

## Lecture 01.03 Information-theoretic descriptions of measurement<sup>5</sup>

*Information theory* studies information quantification, storage, and communication. Liberal use of it is made by *metrology*: the study measurement and measurement applications.<sup>6</sup> A measurement instrument can be considered an “information machine” that takes an input *state* of an object and yields an output *reading*.

information theory

metrology

Information theory provides metrologists with a mathematical apparatus for computing the amount of information in a given information channel, typically in terms of probabilities. This same apparatus can be used for measurement, where we consider measurement to be the communication of information from the state of the measurement object to the measurement reading. The analogy between information transmission and measurement is incomplete in that information encoded and transmitted is (in theory) known by the encoder, whereas information the object “encodes” and “transmits” via the measurement instrument is typically considered unknowable any other way.

This is an active area of research. A related, recent proposal is one by Bas van Fraassen that posits two levels:

- a *physical* level at which the instrument yields a reading of the state of an object and
- an *abstract* level in which measurement reduces the region in which a mathematical representation of the physical state exists in a state space.

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<sup>5</sup>See Tal (2017) for more information.

<sup>6</sup>Metrologists work for places like the US National Institute of Standards and Technology (NIST), research laboratories that develop precise measurements, and companies that develop precision instruments.