do or do not, there is no try."