Applied Time-Series Analysis
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Lecture – 30
Lecture 13B - Autocovariance & Autocorrelation Functions-5

Now, all of this is this how if the history began more. It is only in Hines side now we put things in perspective and say things look like this; however, while veneers started off with this kind of forecast and Kolmogorov have started off with the different kind of forecast expression, both of them converged to this kind of a setup. You can say either veneer or veneer school of thought or Kolmogorov of Kolmogorov school of thought both of them converged to the same set up that you see on the board and then they ask a question which or what class of random processes can be expressed as this white noise passing through some kind of a filter.

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We will understand this filter term later on when we go through the frequency domain descriptions, the term filter will become a lot more obvious, but that was a question that was asked can I bring any random process in this frame work and the answer was no you cannot; you can bring a large class of stationary processes only into this frame work to begin with and that to not all stationary processes there are some restrictions, but by and large a lot of stationary processes come in to that class which can be given this kind of a representation and that result is known in the form of the celebrated spectral factorization result.

But we will not go in to that as the result name itself suggests, we need to be conversant with the notion of spectra or spectral densities and so on. So, it is bit early to talk about that result, but this preface is necessary for us to get into the world of models and remember when we decided to study ACF, apart from thinking of it as a measure for predictability we also said we will use it to figure out what kind of models are appropriate.

We look at the signature I showed you some examples right and we do some differences, but apart from that we could not go further, but now is the time to turn to that and carry out something theoretical study, what we will do is we will study two class of models that belong to this class here known as the moving average and the autoregressive models and ask if the model is if the process is of a moving average type, then what kind of signatures does it leave behind in ACF you know when I am of a particular nature I would sign in this way there is a whole signs behind handwriting right just base on the signature there are people experts who can actually build on the characters you say if this person is of this type and so on.

Likewise in time series we look at the ACF signatures and try to guess what model is appropriate, but at in all situations we should remember this is only a mathematical abstraction keep that in mind any questions yes.

Student: Sir if can we can use (Refer Time: 03:25).

It is embed it can be easily estimated. So, given one realization you can estimate it easily; you cannot you will not be able to compute the theoretical one because you need the full ensemble, but given one realization I can easily estimate it with fairly good degree of reliability right. So, that is a good question because that also makes the question why cannot I look at any other measure of dependence right and I can in fact, for non-linear processes there are a number of measures available, for linear process you do not have to turn to any other measure apart from correlations sometimes you may have to depending on whether you expect to see out layers in your data right then you use still ACF can be used, but then you will use robots estimates.

But that is one of the criteria in selecting a measure of linear dependence whether it is linear or non-linear, whether you can estimate it fairly easily and that was also the argument for based on which we discarded the direction of periods right, we said joined periods are very difficult to estimate, so let us not get in to that, let us work with movements. So, this is nothing, but a second movement and fairly easy to estimate. So, now yes.

Student: So, when we try performing regulation on past observation are we trying find the train but also you saying that processes stationary.

Yes.

Student: So.

What do you mean by trend you have to use now you have to be care very careful when we use certain technical terms what do you mean by trend?

Student: So, you are trying find a relationship let us say a better line on previous observations and then use that line to predict what will happen in the next instant.

No. So, so for the benefit of the students who are sitting in other hall my ta or the ta as actually given me another word of advice, which is that please repeat the question that the student as asked and the question is that by fitting regression model like this whether we are fitting a straight line or some kind of a line and there by violating the assumption of stationarity and the answer is no, we are not fitting any straight line at all we are there is there is no the kind of trends that we talk about in non stationarities are explicit functions of time, here they are functions of the process is a function of itself.

But your point is well placed in another sense; in the sense that there is no guaranty that always this model will produce the stationary series, one we will when we discuss autoregressive models bit more in detail, we will talk about the constraints that one as to place on d 1 and d 2 so as to guaranty stationarity; but there is no connection with this and trends that we spoke of in non stationarities, we are not fitting a straight line here, but yes there are constraints on models; that means, not all the models of this type are admissible for stationary processes there are some restrictions that we have to place on those coefficients, so as to ensure that vk is stationary, but it is a bit early to talk about it.

For us right now we want to ask if the processes for example, can I look at the ACF and conclude that this is the process or there is some other process that is generating and that is the question that we will now study right and in today's and tomorrows lectures any other questions.

Student: Sir.

Yes

Student: Should not (Refer Time: 07:06) also dependent and also estimated we use. So, we use the (Refer Time: 07:11) depends only on the randomness (Refer Time: 07:13) but how good or estimated will also play a role (Refer Time: 07:13).

So the question that is being ask is whether e k depends on the estimate that we employed right now again that question actually is not so well posted because there is confusion between theory and practice, at the moment we are only talking about theory right the only estimate in fact this is not an estimate it is a prediction, we are studying this theoretical case where infinite observations are available d 1 is kind of known and so on. So, all we are saying is this is e k is theoretically it should be the residual whatever is left out if I am given infinite observations, my model should be such that theoretically the residual as white noise characteristic.

At the moment we are not using the estimates of this coefficient, we are not working with an estimated model; when we use model estimates then your question is valid that the e k will depend on estimate of course, whether it as white noise characteristics are not depends on whether the model that you have fit first of all if the structure is appropriate for the process and secondly, whether the estimates have been obtained in optimal ways, so as to produce a white noise series; but that is basic premise in actually estimating a model correctly, those are the two basic guidelines among the many that we use to figure out if you have estimated the correct model or in appropriate model there is nothing like a correct model.

When we learn how to model, once we have fit a model in the first round iteration we will use that, we will ask that if the residual as white noise characteristics; if it does not then; that means, my model structure is not correct possibly when I have to go and refine my model, but that is also part of the game when I do not know the model, we are saying regardless of what the model is ideally this is how things should be and this now sets the bench mark or they gives us the guidelines for identifying the correct model structures. So, at this movement we are not turning to estimates at all, we are not using estimate we are just talking about the we are still living in a theoretical world of course, occasionally I am directing you to routines in r that will allow you to estimate because in a slowly you should be familiar with the routines, the theory of estimation will come bit later.

Any other question; so let us move on and now look at how the ACF actually looks like for different processes, but before I do that just some kit bits about by white noise processes.

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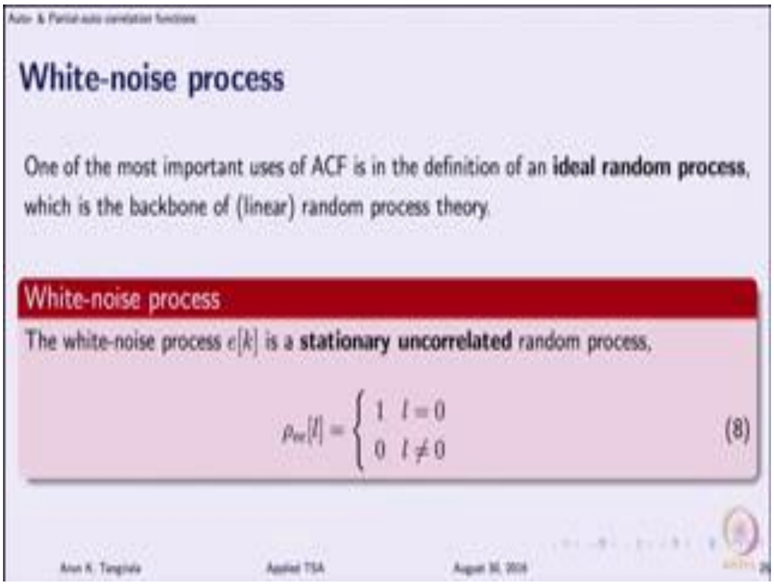

The definition of white noise, if you look at it does not impose or assume any distribution, it does not say that the white noise process should followed out of a Gaussian or a uniform or a chi square or nothing like that, it simply says the process should be stationary and uncorrelated that is all. So, there is no imposition on the distribution therefore, one can have a Gaussian white noise, one can have a uniform white noise and so on, in practice we work with Gaussian white noise.

And because that has some very nice properties and also the linear random processes are kind of in the Gaussian white noise frame work and many other reasons why you are seen the Gaussianity assumption is popular. In fact, as I said there is a process which is much more stronger version of white noise which is a IID process.

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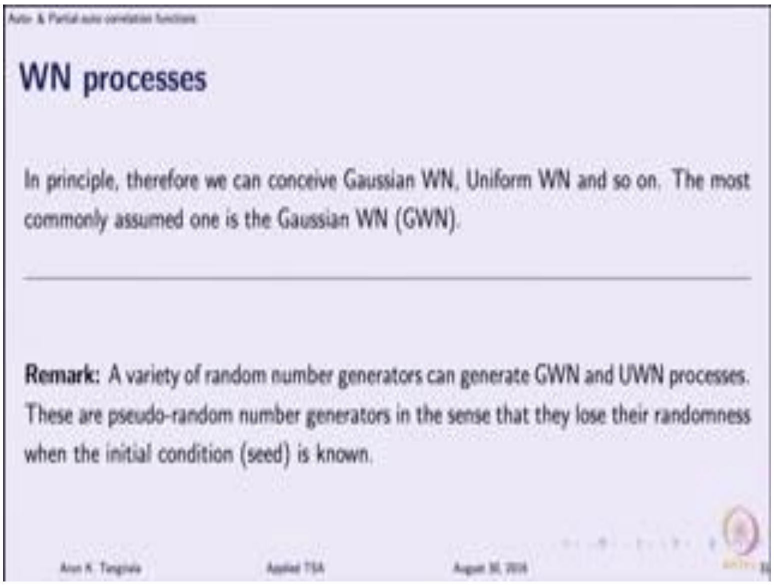

A Gaussian white noise processes in fact, an IID process because we know that when two variables have a joined Gaussian distribution, what do you mean by Gaussian process? You should understand what do we mean by Gaussian process? I pick any set of observations of the random process they should have joined Gaussian distribution, any I pick a pair they should followed of a join Gaussian, I pick hundred observations they should follow out of join Gaussian. So, all the observations and in fact, follow should follow out of a Gaussian process and Gaussian white noise is where the variable the observations are uncorrelated, the process is now kind of is purely uncorrelated there is no assumption on the independence.

So, of course, you have a verity of random numbers that a generators that we work with depending on the software, they are actually pseudo random number generators you should remember that the r norm that you are using or something else that you are using for random number generators r norm if you look at that routine, it randomly samples they varieties from a Gaussian white noise process you can think of it that way or from a Gaussian distribution whichever way. The other way of remembering a white noise processes that time ordering does not matter, you can shuffle the white noise process and still have a white noise process.

What we mean by shuffle is the time stamps. I can rearrange the time indices and still the white noise properties preserved same is not true for a correlated process; obviously, you they are under the timing instance we are breaking the internal correlation of course, now that idea is used in boots trappings and surrogate data analysis and so on, we would not go in to that right.

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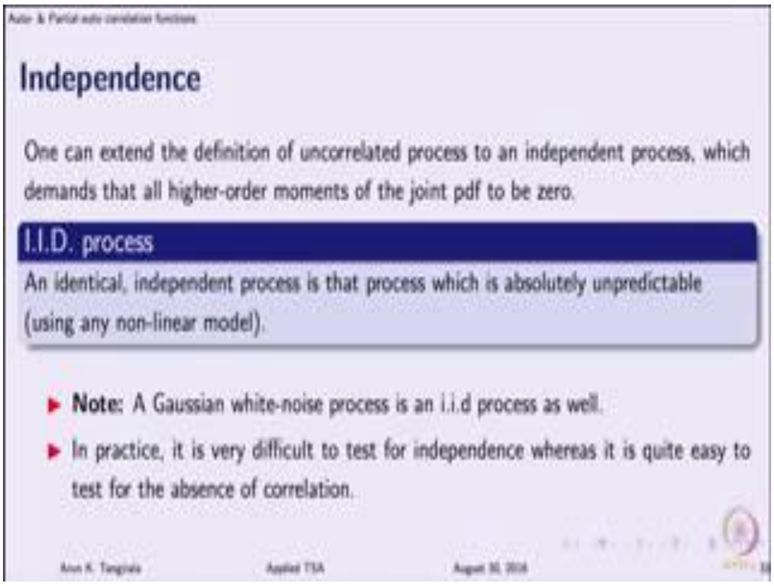

So, as I said IID process is the stronger version of white noise process, where independence is assumed and a Gaussian white noise process is IID. So, in some sense it is safe to work with the Gaussian white noise process from this view point as well. So, the bottom line is we will always assume unless otherwise stated the white noises that we encounter, that we assume are all Gaussian white noise processes unless otherwise explicitly stated.