

Chapter 1.3: Randomness, Probability and Stochastic

Chapter 1.3.1: Some Basic Definitions

But it's time to talk about real randomness now, randomness, which we can add to the networks, that we have build so far.

To get at least a whiff of a systematic approach to the surprisingly huge amount of techniques and modules wearing the word "random" in their names I'd like to make some musically useful definitions before jumping into patching and patches. On the following pages I'll call a process "**completely random**", when the probability of all technically possible next events is equally high (or low), and any prediction of what's going to happen would be nothing else than guessing like guessing numbers at a lottery. "random" doesn't even mean "changing". To give an example: the successor of a pitched note event in a (completely) random process can be the same pitched note event again, as well as a note of any other pitch. "Completely random" means: I cannot exclude anything, that's technically possible – not even 100times the same event in a row. Even if the probability of hearing 100times the same pitch of a note in a row in a random process is quite low – I cannot exclude the possibility that it happens.

If there are borders, if I can exclude certain goings on, then I'll call it "**limited random**". When I use a quantizer to limit the occurring pitches (to stay with the aforementioned example) to a certain scale, but the successor of a note can be any note (included the same note again), then we have limited randomness (you may even call it "tamed" randomness though).

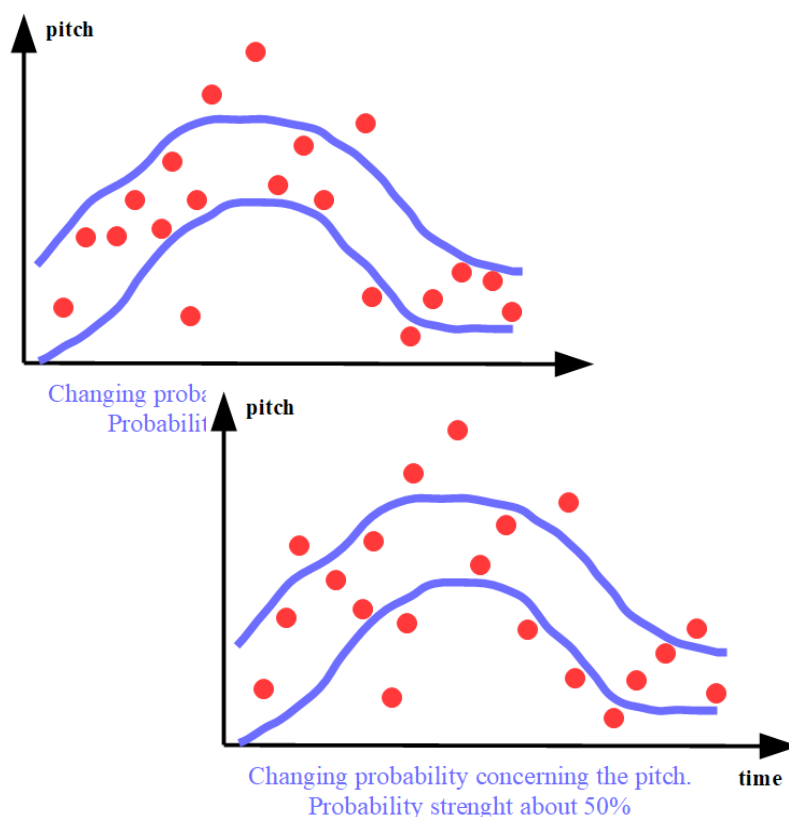
In probability theory the terms "random" and "stochastic" are used interchangeably, but I'm going to give them slightly different meanings in this book. I call a process "**stochastic**", when the probability of the occurrence of certain events is higher or lower than the occurrence of other events. If e.g. the occurrence of the note G5 in a scale is set to double (or 2 or any other number - depending on how the module, that I am using calls it), this note G5 will occur twice as often as any other note in the scale -

when I am patient enough to wait for a long time and to let a high enough number of events going by, because I am still not able to predict, WHEN G5 will occur.

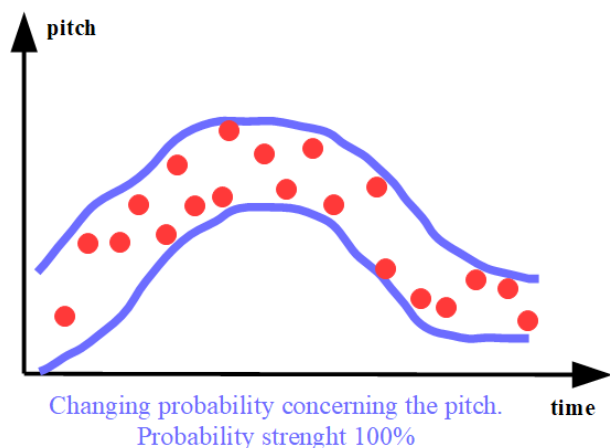
The last example shows, that a limited random process can be a stochastic process as well: I limit the number of possible note events to a certain scale, AND influence the probability of a certain note in this scale. I think it's self-evident, that a probability of 100% means no randomness at all.

An interesting method is using “**probability masks**”.

This means creating developing/changing probabilities. I could – just an example - modulate the probability of the occurrence of lower frequencies or higher frequencies. To avoid a misconception: I don't mean setting developing (changing) limits, but changing probabilities. Probability masks play a huge role in granular sound processing and granular compositions (see my ebook “In the World of Grains – Part 1”). The following graphs show examples of a random process, that produces different pitches. It's a stochastic process (in the meaning of my aforementioned definition) with an overlaid probability mask. The pitches of the occurring notes lie more and more in higher pitch regions at first, but develop to lower pitch regions after some time. Nevertheless, there are still a number of pitches outside the regions, which is defined by the probability mask. How many pitches lie outside the mask depends on how high/low I have set the probability, how “strong” the probability is set.



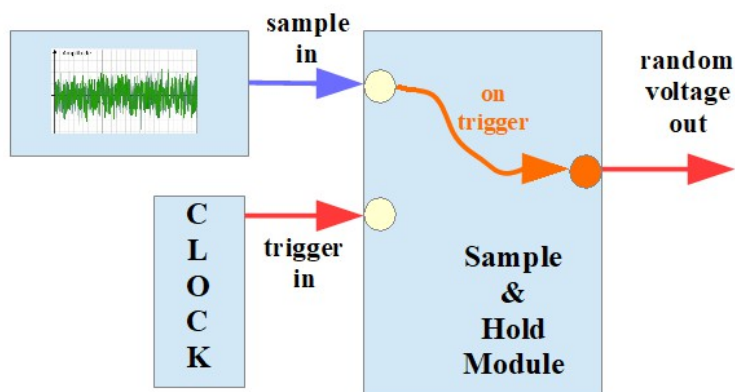
With 100% probability of the occurrence of pitches within the blue borders we have a **limited random process with changing limits**.



I'll return to these more basic (and a bit theoretical) aspects later in the chapter about compositional aspects, but now it's time to make some sounds and do some patching.

Chapter 1.3.2: Sample & Hold

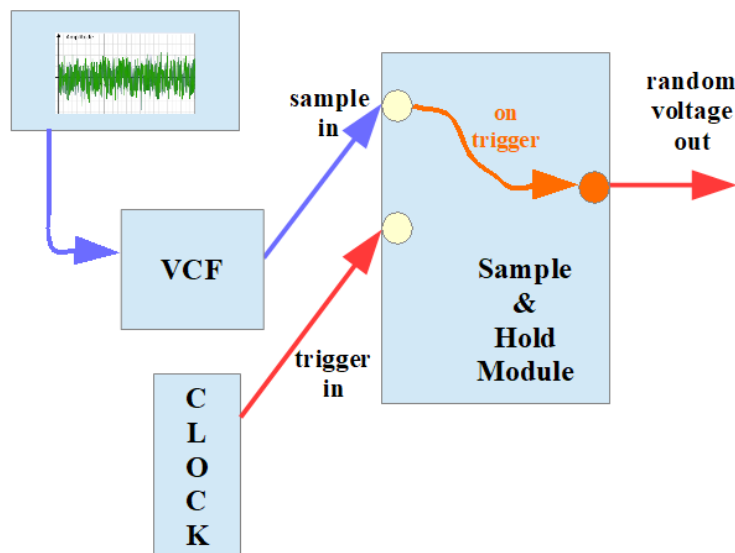
It might not seem to you, but there are some aspects of using sample & hold techniques, that a remarkable amount of people are not aware of. The "classic" set up reads "patch white noise into the S&H unit, which is then triggered by a dedicated clock generator or LFO". The values, that the S&H unit gives out are completely random (the limitation to voltage levels which normally/mainly don't allow to cross the borders of audibility are not of any musical meaning - I call it "completely random" therefore).

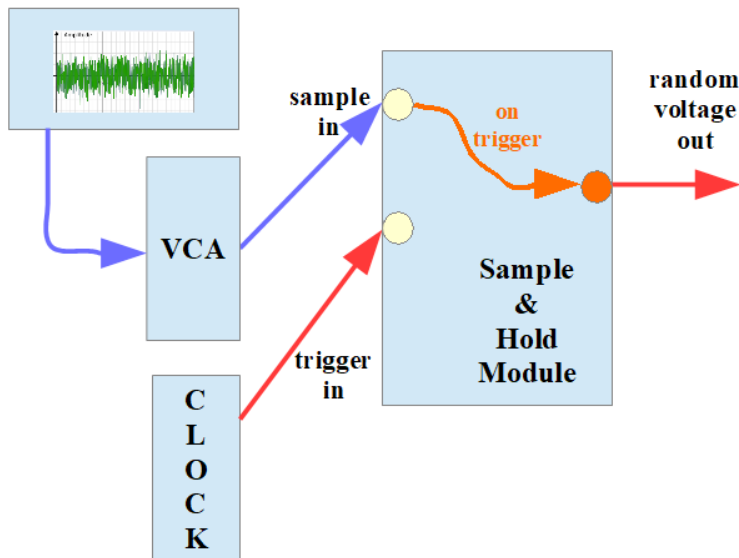


These random voltages can be used anywhere in our networks, either as additional components or substituting any of the aforementioned network components, e.g. to randomly change the frequency of an LFO or to randomly take a sample by a shift register etc. As long as I use unfiltered white noise as the source for the unit to take samples from, things can be quite nice and fun but not really exciting.

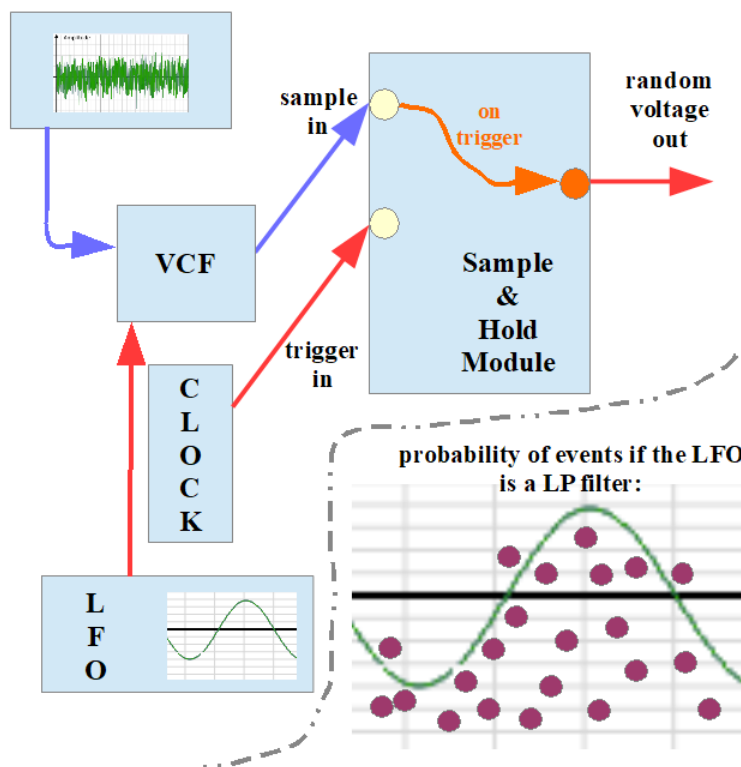
Things get more interesting when I start filtering the white noise before I feed it in the S&H unit. And as even filters with quite steep filter curves (e.g. 48 dB) don't completely cut off at the cut-off frequency, we get a stochastic process. With a low-pass filter e.g. the **amplitudes** of higher frequencies get lower the farther they are above the adjusted filter frequency – and so do the randomly sampled voltage levels. Or – in other words – the probability of higher CV outputs of the S&H module declines.

But when I limit the amplitudes at all by applying a VCA (between the source of the white noise or between the output of the S&H module and the “rest of the world”) then I get limited random processes, as I completely exclude high voltage levels.





The preset “SuHone.vcv” (only available in the book, see <https://dev.rofilm-media.net>) and the video behind the following link demonstrate these situations. <https://youtu.be/tFCuO2Bd3nk>



Let me return to filtering.

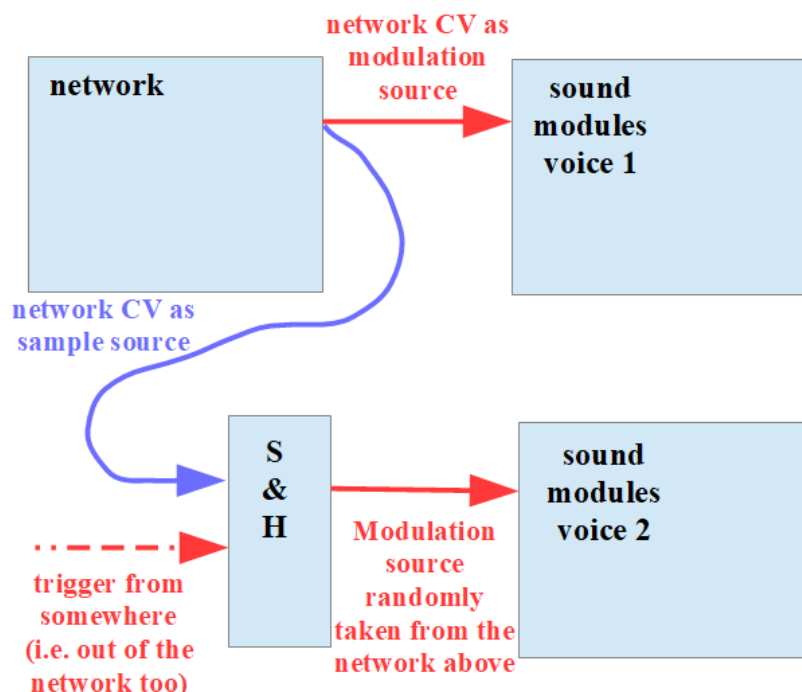
When I modulate the filter’s cut-off frequency I create a probability mask. The preset “SuHtwo.vcv” (only available in the book, see <https://dev.rofilm-media.net>) and the video behind the following link show an example.

<https://youtu.be/AnovCRNls3g>

But don't be mistaken: the reason for less higher notes being in the resulting random succession of pitches is NOT the missing of higher frequencies in the spectrum of the noise, but filtering certain frequencies out means there are simply less higher amplitudes in the spectrum as a whole, which means the probability of sampling a high amplitude, a high voltage level is reduced.

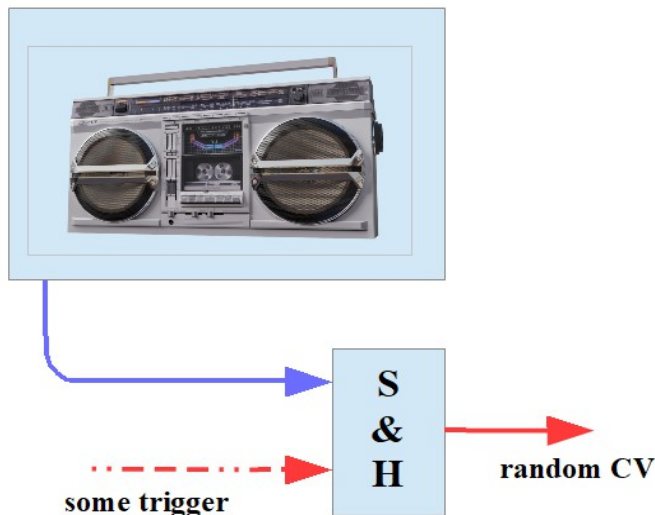
But white noise (or noise in general) is not the only source a sample and hold unit can take samples from. We can of course take the output of an LFO network and sample its voltage levels. Depending on the structure of the network we get again completely random sequences or limited random sequences or stochastic developments. The sampled network can serve as a modulation source (like in the last sub-chapters) and as a source to take samples from at the same time. The graphic shows the principle, and the preset "SuHnet.vcv" (only available in the book, see <https://dev.rofilm-media.net>) is an example, which sets up on the preset "complex_1.vcv" mentioned in chapter 1.1. The video behind the following link demonstrates this preset and gives further explanations.

<https://youtu.be/lm2rk5P8BaU>



Another interesting source to let the S&H module take random samples from are recordings of anything you can think of: recordings of your own music, recordings of CV developments, field recordings etc. And if you

make recordings especially for being used by S&H units, you can take care of special amplitude distributions. For example you can record rather low amplitudes with some high amplitude peaks here and there (or the other way round), or you can make the amplitudes rise and fall in certain ways. Planning your recording lets you gain either completely random sequences from your S&H unit, or limited randomness or stochastic sequences. Or you can lay the foundation of probability masks.



You can even use the S&H unit to analyse your existing recordings in a very special way - if you think it might bring some insight :-). Patching the output of a sample player module to the input of the S&H unit we can make use of the full playback functionality of the sample player (looping, ping-pong playback, changing start point and endpoint, random jumps etc.) while the S&H module is taking random samples. The preset “SuHfield.vcv” (only available in the book, see <https://dev.rofilm-media.net>) and the video behind the following link show more details about the matter.

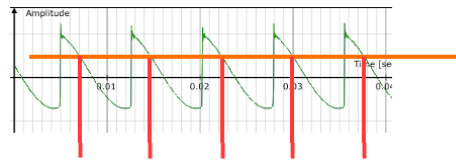
<https://youtu.be/ksFMZmadbiA>

Using simple regular waves as sample sources brings the relation of the two participant frequencies into the centre of our attention. Let’s feed a saw wave of the frequency F_{saw} in the S&H unit, which is triggered at a frequency of F_{trig} . The relation

$F_{\text{saw}} : F_{\text{trig}}$ determines, if I get a regular arpeggio following the slope of the saw wave, or a quite unsorted but at least kind of regular sounding succession of CV, or a rather regular arpeggio with some irregular CV

levels here and there.

With $F_{\text{saw}} = F_{\text{trig}}$ there is no CV change at all at the output of the S&H module, because the regular -e.g. a saw wave – sample source is caught at always the same “point” in its development by the trigger.



Trigger pulses

Choosing a non-integer frequency relation and modulating the trigger frequency at a not too fast rate, we can make the resulting CV sequence (slowly) walk in and out of regularity. The preset “SuHreg.vcv” (only available in the book, see <https://dev.rofilm-media.net>) and the video behind the following link show some examples.

<https://youtu.be/31UK3exwhbw>

...to be continued