# Modelling Labware and Containers

The Production Software Team write bespoke Laboratory Information Management Systems (LIMS) that are used in the high-throughput sequencing pipelines at the Sanger Institute.

Below are descriptions of some of the characteristics of the entities that we model.

## Labware

- Can have a barcode,
- Can be comprised of one or many containers,
- Can have state - pending, started, passed and failed, which can be changed. Can move from pending to started and then started to passed or failed.
- Plate, Sample Tube, Library Tube and Flowcell are all types of Labware

## Container

- Contains none to many samples,
- Can have a location within a piece of labware,
- Samples can be copied from one container to another,
- Tags can be applied to all samples within a container,
- Cannot contain two samples with the same tag,
- May or may not have a barcode.
- Well, Sample Tube, Library Tube and Lane are all types of Container.

## Tag

- Must have a DNA sequence which can uniquely identify it (e.g. ATTGGCAT),
- Once two or more samples have had tags applied and have been put in the same library tube or well, they cannot be moved into another tube or well without all of the other samples that are in the same tube or well being moved with them,
- A tag can be applied to multiple samples

## Sample

- Must have a name
- Names must be unique
- Must be in a container
- Can have at most one tag applied to it

## Sample Tube

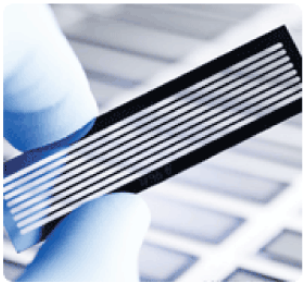
- Has a Barcode beginning with NT,
- Contains one sample only.


## Library Tube

- Has a Barcode begins with NT,
- Contains one or more uniquely tagged samples.

## Flowcell

- No barcode,
- Consists of two or eight lanes.



## Lane

- No barcode,
- Will have a state of pass or fail,
- Must have a numerical identifier (1..N) called position,
- Can contain one or more tagged samples.

## Plate

- A two-dimensional array of 96 or 384 wells,
- Has a Barcode beginning with DN.

## Well

- Must have a co-ordinate within a plate (A1, B6 etc.)
- Is similar to a library tube or sample tube but has no barcode.

## Tasks

Using either Ruby, Java or Python, write code that provides the following functionality: -

- Model all of the entities listed above
- Be able to create plates (and their wells), sample tubes and library tubes
- Add and remove sample(s) from a container
- Move sample(s) from one container to another
- Add tags to samples
- Search for a container by its barcode
- Obtain a list of samples (and tags) for a plate or tube

There is no need to consider persistence, so you do not need to create a database or use ORM, but you can if you want to.

If you want, feel free to complete the task using TDD or BDD.

Some of the requirements are ambiguous (just like the real world!) so you will have to make some assumptions.

It should be written assuming that the audience have no familiarity with the language / framework that you have chosen (i.e. it should be well documented or have a good runnable test suite or both!).