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Seminar on Proofs by Counting in the HWS 2021

The seminar will be held in English. It will follow the book

[BQ03] **Arthur T. Benjamin and Jennifer J. Quinn:**
Proofs That Really Count. The Art of Combinatorial Proof.

The Dolciani Mathematical Expositions, The Mathematical Association of America
2003.

The textbook reduces proofs of formulas into counting problems. Such a combinatorial method, though elementary, is surprisingly powerful. It leads to concrete proofs, and it inspires us to a new understanding of old theorems or to discover new identities. So the book above is ideal for a seminar as an introduction to combinatorial proofs. The contents are so explicit that we can read the book while doing calculations by hand. The book has the following contents:

Chapter 1 introduces a combinatorial interpretation of Fibonacci numbers serving as the foundation of Chapters 2–4. They explore identities involving generalized Fibonacci numbers including Lucas numbers (Ch.2), arbitrary linear recurrences (Ch.3), and continued fractions (Ch.4). Chapter 5 turns to identities involving binomial coefficients. In Chapter 6, one studies binomial identities with alternating signs. In Chapter 7, one investigates identities between Harmonic and Stirling numbers. Chapter 8 considers classical results from number theory. Chapter 9 is challenging more complex Fibonacci and binomial identities.

The seminar will take place

on Wednesdays by Zoom sessions,

The number of days needed will depend on the number of talks.
There will be up to 10 talks (but it could be less).

The seminar aims at students in the bachelor or Master *Mathematics in Business and Economics* and in the bachelor or Master *Education Mathematics*.

If you are interested in a talk, please contact Dr. Mase,
mmase@mail.uni-mannheim.de,
by the end of the first teaching week in the HWS 2021, so by Friday 10.09.2021.

The seminar has several aims.

(1) One is that the participants give a good talk and during preparation learn, how to achieve this. This means that one has to digest the material well, to choose well what to tell in detail and what not, and how to tell it. The talks shall take 90 minutes. Longer is forbidden absolutely, but much shorter is also bad. There is definitely for each talk enough material to fill 90 minutes (if the material in the main part should not be enough, one could add material from some exercises).

(2) All participants shall learn from all talks (not only their own one). It is good to prepare also for the other talks, by reading the relevant chapter. Doing that one could note some good questions which one can then pose during the talk if they are not answered anyway in the talk. The second aim requires presence at all talks.

(3) The book presents the material in a way, which is almost ready for seminar talks. The seminar shall cover (almost) all material in the book.

Talk 1:

Fibonacci Identities. Chapter 1.

Talk 2:

Gibonacci and Lucas Identities. Chapter 2.

Talk 3:

Linear Recurrences. Chapter 3.

Talk 4:

Continued Fractions. Chapter 4.

Talk 5:

Binomial Identities. Chapter 5.

Talk 6:

Alternating Sign Binomial Identities. Chapter 6.

Talk 7:

Harmonic and Stirling Number Identities. Chapter 7.

Talk 8:

Number Theory. Chapter 8.

Talk 9:

Advanced Fibonacci & Lucas Identities (Part I). Subsections 9.1 and 9.2.

Talk 10:

Advanced Fibonacci & Lucas Identities (Part II). Subsections 9.3, 9.4, 9.5 and 9.6.