1. Curriculum Vitae

Personal information

Name:	Carsten Schneider
Date of birth:	September 24, 1971
Nationality:	Germany
Home URL:	`https://www.risc.jku.at/people/cschneid/`

Education

1991–1997	Studies in computer science, Friedrich-Alexander University, Erlangen; degree: Diplom Informatiker (with distinction)
1998–2001	Ph.D. studies at RISC, JKU Linz; degree: Doctor Technicae (with distinction); award of a DAAD grant for one year
2008	Habilitation in mathematics at JKU Linz
2014–	Associate Professor (permanent) at JKU Linz

Publications

So far I have published around 140 articles in journals and proceedings. Among them about 55 articles deal with the derivation of symbolic computational algorithms based on difference ring and special function theories for nested sums and products; using these tools, the remaining articles focus on non-trivial applications within a big range of research fields, such as combinatorics, special functions, numerics, number theory or particle physics; in total they accumulated 4029 citations (google scholar; May 28, 2020). Here I list only my JSC contributions:

- CS. *A refined difference field theory for symbolic summation.* JSC(43), 2008.
- J. Blümlein, S. Klein, CS, F. Stan. *A symbolic summation approach to Feynman integral calculus*. JSC(47), 2012.
- CS. *A difference ring theory for symbolic summation.* JSC(72), 2016.
- CS. *Summation Theory II: Characterizations of RΠΣ-extensions and algorithmic aspects.* JSC(80), 2017.

Mathematica software

In the frame of my research group "Computer Algebra for Quantum Field Theory" (see `https://www.risc.jku.at/research/QFT/`) I devote a lot of energy in the highly non-trivial task to develop very efficient mathematical software based on advanced algorithms in symbolic computation that can be also used for non-experts. For instance the following Mathematica packages are used world-wide by a big community to solve problems coming, e.g., from particle physics, combinatorics, number theory or special functions:

- the package `Sigma` (based on sophisticated difference ring algorithms, 50.000 lines of code);
- the package `EvaluateMultiSums` for the simplification of gigantic multiple sums (7-fold sums/up to 1 GB of summand size, 8.600 lines of code) utilizing Sigma as backbone.

In addition, the packages `SumProduction` (reduction of millions of sums to few master sums) and `SolveCoupledSystem` (solving huge coupled systems), are tailored and used heavily within the particle physics community.

Organization of scientific meetings (selection)

- Involvements in program committees: ISSAC (Seoul, Korea, 2009; Bath, United Kingdom, 2015), *15th DESY Workshop on Elementary Particle Theory* (Nürnberg, Germany, 2020)
- Co-organization of sessions: *Symbolic computation and quantum field theory* at the conference *Applications of Computer Algebra* ACA'08 (Hagenberg, Austria, 2008); *Symbolic summation and integration: algorithms, complexity, and applications* at the conference *Applications of Computer Algebra* ACA'15 (Kalamata, Greece, 2015); *Symbolic computation and elementary particle physics* at the *5th International Congress on Mathematical Software* ICMS (Berlin, Germany, 2016)

- Organization of workshops/conferences (in total 13 events)

2014–	Organizer of five summer schools in *Algorithmic and Enumerative Combinatorics* (Hagenberg, Austria, see `https://www.risc.jku.at/conferences/aec2019/` for the latest one)
2016	Co-organizer of the satellite workshop *Symbolic Summation and Integration* of the ISSAC (Waterloo, Canada, see `https://bohr.wlu.ca/ezima/WWCA2016/`)
2017	Co-Organizer (and program co-chair) of RADCOR 2017, (St. Gilgen, Austria, 82 talks, see `www.risc.jku.at/conferences/RADCOR2017`)
2018	Co-Organizer of the workshop *Combinatorics, Special Functions and Computer Algebra* (Hagenberg, Austria, see `https://www.risc.jku.at/conferences/paule60/`)

Reviewing activities (selection)

since 2013	Editorial board member of the Journal Mathematics
since 2017	Member of the advisory board of RADCOR (International Symposium on Radiative Corrections (Applications of Quantum Field Theory to Phenomenology))
since 2020	Editorial board member of Annals of Combinatorics

Moreover, I am regularly referee for, e.g., JSC, Proc. of ISSAC, Advances in Applied Mathematics, Applicable Algebra in Engineering, Computer Physics Communications, Discrete Mathematics, International Journal of Combinatorics, International Journal Number of Theory, Journal of Algebra, Journal of Difference Equations and Applications, Journal INTEGERS, Journal of Integer Sequences, Journal of Statistical Computation and Simulation, Nuclear Physics B, Ramanujan Journal.

Invited plenary talks (selection)

1. 21st FPSAC, JKU Linz, Hagenberg, Austria. July 24, 2009.
2. ACAT 2013 (15th International Workshop on Advanced Computing and Analysis Techniques in Physics). Beijing, China. May 17, 2013.
3. AofA 2015 (26th International Conference on Probabilistic, Combinatorial and Asymptotic Methods for the Analysis of Algorithms), Strobl, Austria. June 10, 2015.
4. ISSAC 2016, Waterloo, Canada. July 22, 2016.

In addition, I gave 68 invited talks at conferences and workshops.

Edited books and proceedings

1. CS and J. Blümlein (ed.). Computer Algebra in Quantum Field Theory: Integration, Summation and Special Functions. Springer (411 pp), 2013. `www.doi.org/10.1007/978-3-7091-1616-6`
2. A. Hoang and CS (ed.). Proc. RADCOR 2017, 2018. 65 articles. `https://pos.sissa.it/290/`
3. CS and E. Zima (ed.). Advances in Computer Algebra. Springer (280 pp), 2018. `www.doi.org/10.1007/978-3-319-73232-9`
4. J. Blümlein, P. Paule and CS (ed.). Elliptic Integrals, Elliptic Functions and Modular Forms in QFTs, Springer (519pp), 2019. `www.doi.org/10.1007/978-3-030-04480-0`
5. V. Pillwein, CS (ed.). Algorithmic Combinatorics - Enumerative Combinatorics, Special Functions and Computer Algebra. Springer (410pp). To appear 2020.

Other scientific activities (selection)

2013–2021	Co-speaker of the Special Research Program (SFB, in short for the Austrian name Spezial-ForschungsBereich) "Algorithmic and Enumerative Combinatorics" (F50)
2018–2022	Local coordinator of the Austrian partner of the Initial Training Network SAGEX funded by the European Commission

Carsten Schneider
Research Institute for Symbolic Computation (RISC)
Johannes Kepler University Linz, A 4040 Linz
Email: Carsten.Schneider@risc.jku.at

Dear Bruno Buchberger,
dear Hoon Hong,
dear Editorial Board,

I have read with great attention your announcement of the Editorship for the Journal of Symbolic Computation (JSC). Although I do not know your expectations in detail, I can imagine that my skills and experiences fulfill the described requirements very well. Below you find my proposal with details on the vision for the JSC and my strong motivation to develop the journal further for future challenges.

2. Vision for symbolic computation and the journal

On the field of symbolic computation

The research field of Symbolic Computation (SC) has been strongly influenced by the Journal of Symbolic Computation (JSC): since 35 years it has promoted high quality publications and has stimulated very fruitful and productive developments in SC. A special accomplishment is a manifest (almost a constitution) for SC that has been introduced in the first issue of the JSC by the founder Bruno Buchberger. After so many years (with all the new developments in technology) it is impressively up-to-date and serves for many of us as an inspiration. Based on that, the essence of symbolic computation in my understanding is the following:

> Symbolic computation deals with the exploration of algorithmic theories, the development of algorithms within these theories and the implementation in software packages in order to solve problems that are modeled in terms of symbolic objects.

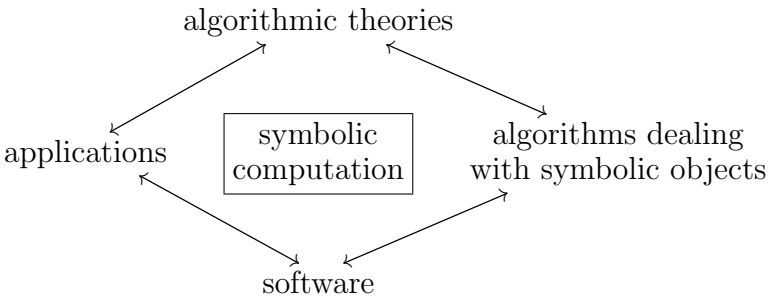


Figure 1: Symbolic computation in action

In particular, it unites non-trivial technologies from mathematics and computer science in order to accomplish this task. A subtle point is the specification of the class "symbolic objects". In order to distinguish SC from numerics, floating point numbers are mostly excluded. Otherwise, the self-understanding may variate within different research topics. In some situations, one may consider only those elements as symbolic objects that can be built purely within polynomial rings, ideals and their interactions. In a more general stetting, symbolic objects are usually not restricted to polynomial representations and their basic operations, but general rewrite rules can act on them that are justified non-trivially by properties coming from outside (for instance, functions/integrals that satisfy certain analytic properties). In particular, symbolic objects can be sequences of elementary program operations or logical expressions. In this meta setting, the symbolic approach aims in parts at the development of algorithms that themselves discover, e.g., new (or improved) algorithms or proofs for unsolved (or not properly treated) problems. Often symbolic computation is also restricted to the union of the research fields of computer algebra, computational logic and mathematical software.

It is my vision that symbolic computation should be considered in this highly flexible and general context in which all the above scenarios (and maybe new situations that have not been considered so far) fit under one common umbrella. In particular,

> SC should be recognized as *the* central platform to support scientists with algorithmic tools in order to solve challenging (or tedious) scientific problems.

Already now many scientists supplement their traditional equipment of pencil and paper with modern SC tools to experiment with expressions and formulas and/or to explore and solve open problems in rather general settings. In my opinion, this change of practice towards symbolic computational methods is already a great achievement: only few branches in mathematics or theoretical computer science entered so deeply in the habit how research is carried out in its inner core. However, besides the experimentation with mathematical formulas or the non-trivial simplification/optimization of expressions, the full potential of SC on a meta level is often neglected or ignored in science. Only in some sub-communities SC is used as a strong toolbox to discover/prove properties in terms of symbolic objects (e.g., identities in special functions, algebraic independence of objects, correctness of algorithms, complexity analysis, e.t.c.), to discover new proofs in computational logic or to invent new or improved algorithms for challenging problems in sciences. It is my point of view that this exceptional feature of SC should be stronger conveyed to the outside so that it is fully recognized in science. It is my vision that SC will be considered in the end as *the* standard environment to automatize the thinking process in terms of symbolic objects and to push it step-wise to higher levels of calculations. Provocatively, symbolic computation should be considered and recognized as artificial intelligence in its best form.

Historically, science has split more and more into different disciplines. But they are still in one or the other way intertwined with each other, and many contributions based on non-trivial computations were unthinkable without non-trivial interactions between them. Based on these new algorithmic developments, I want to press the following point.

> SC can and should be used as a global framework to unite algorithmic interests in different research areas (like, mathematics, computer science, but also, e.g., physics) and to give new opportunities for mutual interactions and synergies.

I believe that the SC community should enjoy this groundbreaking capability to serve as an algorithmic medium and to actively strengthen interdisciplinary connections not only between mathematics and computer science but also to other disciplines. For instance, natural links such as automated reasoning or artificial intelligence should be intensified or newly established,

existing connections to, e.g., the special function and combinatorics community should be strengthened, and old links, e.g., to the particle physics community should be reactivated. For example, Schoonschip (1963) was one of the first computer algebra systems introduced by M.J.G. Veltman (who won the novel price in physics) that has been developed further to the computer algebra system FORM (developed by J.A.M. Vermaseren) and actively used within the particle physics community. In this latter community, many highly interesting SC tools and methods are pushed forward to treat challenging symbolic objects that are either large in size (ranging between Gbs and Tbs) or composed by highly complicated mathematical structures (like, e.g., higher-loop massive Feynman integrals). I strongly feel that a closer interaction of such different research areas under the common umbrella of SC will stimulate and inspire many new developments in algorithmic mathematics and computer science. For instance, I co-edited a book on *Computer Algebra in Quantum Field Theory Integration, Summation and Special Functions* within the RISC book series *Texts & Monographs in Symbolic Computation* that brought together highly non-trivial SC methods coming from mathematics and particle physics. This interaction of different research fields in SC gained since 2013 already 28k downloads[1].

On the scope of Journal of Symbolic Computation

The Journal of Symbolic Computation (JSC) and the research field of Symbolic Computation (JSC) are ultimately linked together. Inspired by Bruno Buchberger's visionary manifest on SC and by my supplementing comments from above, I would like to extract four aspects that should be taken into account for the future activities and responsibilities of the JSC.

(1) The JSC should continue to be the central flagship of SC to support new developments in algorithmic mathematics and to spread it in the digital age.

Ever since the JSC exist, it can be considered as the central communication platform to present new exciting algorithmic theories, new algorithms together with their complexity analysis, and their powerful implementations in stable software packages. This central task to push forward fundamental

[1]See `https://link.springer.com/book/10.1007/978-3-7091-1616-6`

research with their potential for practical problem solving is the backbone of SC and should be developed further with full enthusiasm.

Due to all the great developments of new symbolic algorithms but also due to modern large-scale computers (huge memory with multi-core processors) that are tailored for the treatment of symbolic objects, SC will have a great future in solving problems that so far have been out of scope. This leads me to my second standpoint.

(2) The JSC should be intensified to an influential megaphone that gives SC the reputation and credit that it deserves in applications.

In order to meet the expectations of aspect (2), the JSC should promote more actively these new exciting developments and its resulting possibilities. Yes, there are other journals that might serve in parts this purpose. But often one gets even the impression, that journals totally miss the trend. For instance, I worked recently on an interesting problem challenged by Doron Zeilberger and submitted it to a highly visible journal in order to communicate the usefulness of SC. However, it was rejected with the argument: "Using computer algebra you succeed in deriving explicit expressions for... Indeed, the combinatorial methods break down, and your article makes a worthwhile contribution to this problem. Still, in our opinion, the paper is not quite suitable for publication in The Mathematical Intelligencer'. There are no new probabilistic (or combinatorial) insights into the problem. The reader will not be able to check the quite lengthy formulae produced by the computer."
Like in this particular instance, I have the impression that many classical journals do not accept the symbolic-computational insight (i.e., the demonstration that SC can be used non-trivially to problems whose solution might be even impossible using other techniques) as a convincing argument to publish articles. In my view JSC should strongly support this trend-setting process. It should promote actively not only new methods and algorithms for solving problems, but should equally strengthen its profile to be a central platform to demonstrate the power of SC in practical problem solving. In the ideal case, scientists should consider JSC as the first choice to submit articles where SC is the driving force to solve interesting problems.

Meanwhile SC can be considered as a very rich and well developed research discipline. Like in many other research fields, the different sub-fields

are based on deep, often complicated mathematical and algorithmic achievements. However, it is getting harder and harder (as a non-expert in a particular sub-field) to find a convincing orientation within the big range of high quality articles. Based on these difficulties, I want to stress the following aspect.

(3) The JSC should actively provide a general overview of the different research topics in SC and to prepare the stage for new developments.

Namely the idea to promote regularly invited survey and/or tutorial articles, as originally stated in the JSC manifest, should be reactivated resp. emphasized in a stronger fashion. The interested but non-expert reader should get sufficient insight about the state-of the-art in the introduced sub-field, should be connected to the available literature (most probably often from the JSC) and should be made aware of the existing software packages and problems that can be handled or cannot be tackled (properly) with the available tools. I will discuss further issues concerning this aspect in the next section.

As stated in the preamble of the JSC, a central task of it is to be a home for the three crucial groups of SC: the algorithm designers, the system implementers and the users. As discussed already in my standpoint (3), the users but also the system implementers should be given a better voice in the research field of SC. In this regard, I want to emphasize the following additional aspect.

(4) The JSC should be highly visible and recognized for all disciplines in sciences (mathematics, computer science, but also in other related fields) that work with SC tools or develop them further.

More precisely, I am convinced that considerable efforts should be undertaken to get other scientific communities on board of JSC. As stated in Buchberger's manifest, JSC should be set up as *the* common publication platform that communicates new SC algorithms and packages coming from all research fields. In particular, publications of research in artificial intelligence and automated reasoning should be stronger promoted. But also within the particle physics community one mostly finds strong SC-publications (new algorithms, new packages and their application) in *Nuclear Physics B* or *Computer Physics Communications* that would perfectly fit to JSC. I have the impression that currently innovative SC tools and interesting applications are cut off form

the rest of the SC community and fruitful discussions and inspiration are often disabled. Clearly, this goal is very ambitious and can be accomplished only step wise But trying to make JSC a home for all SC communities seems to be a central goal and essential to be ready for future developments.

On the organization of the journal and outlook

The editorial team is highly recognized and reflects in many ways the different focuses and understandings of SC. It is built by highly creative scientists that are open minded to new ideas and developments in their own field, but also other fields or new research topics that have been neglected so far. I believe that the editorial board is the inner core of JSC that should be mostly visible as the driving force of JSC. Without them a fair and careful refereeing process –how it is currently executed in an impressive manner– would be unthinkable. Definitely, one should not change such a "winning team". Contrary, one must support it as much as possible so that its members continue to proceed with such enthusiasm and dedication. In particular, as editor one should be open-minded and flexible in new developments and suggestions from the editorial board how the refereeing process should or could be improved.

Besides the editorial board, the publishing company plays an important role for the implementation of the JSC. In general, it can provide excellent electronic tools to take care of the refereeing process and to support the editorial board and the editor in their duties. In particular, the editor and editorial board can be dispensed from tedious tasks like taking care that all articles have a common style and fulfill all the requirements set up by the editorial board. While I have co-edited 4 books (with Springer), I appreciated very much this supporting service.

In general, I believe that the editor should be considered as part of the editorial board that brings in new impulses and/or helps to coordinate and implement innovative ideas form the editorial board. Concerning the organization and outlook of the JSC, I would like to emphasize the following considerations.

• In my opinion, standard issues are the driving engine to distribute fascinating and up-to-date research. Ideally, a fair balance (also based on the submission and acceptance load) between the different building blocks of symbolic computation (see Figure 1) should be accomplished. In particular, the JSC team should strongly support new trendsetting algorithmic ideas

and/or exciting applications. In this regard, the time frame between acceptance, online availability and final publication should be in a reasonable time frame (the current time frame of 10-11 months seems a bit long). Besides these regular issues in JSC, I strongly support the idea to publish also special issues on successful topics that are strongly growing and thus deserve a larger platform to be presented accordingly.

• JSC can be considered as the publication medium within in the inner core of the symbolic computation community. In order to enlarge this inner circle and to attract more groundbreaking articles that are relevant for symbolic computation, the JSC (i.e., the editor and the editorial board) should work more systematically together with different streams of conferences in symbolic computation and related areas such as automated reasoning and artificial intelligence, or research areas that strongly use/develop symbolic computation methods (such as the combinatorics, special function or the particle physics community). In order to accomplish this task, first steps might be a careful extension/enrichment of the editorial board with colleagues from related research fields or actively offering special issues in such related fields.

• Looking at the current habits in publications (e.g., uploading preprints in the arXiv), I strongly feel that physical printing is only a sideline and electronic publishing (with all their possibilities) should be further strengthened in cooperation with the publishing company. In this regard, I would like to indicate the following aspects that could be discussed for the future developments of the JSC.

(i) More and more funding agencies require that articles must be freely accessible for the scientific community. Some journals (even Elsevier, e.g., with Nuclear Physics B) run meanwhile fully in open access mode. It would be great if similar regulations could be accomplished, e.g., with Elsevier.

(ii) If the interested reader does not have access to an article, she/he can find in most cases the corresponding preprint on the web (often the arXiv or similar preprint databases). A more convincing and honest strategy would be to offer such available links directly from the publishing web page.

(iii) As mentioned earlier, JSC should invite on a regular bases experts in their research field to write overview articles for the non-experts. I

strongly propose that at least these articles should be made freely and prominently accessible on the JSC web page.

(iv) Since decades JSC collects exciting articles and I feel that this treasure of knowledge should be sorted in a better way: I could well imagine that, e.g., certain key topics (like, commutative algebra, special function algorithms and their different sub-fields, proving systems, symbolic integration/summation, Galois theory of difference/differential equations, data management, theory of Gröbner bases, etc.) are properly listed on the JSC web page with extra information, like further links to the corresponding articles (within JSC but also to other substantial contributions in other journals). In this regard, also available overview articles (see item (iii)) and links to software packages should be connected properly. Clearly, this organization of the gigantic JSC database (running since the beginning of SC) is non-trivial and should be set up step wise by the whole SC community.

I feel that such improvements (or even better ideas from the editorial board) might increase the visibility of JSC and to provide new exciting services for the SC community.

3. Motivation

I studied computer science at the Friedrich–Alexander–University Erlangen–Nürnberg and did my master thesis under Volker Strehl where I had my first contact with amazing topics in symbolic computation. When I got the offer from Peter Paule to join the Research Institute for Symbolic Computation (RISC) as PhD student, I jumped immediately at the chance to get a deeper insight in this field. In particular, I could follow the well-designed curriculum for symbolic computation initiated by Bruno Buchberger and carried out by an excellent team of teachers at RISC. Within my studies (strongly influenced by my PhD advisor and friend Peter Paule) but also in my current research I have internalized the three concepts on which RISC is based (compare also the definition of symbolic computation in the first issue of the JSC): research, education and application and the strong interaction among them. Finally, I completed my PhD at RISC in 2001 and obtained the Habilitation in the field of mathematics in 2007 at the Johannes Kepler University Linz.

My main research area is symbolic computation: I contribute in the development of summation theories in algebra, design algorithms based on these theories, and implement them in efficient software packages. Notably, my research work is driven by concrete applications to solve problems in discrete mathematics (number theory, combinatorics, analysis of algorithms, etc.) and interdisciplinary research areas such as large scale problems in particle physics. In the latter discipline I produced jointly with colleagues from DESY (Deutsches Elektronen-Synchrotron) around 80 articles in which we provide summation, integration and special function tools and apply them to non-trivial calculations that so far have been unfeasible. In particular, I had the chance to meet not only many colleagues working in symbolic computation within the fields of mathematics and computer sciences (e.g., ISSAC, ACA) but also within other research areas, like elementary particle physics (regular participations at the Loops and Legs workshop, co-organizer of the RADCOR conference 2017 which I also serve in the steering committee, plenary speaker at ACAT, etc.). Furthermore, I co-edited already 4 books (a 5th is in preparation) that focus on symbolic computation methods and their applications to different research areas, like combinatorics, special functions or particle physics. Summarizing, I am thrilled to see how more and more technologies in symbolic computation enter the game to solve groundbreaking problems that so far were out of scope.

The Journal of Symbolic Computation has been doing a great job start-

ing from 1985 and I got inspired by many exciting ideas that have been published there. With no doubt, the research field of symbolic computation is strongly intertwined with the JSC. In particular, the current success of symbolic computation is based on the continuous efforts of the editorial board of the JSC.

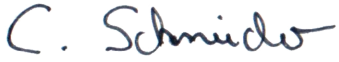
I believe that I can bring in successfully my experience in order to develop in joint effort with the editorial board the JSC further to a modern communication platform. Here the interplay of developing constructive mathematical theories, designing efficient algorithms and implementing stable software packages will be emphasized. In the light of a new generation of advanced hardware that is tailored for SC, many new exciting applications will arise in the near future. I strongly vote that special emphasis should be put on the presentation of these trend-setting new developments in symbolic computation.

Summarizing, based on my experiences in developing symbolic computational algorithms and applying them to interdisciplinary research fields, I can well imagine to support the JSC substantially by, e.g.,

- stimulating other research groups to publish more actively their research work in JSC;
- focusing (besides the development of algorithms) on new exciting trends in applications;
- making JSC ready for future electronic technologies in publishing.

I personally have high respect for all the developments in SC and admire the achievements how the JSC contributed in this task. I would be very happy to support the editorial board of the JSC as editor and to develop jointly as team new innovative ideas so that the JSC will be also in the future the flagship for symbolic computation.

Many thanks for your consideration and best wishes,



Carsten Schneider