Indian Institute of technology Madras
Presents

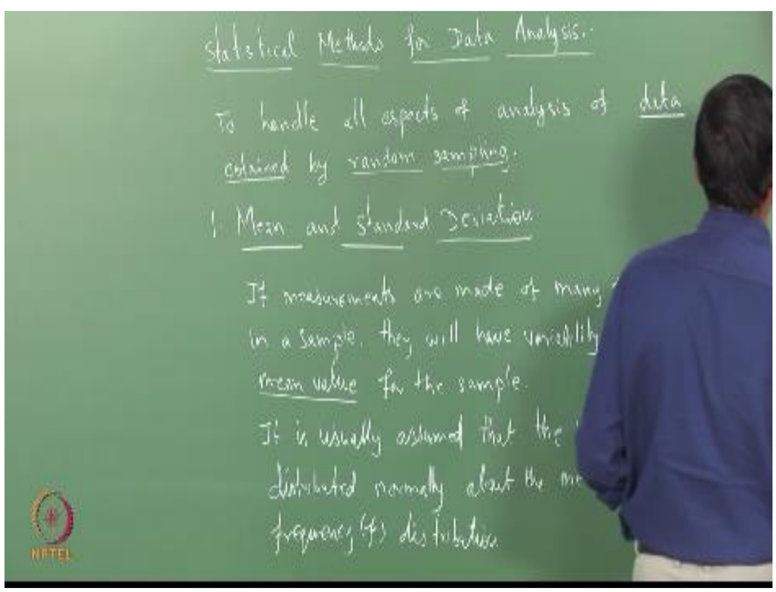
NPTEL
NATIONAL PROGRAMME ON TECHNOLOGY ENHANCED LEARNING

Tutorial-3
Materials Characterization
Quantitative metallography

Dr. S. Sankaran
Associate Professor
Department of Metallurgical and Materials Engineering
IIT Madras
Email: ssankaran@iitm.ac.in

Hello everyone welcome to this material characterization online course or Ns ny NPTEL in last two classes we have been looking at optical metallography or microscopy in the form of a tutorial classes I would like to continue this same thing today I would like to introduce some of the statistical methods in which we will be able to do some a quantitative metallography which I demonstrated in the last few classes so I will straight away start the this methods.

(Refer Slide Time: 00:50)



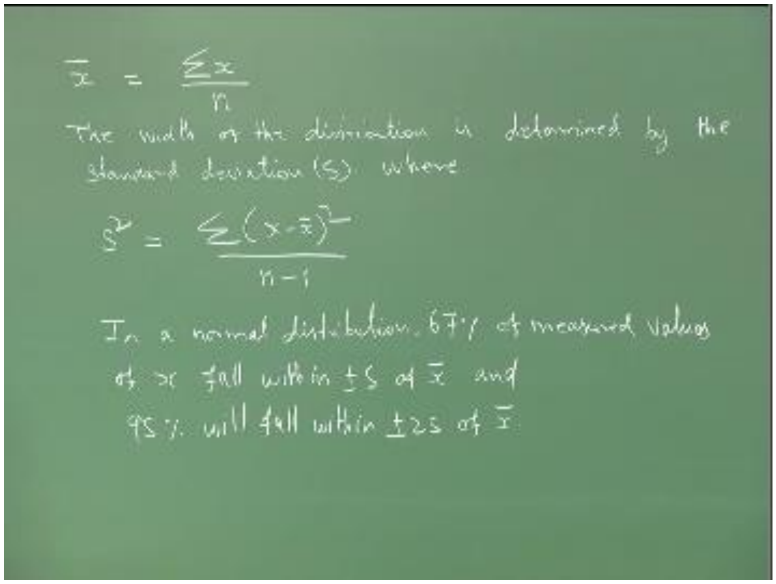
Okay we have to now just look at why do we need this statistical methods for example what I have just write here is to handle all aspects of analysis of data obtained from random sampling so what does it mean for example in the quantitative metallography what we have just discussed in the last class for example if you want to calculate the all in fraction of the second phase or a particle fraction in a matrix or if you want to just measure the particle size or the grain size and so on so you do the sampling.

In a random manner so any data which you obtained in a random sampling for example I mention that you have to do the sampling with the several micro graphs whether you will use it any prom whether it is a grained or a mesh so on so we will just look at the actual examples when I go to the next class but I will just briefly mention what are all the mathematical tools which are required to have the statistical analysis so that is the idea of this tutorial class so first one which comes in that category is mean and standard deviation.

You must all heard about this mathematical terms in your previous classes but now but then why we do apply these methods here is how to represents data which you obtained from the metallography measurements to get a quantitative information about micro structure so that is our primary in so unless you have this background so you will not appreciate when we actually go on work of the examples that is why I am just introducing this statistical methods briefly.

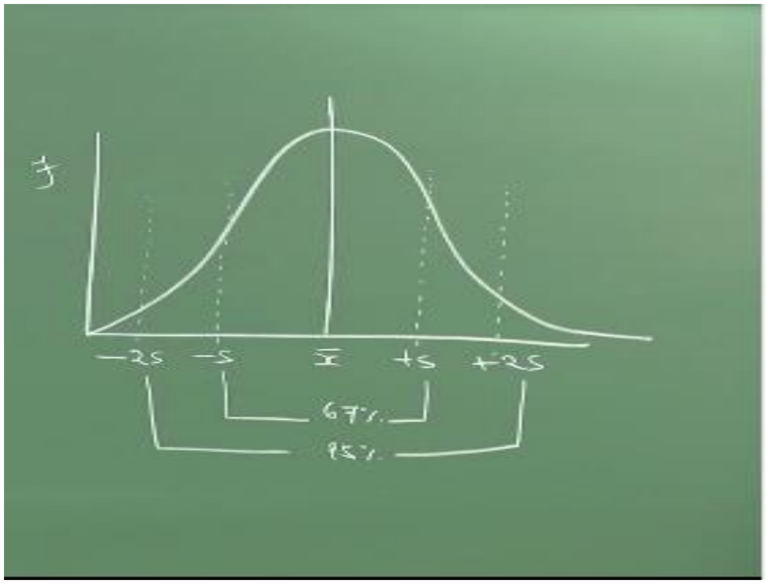
So what is mean and standard deviation I will briefly write, so the measurements are made of many features in a sample they will have variability about mean value for the sample what does it mean it means it is usually assumed. Assume the values so it is usually assume that the values x whatever it to may be measuring for many of the metallographic parameters like orstollogical parameters x or distributed and normally about the mean that is x bar to give a frequency f distribution so how to visualize this we will so let us try to write that is mean x bar is.

(Refer Slide Time: 08:16)



∑x/n and the bit of so the mean x bar = ∑x/n the bit of distribution is determined by the standard deviation S where S^2 = ∑x – x bar2/ n- 1 suppose if you in a normal distribution so what I have written here for a normal distribution 67% of the measured values of x fall within + or – S(xbar) and for a 95% of confidence level will fall within + or – of 2S of the x bar so we can plot this and then we can discuss about that so let us plot this what is that time seeing.

(Refer Slide Time: 11:44)



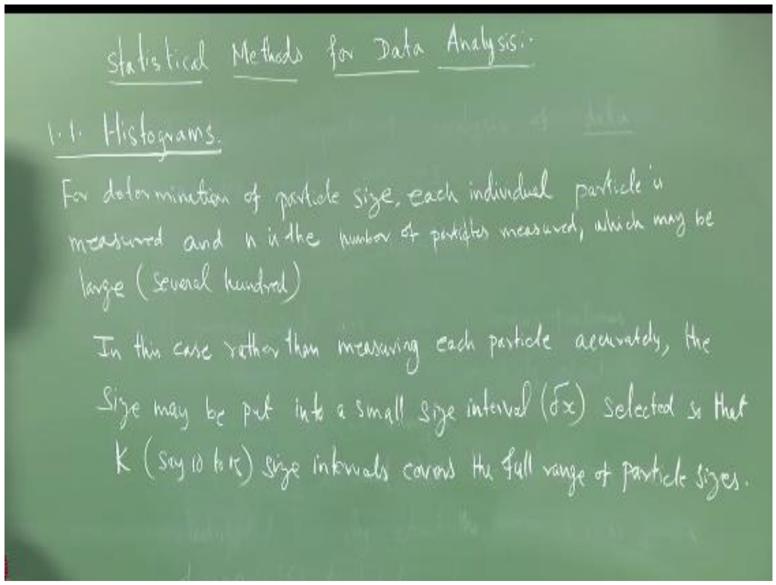
So we can plot this and then we can discuss about that so let us plot this what is the time seen. So whatever we have just written here we have just plotted this so the you have x bar which is the maximum which has got a distribution between ± x for a 67% of a confidence level ± 2s so this is how the distribution is mentioned here.

So how does this help in comitial metallographic for example if you want to measure the volume fraction of these second phase in a two phase material so you just use some of the traverse line across the a micrograph and then you just start counting the point which is intersecting or the number of features for unit line that also you will do random counting or random sampling and then which can be plotted with this kind of distribution.

So the one of the straight rule is suppose if you choose a random line for a traverse which is traversing the micrograph and you have to make sure that no 2 points are intercepts will fall the same features of the micrograph whatever we are interested to measure, so that is the statistical rule we have to make sure that the traverse line that is random line or well separated from the features which we are measuring.

That means you should not measure the same features twice so then the random sampling is valid and this can be represented by this simple distribution functions, so now we will just look at the other way of distributing the data called.

(Refer Slide Time: 15:26)

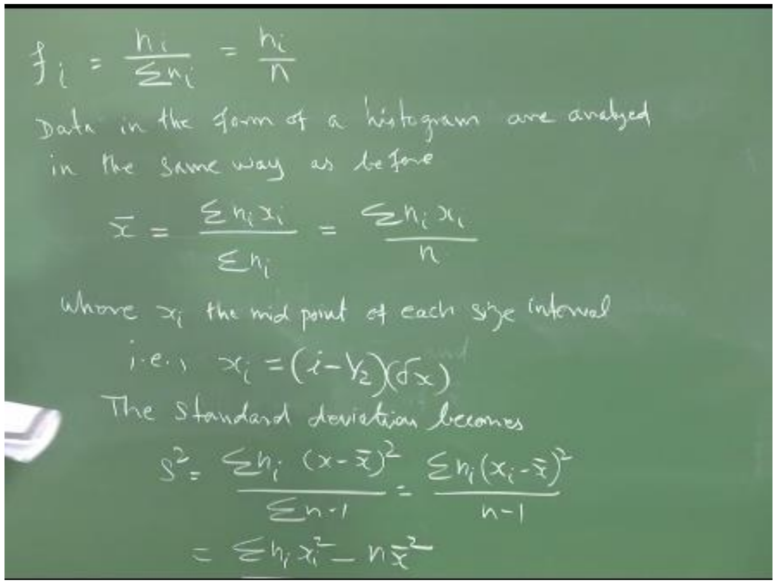


So what I have written here is suppose if you want to generate an histogram where you have the complete partially distributed in a matrix to measure the particle size and its distribution and so on the one tedious method of doing is, measure the particle accuracy and then start counting and put the sizes into different classes so instead of doing individual particle measurements you fix the range a small size intervals Δx.

Selected so that okay suppose you have K times that is say 10 or 15 so many intervals, the intervals number of intervals you can choose depending upon the size range you have for very small size to a big great big size or medium size and so on for example if you have 10 to 15 size intervals which covers the full range of particle size which is where in the micrograph, so you can choose that.

Then we can generate an histogram easily, so what we can do is, to approximate a normal distribution something like what we have seen before so a histogram.

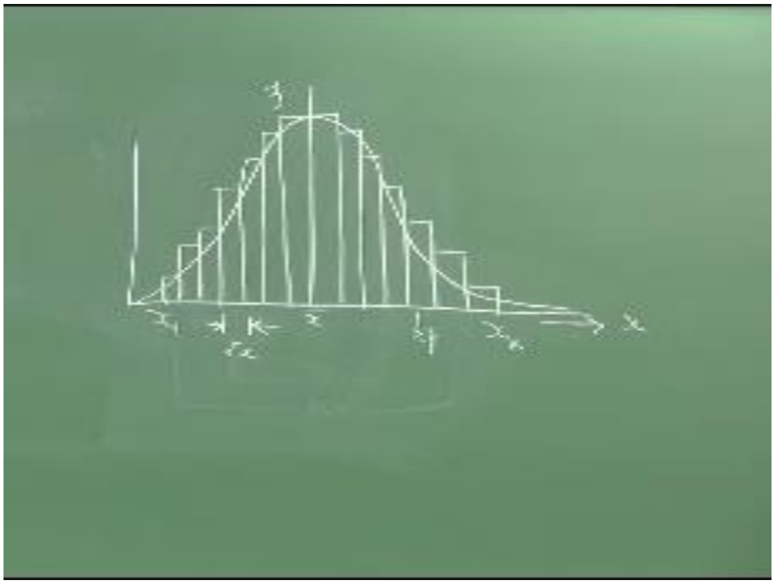
(Refer Slide Time: 21:40)



So what is that we have written here I said that instead of measuring a individual particle we can chose a size interval δx and if you plot a histogram it can be done by plotting number that is n of each size group x_i where i is the values of 1 to K, it can have for example 10 to 15 something like that and then you can write $f_i=n_i/\Sigma n_i$ which is nothing but n_i/n this n is the number in the each size group that is the n and so the data in the form of a histogram or analyze in the similar to what we have seen in the previous normal distribution so you can rewrite this mean $\bar{x}=\Sigma n_i x_i/\Sigma n_i$ which is nothing but $\Sigma n_i x_i/n$ where x_i is the midpoint of the each size interval that is $x_i=(1-1/2)(\delta z)$ this δx that is the size interval you have chosen δx is here.

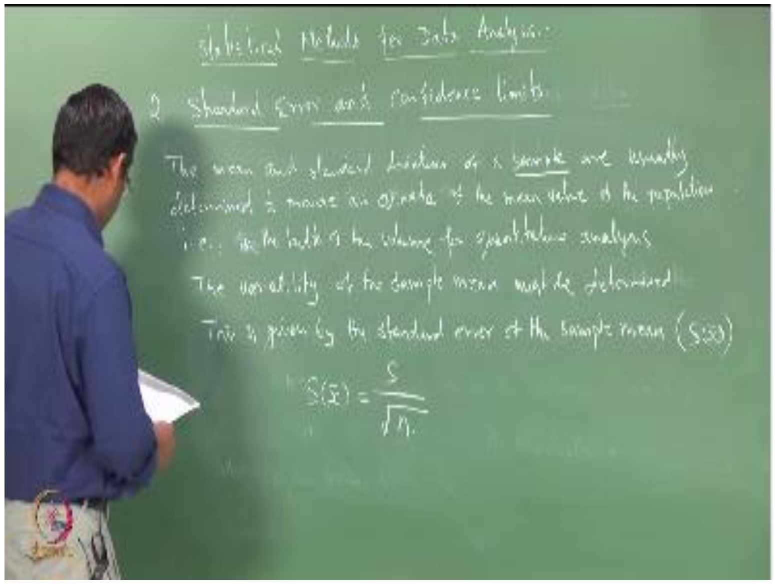
So then we can rewrite the standard deviation which is S^2 like what we have written similarly is equal to $\Sigma n_i(x-\bar{x})^2/\Sigma n-1$ which is nothing but $\Sigma n_i(x_i-\bar{x})^2/n-1$ which can be recessed like this $\sigma n_i x_i^2-n\bar{x}^2/n-1$. So this is what you will have if you choose to select a size interval to plot a particle size distribution in a which is having a huge size range, so how does it the plot will look like let us plot the histogram for just per a comparison.

(Refer Slide Time: 27:26)



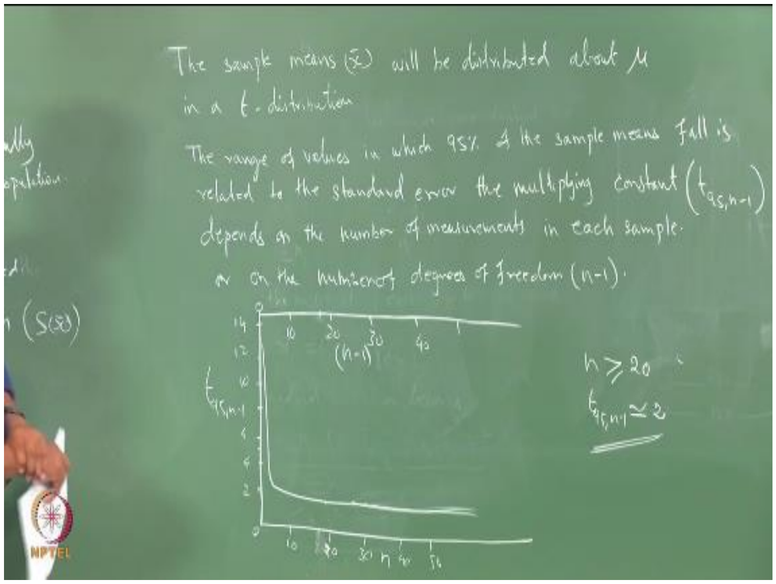
So this is how the histogram will be looking like so I have just super impose the normal distribution curve for the easy reference or we have done in the previous case here you see that x̄ and this is at random xi so you have the size range x1 to xk so you have this, so this is the δx size range you have chosen and this is how your histogram will be looking like if you choose to measure a particle size in a micro graph, so this is another technique statistical technique. So what we will do the next one is the standard error and confidence limits.

(Refer Slide Time: 30:23)



So we are just looking at the next parameters standard error and confidence limit, the mean and the standard deviation of a sample are usually determine to provide an estimate of a mean value of a population that is in the bulk of the volume for the quantitative analysis, so to do this the variability o the sample beam must be determined. So this is given by the standard error of, so we are trying to find out the variability of the sample beam so and this is given by the standard error of the sample beam that is $S(\bar{x})$ which is related to the standard deviation like this, so standard error that is s, $\bar{s}=s$ which is standard deviation divide by $\sqrt{n}$.

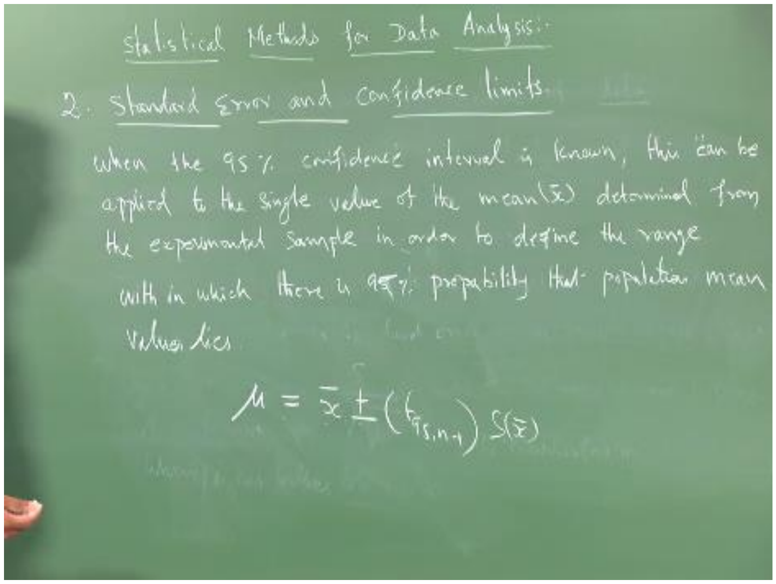
(Refer Slide Time: 35:18)



So what I have written her is we are talking about the sample means X bar we will be distributed about ~. The sample being itself distributed about ~ in a T distribution I will just show you what it this T distribution. And before that we will see that range of values in which 95% of the sample means fall is related to the standard here. The multiplying constant T 95 N – 1. Depending upon the number of measurements in each sample or the number or deals freedom, so this is what we realize so what now I do is in this plot the T 95 N-1. And you have small n so T 95 N- is a constant versus the number of measurements.

It will be so this is having 0, so what you can see is the dependence of T 95 n- on the number of measurements small n. you can see that and beyond, so beyond this 20 number of measurements it remains almost 2. So this is what this part is illustrating, so the standard error multiplying concept depending number of measurements to make that is small N that is this plot is given. And you can say that,

(Refer Slide Time: 42:09)



So what I have written is when the 95% confidence interval is known and this can be applied to this single value of the mean X bar. Determined from the experiment sample in order to define the range within which 95% of probability mean lies. Which can be written like ~ X bar + or – into T 95 N -1 into S into X bar. This is standard error and this is the multiplying constant and this is the population means. So this is how we have to look at the confidence limit. I will just continue this few more parameters and then we will actually apply these techniques basic metro graphic. Examples in the next tutorial class thank you.

IIT Madras Production

Funded by

Department of Higher Education

Ministry of Human Resource Development

Government of India

www.nptel.ac.in