Activity Report for the Year 2022

Christer Oscar Kiselman

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Contents

1. Seven publications

During 2022, I have published two books, one journal article, three book chapters as the sole author, and one joint article with Hania Uscka-Wehlou.

1.1. *Elements of Digital Geometry, Mathematical Morphology, and Discrete Optimization* (22-1)

This as a book published by World Scientific in Singapore on 2022 January 18, comprising xxiv + 461 pages. ISBN 978-981-124-829-0. Price 125 GBP.

The manuscript was submitted on 2020 November 29 and accepted for publication on 2021 March 11. An almost final version was sent 2021 May 20. The final version was sent on 2021 December 02.

1.2. *Zamenhof's Yiddish Grammar and His Universal Language: Two Projects in Ashkenazi Culture* (22-a)

This is a counterpart, comprising 167 pages, of the Esperanto text mentioned in the report for the years 2020 and 2021 under Subsection 1.11. Published in January 2022 by Petr Chrdle, Director of KAVA-PECH, Dobřichovice. ISBN 978-80-88326-25-0.

1.3. *Generalized elementary functions* (22-2)

A text (14 pages) on classes of functions that are elementary in a wider sense than the functions which are elementary in the sense of Liouville. Published online on 2022 February 17.

Submitted on 2021 March 05. Two referee reports received in May 2021. A revised version submitted 2021 May 14. Final version sent on 2021 May 17. Accepted for publication in *Complex Analysis and Elliptic Equations* on 2022 January 03.

1.4. False friends, sharp corners, and language traps (22-3)

Kiselman, Christer O.; Uscka-Wehlou, Hania. Falska vänner, vassa vrår och språkliga fällor [In Swedish; title translated as: "False friends, sharp corners, and language traps"]. *Nämnarens artikelsamling*, March 2022, pages 23–31. (This joint paper is a reprint of our 2017 article; see item 17-4 on my web site.)

1.5. Complex convexity (22-4)

A chapter in the *Handbook of Complex Analysis*, pages 245–377, edited by Steven G. Krantz, published on 2022 September 16 by Taylor & Francis.

Submitted on 2021 January 08. Two referee reports received on 2021 January 16. Accepted for publication on 2021 March 06. Final version sent 2021 November 19.

1.6. Digital geometry, mathematical morphology, and discrete optimization: A survey (22-5)

A chapter in the volume Lecture Notes in Computer Science, *DGMM*, Number 13493, edited by Étienne Baudrier et al., pages 26–31.

1.7. Cauchy problems for discrete holomorphic functions (22-6)

A chapter in the book

Sabadini, Irene; Struppa, Daniele C. 2022. *In Memory of Carlos A. Berenstein (1944–2019)*. Cham: Birkhäuser, pages 281–297.

This book was published in December of 2022. The text had appeared previously in *Complex Analysis and Operator Theory* in the Topical Collection, Volume 7, Issue 4, pages 281–297. The text is the same as in my earlier publications 20-4 and 21-5.

2. Work accepted for publication

2.1. Duality of convolution operators: A tool for shape analysis

Accepted for publication in Springer's series *Mathematics and Visualization* on 2021 July 14.

Manuscript submitted on 2019 April 30 (19 pages). Two referee reports received on 2020 July 20. Revised version sent on 2020 July 23.

2.2. Which convexity properties are preserved under linear mappings?

A manuscript (13 pages) on convexity properties of marginal functions defined on arbitrary subsets of $\mathbf{R}^n$. Submitted on 2021 November 11. Accepted for publication in *Journal of Convex Analysis*, volume 29, Number 4, on 2022 January 31.

3. Two unpublished texts

2022-09-03. Report from Canada: *Canada in August 2022*, 7 pages. I participated in the 107th World Congress of Esperanto in Montréal and visited the Canadian Language Museum in Toronto, `ca2022.pdf`.

2022-11-09. Report from France: *Strasbourg and Paris in October 2022*, 3 pages, `fr2022.pdf`.

4. Five invited talks

4.1. Linnaeus University

I was invited to give a lecture at Linnaeus University, Campus Växjö, on 2022 March 23. The title was "Discrete phenomena, which are of growing interest in science, can be difficult but need to be understood." The talk was related to the book mentioned in Subsection 1.1 above.

4.2. Montréal

On 2022 August 11, I was an invited speaker at the Conference on Esperanto Studies, which was an integral part of the World Esperanto Congress held in Montréal. The title of my talk was "Du projektoj en aŝkenaza kulturo: la jidogramatiko de Zamenhof kaj lia Lingvo universala" (Two projects in Ashkenazi culture: Zamenhof's Yiddish grammar and this Universal Language).

4.3. Stockholm

Ever since Mikael Passare died in Oman in 2011, Stockholm University has organized a meeting each year in September or October. In the beginning the talks were devoted to his memory, later to themes related to his research interest, and nowadays on more or less every possible topic.

On 2022 October 19, I gave a talk at Stockholm University during the *Analysis Day Dedicated to Mikael Passare's Memory*. It was entitled "The International Congress of Mathematicians 1962: Some memories." That was the first international congress I participated in, and I played a small role in its preparation, visiting the Mittag-Leffler Institute for the first time.

4.4. Strasbourg

On 2022 October 26 I was an invited speaker at the International Conference *Discrete Geometry and Mathematical Morphology* (DGMM) held in Strasbourg 2022 October 24–27. This conference is a combination of two earlier series of conferences, viz.

Discrete Geometry for Computer Imaginary (DGCI) and *International Symposium of Mathematical Morphology* (ISMM). My title was "Digital geometry, mathematical morphology, and discrete optimization: A survey." I was physically present.

4.5. Seoul

On 2022 November 10, I was invited to talk at the *Fourth International Conference on Machine Learning and Intelligent Systems* (MLIS 2022), held in Seoul. My title was "Digital geometry, mathematical morphology, and discrete optimization: A survey." The whole event was on Zoom, so I gave this talk from my home in Uppsala.

5. Participation in congresses and conferences

During 2022, I have participated in one congress and five conferences, and given five talks:

5.1. 2022 July 25–28: *The 1st Al-Khorezmi International Conference on Modern Problems of Mathematics*, held at Urgench State University, Urgench. The main organizer was Azimbay Sadullaev. I participated via Zoom in some of the sessions.

5.2. 2022 August 06–13: *The 107th World Congress of Esperanto*, which took place in Montréal, Québec, Canada. I was physically present.

5.3. 2022 August 11: *The 43rd Conference on Esperanto Studies* held in Montréal. See Subsection 4.2 above on the talk I gave, being physically present.

5.4. 2022 October 19: *Analysis Day in Memory of Mikael Passare*. See Subsection 4.3 above on the talk I gave, being physically present.

5.5. 2022 October 26, Strasbourg. I refer to Subsection 4.4 above on the talk I gave, being physically present.

5.6. 2022 November 10, Seoul. See Subsection 4.5 above on the talk I gave on Zoom.

A conference in Kampala, planned to have taken place in October of 2022, has been postponed to 2023 August 01–04.

6. Organization of meetings

The one-day conference *Analysis Day in Memory of Mikael Passare* on 2022 October 19 was organized by Mats Andersson, Jan Boman, Christer Oscar Kiselman, and Pavel Kurasov. The latter was the main organizer. See Subsection 4.3 above for my talk.

7. Six referee reports

2022.R1. *Journal of Mathematical Imaging and Vision*

The editors ask for a second referee report on a manuscript of discrete convexity; see 2021.R4 in the report for the years 2020 and 2021. Report sent on 2022 February 05.

2022.R2. *Journal of Mathematical Imaging and Vision*

David Coeurjolly asks for a referee report on a manuscript on minimal distances generated by paths in the plane. Request received 2022 March 28. Referee report submitted 2022 April 23.

2022.R3. DGMM 2022

Srečko Brlek asks about a manuscript submitted to the conference *Discrete Geometry and Mathematical Morphology* to be held in Strasbourg 2022 October 24–27. Request received 2022 April 30. Referee report submitted 2022 May 05.

2022.R4. *Amuza matematiko*

Petro Chrdle asks me to report on a manuscript entitled *Amuza matematiko*, 370 pages. Request received 2022 May 18. Report submitted 2022 May 29.

2022.R5. *Journal of Mathematical Imaging and Vision*

David Coeurjolly asks about a revised version of the manuscript mentioned in Subsection 2022.R2 above. Request received 2022 September 29. Referee report submitted 2022 October 04.

2022.R6. Springer Nature

Donna Khernik of Springer-Verlag asks me about a revised version of the book manuscript written by several persons and mentioned in the *Activity Report for the Years 2020 and 2021*, Section 2021.R5, Springer Nature. Request received 2022 October 14. Referee report submitted 2022 October 17.

8. A visitor

8.1. Rahul Gaurav was invited to give three guest lectures

Rahul Gaurav of the *Institut du Cerveau* (the Brain Institute) in Paris was invited to give a lecture on 2022 May 24 in the *Complex Systems Seminar Series* (CoSy), which is organized by *The Center for Interdisciplinary Mathematics* (CIM) of Uppsala University and run by Jörgen Östensson. The title of Rahul's lecture was "Advancements in deep learning-based MRI biomarkers in neurodegemerative disorders."

At 16:00 on the same day, Dr Gaurav gave a second lecture at Uppsala Academic Hospital, the Department of Neurology, later the same day, entitled "AI-based MRI biomarkes in REM sleep behavior disorders & Parkinson's disease."

A third lecture by Rahul, on May 25, at the Karolinska Institute, Department of Clinical Neuroscience (in Solna near Stockholm) had the title "Can deep learning help in understanding REM sleep behavior disorder & Parkinson's disease using multimodal MRI?"

9. Four visits

9.1. Montréal

During a week in August of 2022 I particated in the 107th World Congress of Esperanto as mentioned in Section 5 above. I visited several museums in the city.

I also participated in the Conference on Esperantology in Montréal, which was an integral part of the above-mentioned congress.

9.2. Toronto

On 2022 August 15 I visited the Canadian Language Museum, *le Musée Canadien des Langues* in Toronto, a unique museum devoted to the languages of Canada and with special emphasis on the indigenous languages of North America. I was invited by Dr. Elaine Gold, Director/*Directrice* of the museum, who guided me there, in spite of the fact that it was closed for the summer.

I visited also several other museums in Toronto.

9.3. Strasbourg

I was an invited speaker, being physically present, at the international conference *Discrete Geometry and Mathematical Morphology* (DGMM) held in Strasbourg 2022 October 24–27. This conference is organized as a combination of the two earlier conference series *Discrete Geometry for Computer Imagery* (DGCI) and *International Symposium of Mathematical Morphology* (ISMM). On October 26, 09:00–10:00, I gave my talk, entitled "Digital geometry, mathematical morphology, and discrete optimization: A survey."

I was chair of the session the same day, 07:00–08:15. The organizer paid for all expenses.

9.4. Seoul

I was an invited speaker of the *4th International Conference on Machine Learning and Intelligent Systems* held via Zoom in Seoul during four days, November 08–11.

I gave my talk, entitled "Digital geometry, mathematical morphology, and discrete optimization: A survey," from my home on 2022 November 10, 08:40–09:05 Swedish time. I was chair of the session earlier the same day, viz. 07:00–08:15 Swedish time.

10. Memberships in academies

Royal Academy of Arts and Sciences, Uppsala	1983 – present
Royal Society of Sciences, Uppsala	1984 – present
International Academy of Sciences (AIS)	1984 – present
Internacia Scienca Akademio Comenius	1986 – present
Esperanto Academy	1989 – 2015-12-15
Royal Swedish Academy of Sciences	1990 – present
Polska Akademia Umiejętności (*Academia Scientiarum et Litterarum Polona*; *Polish Academy of Arts and Sciences*)	2002 – present

Confirmed by the President of the Republic of Poland on 2002 July 12
The diploma handed over by the Ambassador of Poland to Sweden, Marek Prawda, on 2003 June 10

11. Honors

Docteur Honoris Causa, Université Paul Sabatier, Toulouse.
Approved by the Minister of National Education on 2000 July 06
Title awarded in Toulouse on 2002 May 17
Gold medal for Zealous and Devoted Public Service, Kingdom of Sweden 2001 June 08
Officier de l'Ordre National du Mérite, appointed by the President of the French Republic, Jacques Chirac. Decree dated 2002 April 05
The insignia of the order handed over by the Ambassador of France to Sweden, Patrick Imhaus, on 2002 October 23
Gustavus Adolphus Gold Medal, awarded by Uppsala University on 2006 May 15
Honorary member, AIS-Bulgaria, elected on 2013 June 25
Diploma of the Universal Esperanto Association for outstanding activity for the International Language Esperanto; for works and publications in science and interlinguistics.
Received in Buenos Aires on 2014 August 02
Pirlot Prize of the International Academy of Sciences in the category *Courses* (one of two prizes for the years 2013–2018).
Decision announced in Lisbon on 2018 August 03
International Society for Analysis, its Applications and Computation (ISAAC), Honorary member, nominated by Professor Joachim Toft of Linnaeus University, Campus Växjö, and elected in March 2022
Doctor Honoris Causa, Linnaeus University, Campus Växjö.
Promoted to Honorary Doctor by Professor Staffan Carius on 2022 March 25

12. Memberships in learned societies

Swedish Astronomical Society, Lifetime member 1954 – present
Swedish Mathematical Society, Lifetime member 1960s – present
American Mathematical Society, Lifetime member 1966 – present
Société Mathématique de France 1960s – present
European Mathematical Society 1990s – present
European Mathematical Society, Lifetime member 2022 – present
Uppsala Humanistiska Förbund (The Uppsala Union for the Humanities) 1990s – present
Scandinavian Society for Iranian Studies (Associate member) 2010 – present
International Society for Analysis, its Applications and Computation (ISAAC), Honorary member March 2022 – present

13. Current research projects

13.1. Complex convexity

Project manager: Christer Oscar Kiselman.

Project description: Two complex variables correspond to four real variables, so in complex geometry, we need to see in four dimensions or more. Can you see in four dimensions without building a *Theatrum Visuale* showing all four dimensions? Yes, it is indeed possible to train one's inner eyes to see in four dimensions. A nontrivial but most rewarding sport. We can actually arrive at true stereoscopic vision ...

A bounded open set with boundary of class C^1 which is locally weakly lineally convex is weakly lineally convex, but, as shown by Yuriĭ Zelinskiĭ, this need not be true for unbounded domains. We construct explicit examples, Hartogs domains, showing this. Their boundary can have regularity $C^{1,1}$ or C^∞.

Obstructions to constructing smoothly bounded domains with certain homogeneity properties are presented.

A current activity is a study of one-sided regularity of subsets of $\mathbf{R}^n$ or $\mathbf{C}^n$. Preliminary results on this kind of regularity were presented at a conference at Stockholm University on 2015 September 16; cf. Subsection 1.7 in the report for 2019.

Advisors: Jan Boman, Ragnar Sigurðsson, and Mats Andersson.

Financed by:

1. Université de Nice 1967-10-01 — 1968-09-30;
2. Uppsala University 1968-10-01 — 2006-04-30;
3. Kingdom of Sweden 2006-05-01 — present.

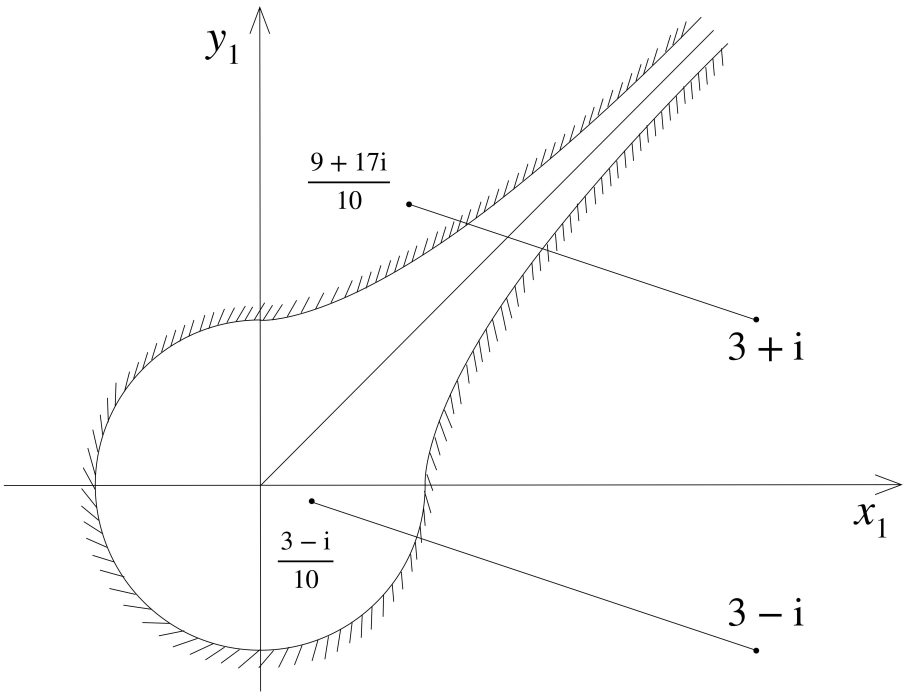

Figure 1. (Project 13.1.) The base in the complex plane of a locally lineally convex set in $\mathbf{C}^2$ which is not lineally convex. From publication 16-1; courtesy Hania Uscka-Wehlou.

Publications

A chapter intended for a book entitled *Handbook of Complex Variables* and edited by Steven Krantz, has been published in 2022: see Subsection 1.5 above. The text was submitted on 2021 January 08 and accepted on 2021 March 06.

One publications appeared online in July 2019; the print version was published in October 2019.

Period: 1967-10-01 — present.

13.2. Convexity of marginal functions in the discrete case

Figure 2. (Project 13.3.) Shiva Samieinia, my Doctor #17.

Project manager: Christer Oscar Kiselman.

Project description: We define, using difference operators, classes of functions defined on the set of points with integer coordinates which are preserved under the formation of marginal functions.

The duality between classes of functions with certain convexity properties and families of second-order difference operators plays an important role and is explained using notions from Mathematical Morphology.

Several generalizations are now being studied.

Period: 2010-01-11 — present.

Partner: Shiva Samieinia.

Financed by: Christer Oscar Kiselman: Kingdom of Sweden.

Shiva Samieinia:

1. The Royal Institute of Technology;
2. Stockholm University;
3. The Ruth and Nils-Erik Stenbäck Foundation.

Publications: An article (10-4), joint with Shiva, was published as a part of her PhD thesis. A joint paper (17-5, mentioned in the report for 2017) was published in September 2017. Most of the results are covered by the book manuscript mentioned in Subsection 1.1 above. However, some generalizations remain to be studied. The paper on duality, mentioned in Subsection 2.1 above, is also relevant here.

13.3. Digital hyperplanes

Figure 3. (Project 13.4.) Adama Arouna Koné, my Doctor #18.

Project manager: Christer Oscar Kiselman.

Project description: Digital planes in all dimensions are studied. The general goal is to generalize to any dimension the results of Kiselman's 2011 paper in *Mathematika* (11-1).

An important part of the study was finished with Adama Arouna Koné's thesis, presented in Bamako on 2016 January 14. There are, however, several possible generalizations which are now being investigated.

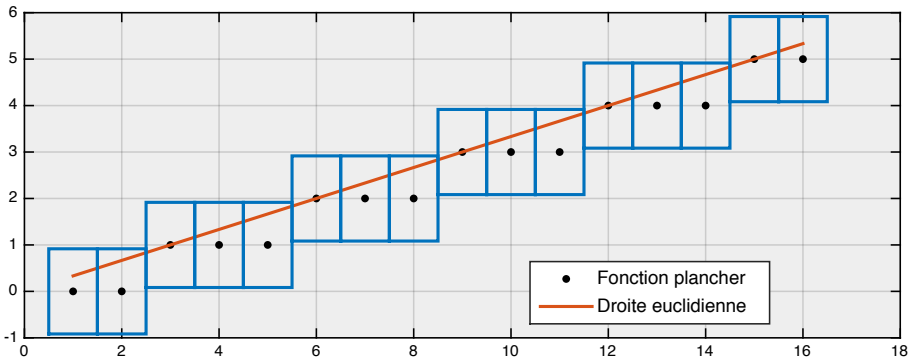

Figure 4. (Project 13.4.) Covering the Euclidean straight line of equation $y = \frac{1}{3}x$ by a dilation obtained using the floor function and with structuring set equal to the rectangle $[-\frac{1}{2}, \frac{1}{2}] \times [-\frac{5}{6}, \frac{5}{6}]$. Courtesy Adama Arouna Koné.

Period: 2010-01-11 — present.

Partner: Adama Arouna Koné.

Financed by: Christer Oscar Kiselman: Kingdom of Sweden.

Adama Arouna Koné:

1. International Science Programme (ISP) 2011–2016;
2. Université des Sciences, des Techniques et des Technologies de Bamako

(USTTB), Bamako I, 2011 — 2018 January 07;
3. École Normale d'Enseignement Technique et Professionnel (ENETP), 2018 January 08 — present.

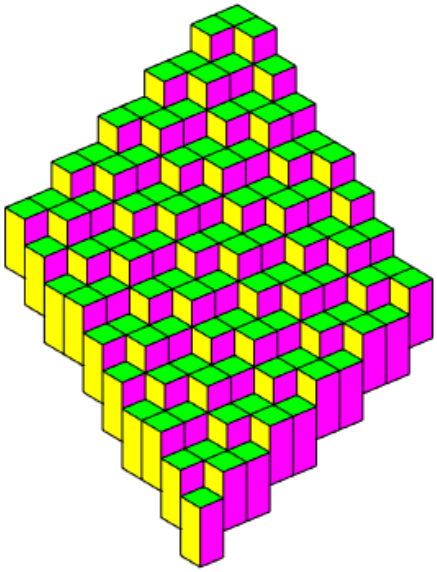

Figure 5. (Project 13.4.) Covering a Euclidean plane by a dilation, using the floor function and with structuring set equal to the box $[-\frac{1}{2}, \frac{1}{2}] \times [-\frac{1}{2}, \frac{1}{2}] \times [-\frac{9}{8}, \frac{9}{8}]$. Courtesy Adama Arouna Koné.

Publications

Koné, Adama Arouna. 2016. *Géométrie digitale utilisée pour la discrétisation et le recouvrement optimal des objets euclidiens.* PhD Thesis, 114 pages. Bamako: Université des Sciences, des Techniques et des Technologies de Bamako I (USTTB).

Koné, Adama Arouna. 2017. Covering a Euclidean line or hyperplane by dilations of its discretization. *Vietnam J. Math.* **45**, no. 3, 351–368.

The results in this project are essentially covered by the book mentioned in Subsection 1.1. Some generalizations remain to be studied.

13.4. Discrete convolution equations

Project manager: Christer Oscar Kiselman.

Project description: We study solvability of convolution equations for functions with discrete support in $\mathbf{R}^n$, a special case being functions with support in the integer points. The more general case is of interest for several grids in Euclidean space, like the body-centered and face-centered tesselations of three-space, as well as for the non-periodic grids that appear in the study of quasicrystals. The theorem of existence of fundamental solutions by de Boor, Höllig & Riemenschneider is generalized to general discrete supports, using only elementary methods. We also study the asymptotic growth of sequences and arrays using he Fenchel transformation. Estimates using the Fourier transformation are studied.

Now duality of convolution operators is being investigated.

Advisors: Jan Boman, Ragnar Sigurðsson.

Period: 2012-01-11 — present.

Financed by: Kingdom of Sweden.
Publications: A paper was published on 2015 May 07 in *Mathematika* (15-2). A second paper appeared in 2017 (17-2); see the report for 2017.
A study of quasicrystals is part of this project. So is the paper on duality mentioned in Subsection 2.1. A majority of the results in this project are covered in the book manuscript mentioned in Subsection 1.1.

14. Four completed research projects

For some research projects finished earlier, see the reports for 2015 through 2019.

14.1. Mathematical concepts and their linguistic expressions in a multicultural setting

Figure 6. Hania Uscka-Wehlou, my Doctor #16.

Project manager: Hania Uscka-Wehlou (Figure 6).
Partners: Christer Oscar Kiselman, Adama Arouna Koné (Figure 5).
Advisors: Lars Mouwitz, Fanja Rakontondrajao, Amites Rasho, Shiva Samieinia (Figure 2), Xiaoqin Wang, my Doctor #8.
Project description: To study the relation between mathematical concepts and their expression in several languages. Special attention is devoted to the use of non-native languages.
Period: 2016-04-01 — 2020-02-29.
Financed by:
Hania Uscka-Wehlou:
1. Man In The Middle AB (MITM);
2. Uppsala University 2017-08-15 — 2019-08-13;
3. Mälardalen University 2019-08-14 — 2020-02-29.

Christer Oscar Kiselman: Kingdom of Sweden.
Adama Arouna Koné:
1. Université des Sciences, des Techniques et des Technologies de Bamako (USTTB), Bamako I, 2016 — 2018-01-07;
2. École Normale d'Enseignement Technique et Professionnel (ENETP), 2018-01-08 — 2020-02-29.

Publications: Three publications: Hania has published two articles joint with me in 2017 and one as a sole author in 2018. See the reports for 2018, Section 10.8, and 2019, Section 12.8.

Presentations: Hania has made five presentations in connection with this project during the years 2016–2018; see the report for 2018, Section 12.8.

14.2. Existence of continuous right inverses to linear mappings in elementary geometry

Project manager: Christer Oscar Kiselman.

Project description: A linear mapping of a compact convex subset of a finite-dimensional vector space always possesses a right inverse, but may lack a continuous right inverse even if the set is smoothly bounded. Examples showing this are given as well as conditions guaranteeing the existence of a continuous right inverse, also for other sets.

Period: 2005-09-08 — 2021-03-10.

Partner: Erik Melin, my Doctor #15.

Advisor: Hiroshi Yamaguchi.

Financed by: Christer Oscar Kiselman:

1. Uppsala University 2005 — 2006-04-30;
2. Kingdom of Sweden 2006-05-01 — 2020-10-19.

Erik Melin: Uppsala University 2005–2008.

Publication: The project was finished with the publication of the joint article named (21-4) on my web site.

14.3. Zamenhof's Yiddish grammar

Figure 7. Л. Заменгофъ, L. Zamenhof (1859–1917) around 1879.

Project manager: Christer Oscar Kiselman.

Project description: Zamenhof wrote a Yiddish grammar (in Russian) around 1880. It was published in full only in 1982. A study of this grammar has been undertaken. In particular, a comparison with his language project *Universal Language* from about the same time is of interest. (*Lingvo universala* was a predecessor of Esperanto, published in 1887.)

Presentations:

- 2016 July 29 at a conference in Nitra: "La jidogramatiko de Zamenhof kaj lia Lingvo universala."
- 2017 November 19 at the *Limmud* conference in Stockholm: "Zamenhofs jiddisch-grammatika och hans språk Lingvo universala."
- 2017 December 13 at the conference *The Heritage and Legacy of Ludwik Lejzer Zamenhof Between Judaism and Esperanto* at *Muzeum Historii Żydów Polskich POLIN* (The Museum of the History of the Polish Jews, Polin), in Warsaw, 2017 December 13–15. Title: "Zamenhof's Yiddish grammar and his Universal Language."
- 2018 February 28 at Uppsala University, Forum for Jewish Studies: "Zamenhof's Yiddish grammar and his five constructed languages." Invited by Lars Mikael Andersson and Cecilia Wassén.
- 2019 May 29 at *Zespół Szkół Ogólnokształcących w Złotoryi*, a public school in Złotoryja, "La kvin artefaritaj lingvoj de Zamenhof" (Zamenhof's five constructed languages). Invited by Małgorzata Komarnicka and Aleksander Pecyna.
- 2019 May 31. I was invited by the organizers of the Annual National Congress of Esperanto, held in Stockholm May 31 through June 02, to give a talk on May 31. My title was "La jidogramatiko de Zamenhof kaj lia Lingvo universala" (Zamenhof's Yiddish grammar and his Universal Language).
- 2022 August 11 in Montréal: *Du projektoj en aŝkenaza kulturo: La jidogramatiko de Zamenhof kaj lia Lingvo universala* (Two projects in Ashkenazi culture: Zamenhof's Yiddish grammar and his Universal Language.)
- 2022 October 26 in Strasbourg: *Digital geometry, mathematical morphology, and discrete optimization: A survey.* Invited lecture at the International Conference *Discrete Geometry and Mathematical Morphology* held at Université de Strasbourg, 2022 October 24–27.

Publications: An article was published in November 2016 (16-b), and a short paper appeared in 2019 (19-b).

An article in Esperanto (107 pages) was published on 2021 January 20; see item 21-a on my web site.

A book in English (167 pages) was published by KAVA-PECH in 2022; see Subsection 1.2.

Period: 2015-08-01 — 2022-08-11. The project was finished with the publication of the last-mentioned book and my talk in Montréal on 2022 August 11.

This project was a continuation of a similar one, where I studied the influence of Yiddish on Esperanto. This last-mentioned project started in 1982 and gave rise to a publication in 1992; see item 92-a in my web site.

Financed by: Kingdom of Sweden.

14.4. Elements of Digital Geometry, Mathematical Morphology, and Discrete Optimization

Project manager: Christer Oscar Kiselman.

Project description: A study of the fundamentals of three related fields of knowledge: digital geometry, mathematical morphology, and discrete optimization.

Partners: Erik Melin, Hania Uscka-Wehlou, Shiva Samieinia, Adama Arouna Koné.

Advisors: Jean Serra, Jesús Angulo.

Period: 2002 — 2022.

Financed by: Christer Oscar Kiselman:

1. Uppsala University 2002 — 2006-04-30;
2. Kingdom of Sweden 2006-05-01 — present.

Hania Uscka-Wehlou:

1. Man In The Middle AB (MITM);
2. Uppsala University 2017 August 15 — 2019 August 13;
3. Mälardalen University 2019 August 14 — present.

Shiva Samieinia:

1. The Royal Institute of Technology;
2. Stockholm University;
3. The Ruth and Nils-Erik Stenbäck Foundation.

Adama Arouna Koné:

1. International Science Programme (ISP) 2011–2016;
2. Université des Sciences, des Techniques et des Technologies de Bamako (USTTB), Bamako I, 2011 — 2018 January 07;
3. École Normale d'Enseignement Technique et Professionnel (ENETP), 2018 January 08 — 2022.

Publications

Lecture notes from 2002 (78 pages) and 2004 (95 pages) are available at my web site.

Lecture notes with the title *Digita geometrio, matematika morfologio kaj diskreta optimumado* (69 pages) from a course held in Warsaw in September 2017 (18-2). Published in 2018 at the web site of the International Academy of Sciences (AIS).

These lecture notes, somewhat revised, were published in January 2021 (item 21-1 on my web site).

A book comprising xii + 458 pages, was published on 2022 January 18 by World Scientific, Singapore; see Subsection 1.1 above. With this publication, the project is finished—however, there is still room for generalizations, possibly in cooperation with the four partners mentioned above.

15. Consequences of Covid-19

During the years 2020 and 2021, the pandemia had many consequences, with several of my planned trips having to be cancelled—among them planned visits to Paris, Toulouse, Montréal and Bern.

In 2022 many meetings, including conferences and congresses, were held via *Zoom*. Technically speaking, this functioned in general to satisfaction, but as witnessed by many, the use of this tool implies a loss of personal contacts, like the small talk during breaks, which is of great importance for reliable contacts between humans.

In Sweden the restrictions were lifted in February of 2022. Meetings and seminars gradually went back to normal after that date.

During a visit to Canada and the US in August of 2022, the author was subject to interrogations and had to show proof of "full vaccination" against Covid several times. He was vaccinated for the fifth time on 2022 September 05.

16. About the author

Gustavus VI Adolphus, King of Sweden, appointed me to be "laborator i matematik vid universitetet i Uppsala" (Associate Professor of Mathematics at the University of Uppsala). I was promoted to full professor in 1979. (The Government of Sweden later changed the name of the university to *Uppsala universitet*, in English *Uppsala University*.)

I retired on 2006 May 01. From September 2014, I was a guest professor at the neighboring Department of Information Technology, in the Division of Image Analysis. I asked for a transfer to the Division of Scientific Computing within the same department, a request which was motivated by a change of my research interests after the submission of my Singapore book in December of 2021—and, as I believed, also well motivated by later publications, which support the change of directions. The request was not accepted by the director of the Division of Scientific Computing.

On 2022 December 05, the Head of the Department of Mathematics invited me back to the Math Department.

I am most grateful for the eight years I was allowed to work in the Department of Information Technology, and likewise for the invitation to return to the Math Department.

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