様式 Form 7 (外国人招へい研究者)

2024年 11月 11日

YYYY/MM/DD

独立行政法人日本学術振興会理事長 殿

To: President, Japan Society for the Promotion of Science

研究活動報告書

Research Report

1.	受入研究者/Hos	t researcher							
N	受入研究機関・部局・職 Name of Host Institution, Department and Title			東京大学・情報理工学系研究科・教授					
	受入研究者氏名 Host Researcher's Name			武田 朗子					
2. 外国人招へい研究者/ Fellow									
	所属研究機関・部局・職			Zuse Institute Berlin · Mathematical Algorithmic Intelligence · Vice					
	Name of Institution, Department and Title			President					
		外国人招へい研究 Fellow's	者氏名 Name	Sebastian Poku	tta				
3.	採用期間/ Fellow	ship Period							
	2024年	4月	23 日	\sim		2024年	8月	31 日	
4	研究課題/Boson	reh Thoma							

4. 研究課題/Research Theme

ランダム射影を用いた部分空間条件付き勾配法の構築

Developing subspace conditional gradient methods based on random projection

5. 研究活動報告/Research Report

(1) 研究活動の概要・成果/ Summary of Research Results

Two closely related lines of research were followed.

- 1. **Random Subspace Frank-Wolfe methods:** We analyzed how the sampling of random subspaces is impacted when the boundary of the feasible region is approached. Standard approaches lead to probabilities of success for sampling a feasible direction of descent dropping exponentially fast as we approach the boundary. This makes it prohibitively expensive in the constraint setting to obtain optimal solutions; and seems to be inherent in the iterative nature of the approach together with hard constraints. As a consequence we started to explore (a) proximal variants, where the feasible region is encoded by means of a barrier function to effectively reduce the problem to an unconstrained variant that is solved with a proximal variant of Frank-Wolfe and (b) alternative sampling schemes, where we do not sample a subspace by means of a projection matrix (similar to Johnson-Lindenstrauss) but rather directly respect the structure of the feasible region in sampling. The obtained research directions seem to be very promising, and a publication is of the obtained results is planned.
- 2. Frank-Wolfe methods for broader classes of functions: In a separate research thread, partially motivated by the

challenges mentioned above, we investigated the use of the Frank-Wolfe method for weakly convex functions and other variants, to broaden the scope of applicability of these methods. We plan to publish the obtained results soon.

(2) 主な研究発表(雑誌論文、学会、集会、知的財産権等)/ Main Research Publications

Currently there are 2 Publications work-in-progress directly related to the research program from the grant:

- 1. Poirion, P., Pokutta, S., Takeda A. (in alphabetic order) Title: Random Subspace Conditional Gradients.
- 2. Pokutta, S., Takahashi, S., Takeda A., (in alphabetic order) Title: TBD

Other submitted or forthcoming publications within the time of the grant (with JSPS attribution in Acknowledgement)

- Braun, G., Pokutta, S., and Woodstock, Z. (2024). Flexible block-iterative analysis for the Frank-Wolfe algorithm. (submitted) URL: <u>https://arxiv.org/abs/2409.06931</u>
- 2. Human-AI Co-Creativity: Exploring Synergies Across Levels of Creative Collaboration, Book Chapter in "Generative Artificial Intelligence and Creativity" edited by Matthew Worwood, James C. Kaufman. (submitted)
- 3. Besançon, M., Designolle, S., Halbey, J., Hendrych, D., Kuzinowicz, D., Pokutta, S., Troppens, H., Viladrich Herrmannsdoerfer, D., and Wirth, E. (2024). Improved algorithms and novel applications of the FrankWolfe.jl library. (forthcoming)
- (3) その他/Remarks

The research activities from above have been complemented by several of outreach activities.

- 1. Signing of Memorandum of Understanding between Japan High-Performance Computing Network (JHPCN) and German National High-Performance Computing (NHR) (July 2024) URL: <u>https://jhpcn-kyoten.itc.u-tokyo.ac.jp/ja/NHR_202407</u>
- Keynote at 16th JHPCN symposium "German <-> Japanese Supercomputing a success story" URL: <u>https://jhpcn-kyoten.itc.u-tokyo.ac.jp/ja/sympo/16th</u> Slides: <u>https://www.pokutta.com/slides/20240712_JHPCN_keynote_pokutta.pdf</u>
- 3. Organization of Conference "Discrete Optimization and Machine Learning Conference" at GRIPS URL: <u>https://doml.zib.de/previous/doml2024.html</u>
- 4. Talk at Discrete Optimization and Machine Learning Conference "Extending the Continuum of Six-Colorings" URL: <u>https://doml.zib.de/previous/doml2024.html</u> Slides: <u>https://www.pokutta.com/slides/20240710_colorings.pdf</u>

Two new collaborations were established while visiting the University of Tokyo.

- Katsuki Fujisawa (Institute of Science Tokyo) Ultra-large-scale solving SDPs appearing in extremal combinatorics URL: <u>https://sites.google.com/view/fujisawa-lab-en/about-us/members/professor-katsuki-fujisawa</u>
- 2. Bruno Lourenço (The Institute of Statistical Mathematics/SOKENDAI)

Possible improvements to prior work ("Projection onto hyperbolicity cones and beyond: a dual Frank-Wolfe approach") via leveraging modern Frank-Wolfe variants, in particular active set-based methods utilizing blending. URL: https://bflourenco.github.io/