Measurement and counting are closely related:

- Both are subject to errors.
- Both involving sampling.
- Can use sampling techniques for both.
- In principle, both involve finitely many samples.
- (Classical) measurement involves potentially infinite samples.
- Can assign probabilities to each sample.

The tag cloud of words associated with probability theory:

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probability, sampling, counting, measurement, error, random,
entropy, stochastic/noisy, density, chance, likelihood, average, mean,
mode, median, standard deviation, variance, expectation, odds, gas,
liquid...
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What are the kinds of questions that one can ask (and hope to answer) using probability theory:

1. What is the probability that X will pass this course?
2. What is the expected number of 'A' grades in this course?
3. What is the probability that the Nobel prize will go to an Indian in the next 20 years?
4. What is the probability that there will be rain within one week?
5. If I invest Rs.10000 in the stock market today, what is my expected return?
6. Given a (radio) signal how can we decide whether it contains information or is all noise?
7. What are the characteristics of gases that make them different from solids and liquids?
8. We can "pour" sand, granulated sugar and rice grains. Is this different from liquids? How?
9. How do I generate a number that no-one is likely to guess in a million years?

We begin with discrete probability in which everything is finite (but could be large!). As we study larger and larger systems in discrete probability theory we will find it useful to:

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- allow infinite (or potentially infinite) "sample spaces"
- allow "random variables" to take infinitely many values
- take limits (recall MTH102!)
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This will bring us into the more general realm of “probability spaces”.

Let us begin with a simple example. I have 180 students (numbered s1 to s180) and 6 tutorial sections (numbered t1 to t6). How many ways can I divide the students into tutorial sections? (A standard “counting problem”.) Given the collection W of all possible such arrangements, one can examine the question of whether s1 and s7 are in the same section.

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- The collection W is called the "sample space".

- An element of W is called a "sample point" (or example == egg
  sample). We usually have in mind that a "random" sample point is
  the subject of our investigation.

- A question such as the one above called an "event"; we can think
  of it as the subset of W of sample points that give the answer
  "yes" to the question. We can also think of it as a property of a sample
  point.

- Probability theory assigns a probability (between 0 and 1) to the
  "chance" that a certain property holds for the sample point (that
  was "randomly chosen"); with 0 meaning (essentially) impossible and 1
  meaning (essentially) certain.
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This assignment of probabilities certainly depends on the *manner* of sampling. For example, if the sections were of equal size based on the registration number, some events would obviously be more likely than other (however, the borderline assignments would still be “a bit random”). On the other hand the sections could be assigned based one the grades in eaerlier courses and that would lead to a different “probability distribution”. Yet another method could be based on tossing a dice for each student. A second counting problem we can wonder about the different ways in which one can make this assignment; where we consider two ways to be the same if they result in the same probability distribution.