Computational Projection Project [1]

E.A. Nurminski
nurminskiy.ea@dvfu.ru

Far Eastern Federal University, School of Natural Sciences,
Ajax St., Vladivostok, Russky Island, Russia

17th Baikal International Triennial School-Seminar
"Methods of Optimization and Their Applications"
July 31–August 6, 2017, Maksimikha Bay, Buryatia)

August 4, 2017

[1] This work is supported by Ministry of Science and Education of RF, project 1.7658.2017/6.7

Aim

Fundamental problem:

$$\begin{gathered}\min \|x\|_{\mathcal{N}} \\ x \in X\end{gathered}$$

- $\mathcal{N}$ — a norm, distance function, ...
- X — polyhedron, shifted cone, composition of sets, ...
- ...

Our primary selfish interests:

$\mathcal{N} = 2$ (orthogonal projection),

X — polytope ($X = \mathrm{co}\{\hat{x}^1, \hat{x}^1, \ldots, \}$).

Great disappointment

- Active Set Algorithms fail due to degeneracy or else.
- No "off-the-shelf" specialized software.
- Underdevelopment: big productivity gap between some specialized routines (f.i. projection on simplex due to Michelot, Malozemov, et al) and general purpose QP.
- Low accuracy, esp. when projected point is close to a feasible set.

Computational convex polytope projection

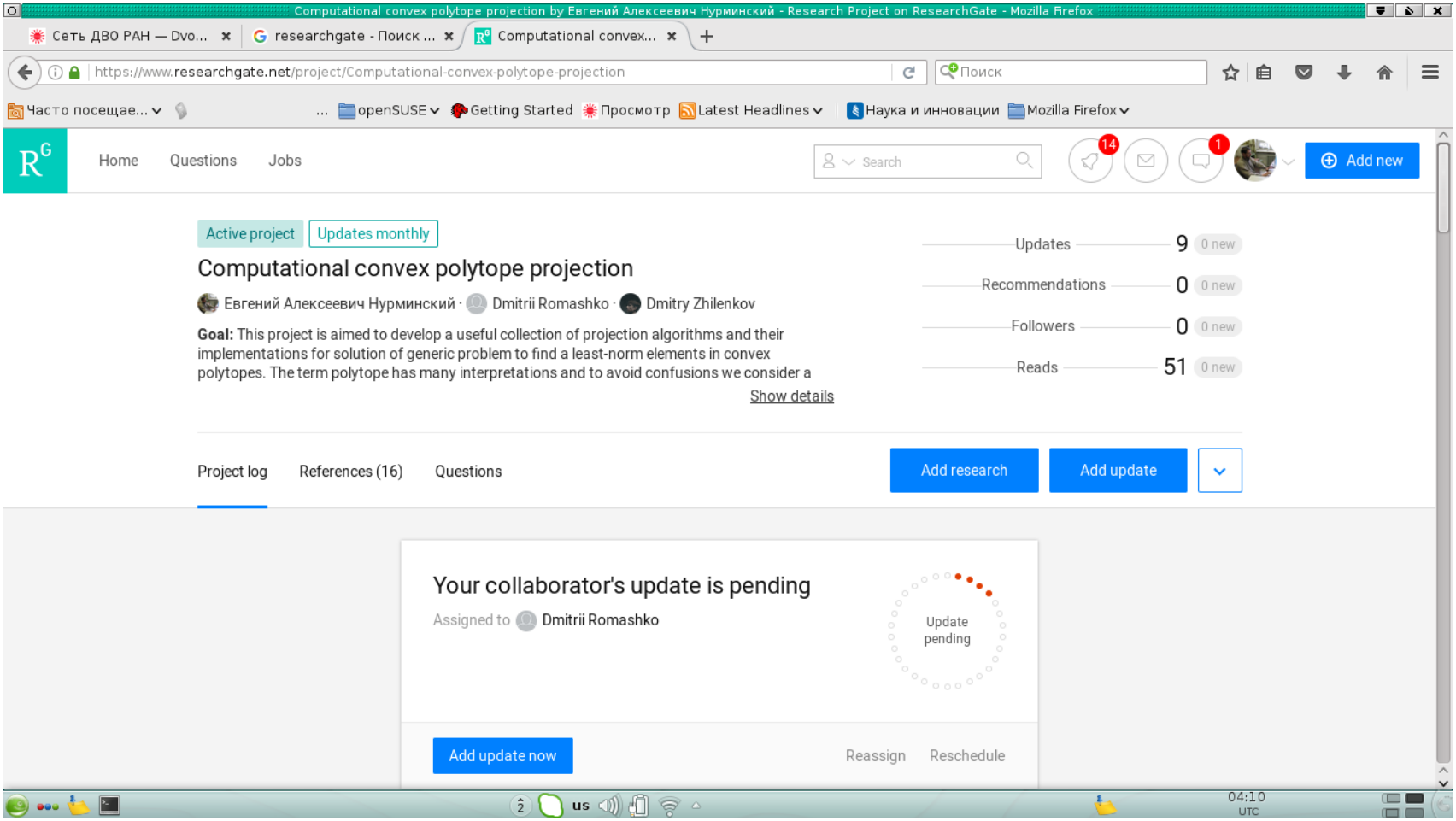
You can find us at

https://www.researchgate.net/project/Computational-convex-polytope-projection

Goal: This project is aimed to develop a useful collection of projection algorithms and their implementations for solution of generic problem to find a least-norm elements in convex polytopes.

Computational CPPP

Computational convex polytope projection project



Flagship product

PTP — **P**oly**T**op **P**rojection

- Current version — 1.5 (June 2017)
- Language(s) — OCTAVE (1.5), Python (1.2, 1.5 forthcoming)
- Size — 247 lines (6312 bytes)
- Calling sequence —

  [z, reps, iter, lmb, kvec, R, info] = ptp(X, maxit, eps, verbose, kvec0, R0)

PTP computational experience

- Nurminski E.A.: Convergence of the Suitable Affine Subspace Method for Finding the Least Distance to a Simplex Computational Mathematics and Mathematical Physics. Vol. 45 No. 11, 2005, pp. 1915–1922.
- Vorontsova, E.A.: Extended Separating Plane Algorithm and NSO-Solutions of PageRank Problem. DOOR 2016, Vladivostok. LCNS, vol. 9869.
- Nurminski, E.A.; Zhilenkov, D.A.: Active Set Quadratic Programming versus Specialized Projection Routine. "LION11 - LEARNING AND INTELLIGENT OPTIMIZATION", Nizhniy Novgorod, 2017, e-copy on the project page.

Nearest Plans

- Projection on polyhedron in outer representation ($X = \{x : Ax \leq b\}$).
  Can be used for LP: Nurminski, E. A.: (2016). Single-projection procedure for linear optimization. J. Global Optimization, 66(1), 95–110;
- Mixed representations: $X = \mathrm{co}\{\dots\} \cap \{Ax \leq b\}$;
- Shifted cone projection: $X = a + \mathrm{Co}\{\hat{x}^1, \hat{x}^2, \dots, \hat{x}^N\}$;
- Dynamic decomposition: $X = \mathrm{co}\{X_1, X_2, \dots, X_K\}, \cap_{k=1}^{K} X_k = X$;
- and so on ...

Collaborators welcome !