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HARALD NIEDERREITER AT 70

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Abstract. The present volume of UDT is devoted to Harald Niederreiter on the occasion of his 70th birthday. It is a really great honour for us to give as an introduction some few facts about his career and the outstanding achievements in his mathematical research. On this occasion we cordially gratulate him and wish him all the best.

Let us start with some biographical facts

Harald Niederreiter was born on June 7th of 1944 and grew up in Salzburg. He studied mathematics at the University Vienna and finished his studies in 1969 with a PhD thesis under the supervision of Edmund Hlawka and with a "promotio sub auspiciis praesidentis", that means, with the highest possible distinction.

After this he moved to the United States where he had positions in Illinois and in Princeton and afterwards to Jamaica where he became professor for mathematics in Kingston.

In 1981 Niederreiter returned to Austria and became director of the Institute for Information Processing and then of the Institute for Discrete Mathematics at the Austrian Academy of Sciences and honorary professor at the University Vienna.

Niederreiter again left Austria and moved to Singapur as professor of Mathematics and Computer Science from 2001 to 2009 and then, one year later, as professor at the King Fahd University in Dhahran, Saudi Arabia for one further year.

Since his retirement in 2009 he is located at the Johann Radon Institute for Computational and Applied Mathematics of the Austrian Academy of Sciences in Linz and at the mathematics department of his hometown Salzburg.

Harald Niederreiter – without any doubt – is one of the internationally most distinguished and influential Austrian mathematicians. He is listed among the worldwide most highly cited authors in Mathematics by the Science Citation Index and he has an enormous work of more than 350 scientific publications and various books. Probably the most famous one, usually known under the short term "Kuipers–Niederreiter" certainly was and is the Bible for any research on uniform distribution of sequences.

In his work he gave most important contributions to the fields of number theory, algebra, complexity theory, discrete mathematics, numerical analysis and cryptology, and with his pioneering work on low-discrepancy point sets he has essentially influenced the development of the field of quasi-Monte Carlo methods.

Niederreiter is a full member both of the Austrian Academy of Sciences and of the German Academy of Natural Sciences Leopoldina, he is a fellow of the New York Academy of Sciences and of the American Mathematical Society, and he is appointed distinguished member of the Austrian Mathematical Society. Further he is a member of the Editorial Board of 18 international mathematical journals.

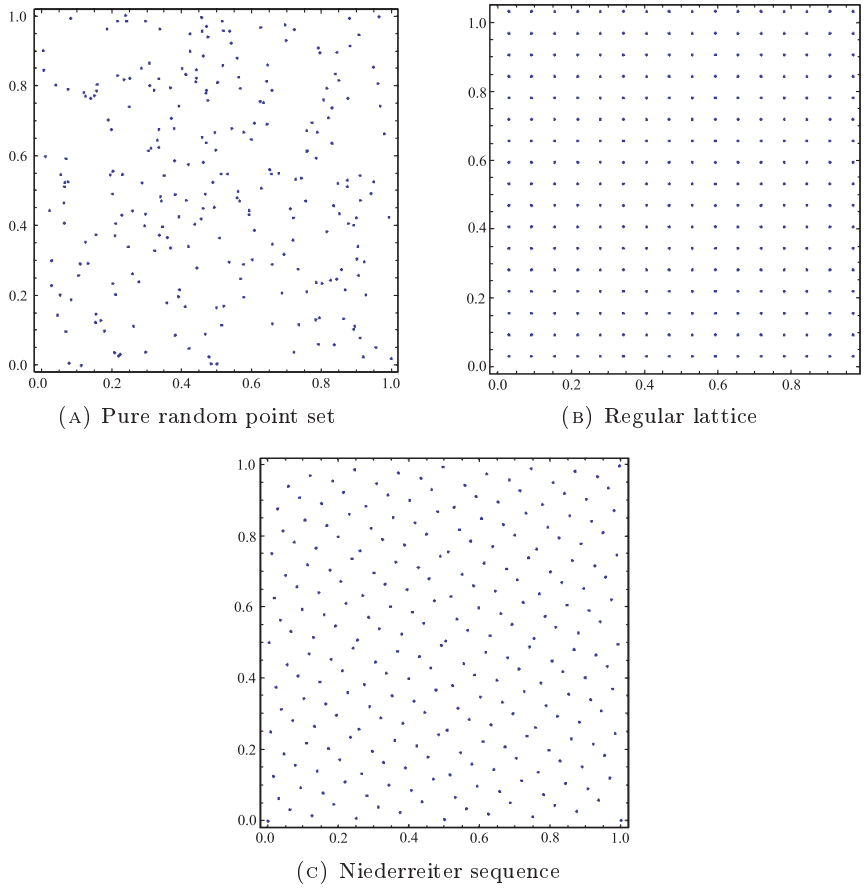
Of course, Niederreiter also was awarded several scientific prizes and distinctions, we just mention one example: Niederreiter was invited speaker at the "International Congress of Mathematicians" in 1998 in Berlin.

In the following we want to give just a very first impression on one of the most important facets of Niederreiter's work:

In April 2014 the 11th International Conference MCQMC 2014 on "Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing" took place in Leuven, Belgium. It is no exaggeration, to say, that in at least 50 percent of the presentations at this conference the concept of Niederreiter sequences was the topic of interest, or Niederreiter sequences were used for concrete applications. Such Niederreiter sequences are a most efficient tool for mathematical simulations in various fields of applications, especially also of applications in sometimes very high dimensions, as it is often the case in mathematical finance. We want to give here just a first visual impression of such Niederreiter sequences in the most simple case, in dimension 2.

Instead of using pure random point sets for simulation purposes, like in Figure 1A or of "too regular" point sets, like a uniform lattice (see Figure 1B) for many cases of applications there exist essentially better choices of sample points which in general provide essentially better estimates. These are quite sophisticated point sets, with very special distribution properties, namely, for example, the so-called digital Niederreiter sequences. You can see the first (again) 256 points of one example of such a 2-dimensional Niederreiter sequence in Figure 1C.

With the general concept of Niederreiter-sequences we are able to generate and to analyse arbitrarily large such sophisticated point-sets which are especially well-suited for simulations in arbitrarily large dimensions. The development of this concept meant a crucial and essential progress in the theory of quasi-Monte Carlo methods.



(A) Pure random point set

(B) Regular lattice

(C) Niederreiter sequence

FIGURE 1

In summer 1990 about 30 researchers from all over the world were invited to the legendary quasi-Monte Carlo workshop in Fairbanks in Alaska. In a very stimulating environment Niederreiter introduced his concept of Niederreiter sequences and he gave lectures on the latest achievements in the theory of quasi-Monte Carlo methods, which later resulted in his famous SIAM book on "Random Number Generation and Quasi-Monte Carlo Methods". This meeting was also the starting point for the idea of the International MCQMC conference series. In the meantime we have reached the 12th meeting MCQMC 2016 which will take place in August 2016 in Stanford, USA.

Let us end our address with some personal notes, at first with an anecdote made aware to us by Harald's old friend Gary L. Mullen:

> *During the summer of 1982 I was planning to visit Harald in Vienna to work with him on several problems involving permutations over finite fields. I had only met Harald once before, actually some years before at a mathematics conference. While I had corresponded with Harald by airmail, I could not remember what he looked like.*
>
> *Harald had suggested that we meet in the Vienna train station. This all sounded fine until the time for travel drew near; how would I recognize him? This was, of course, before the time of email and cell phones; to send an airmail letter and wait for his response would have easily taken at least a month.*
>
> *Well as the day of my trip drew near, I said, to myself, "Don't worry, I'll figure out something when I arrive."*
>
> *My flights went well and my train ride to Vienna was exciting seeing the beautiful Austrian countryside. But as I got closer and closer to Vienna my stomach began to churn, how would I recognize Harald?*
>
> *I got off the train and holy moly, there were people everywhere, going in every direction. The arrival area was huge and packed with people as this was in the high summer tourist season. There I was with several very heavy bags (I was planning to stay for about three months). What to do? Then it dawned on me that it might not be likely that Harald would recognize me either; as he had only seen me once, years before.*
>
> *I stood there for several minutes, Hmmh! What should I do? Then off in the distance, actually on the far side of arrival area, I noticed a guy holding up a reddish/orange book. At first I thought this behaviour was a bit unusual, but then the light came on: the book was a "Mathematical Review", something that every mathematician would surely recognize.*
>
> *I made my way toward the fellow with the book, and sure enough, he said, "Hi, I'm Harald Niederreiter, are you Gary Mullen?"*
>
> *My heart beat a sign of relief. Harald, being the very smart problem solver that he is, had already solved the problem.*

Another very short anecdote was the following experience of the first author:

> *In the 1990s during a walk in Dagstuhl in Germany, where we attended a workshop on complexity theory, I expressed to Harald my doubts about the relevance of my research, and whether my research work will be of real interest for anybody (everybody who does mathematical research will sometimes know this feeling). Harald's answer was: "You can be sure, that you always will have at least one very interested reader!"*

And today Niederreiter is in close and intensive cooperation with most of the young members of the Johann Radon Institute for Computational and Applied Mathematics of the Austrian Academy of Sciences in Linz and with many researchers in the field all over the world, he is a guide and a source of inspiration for our work, and he is always an interested reader of their research work and still of our work.

In this sense, Harald, we hope that you will enjoy reading the contributions in this volume.