

Computational Projection Project ¹

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Fundamental problem:

$$\min_{x \in X} \|x\|_{\mathcal{N}}$$

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

Our primary selfish interests:

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

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

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

The screenshot shows a web browser window displaying a ResearchGate project page. The browser's address bar shows the URL: <https://www.researchgate.net/project/Computational-convex-polytope-projection>. The page header includes the ResearchGate logo and navigation links for Home, Questions, and Jobs. A search bar and a user profile icon with a notification badge are also visible.

The main content area features the project title "Computational convex polytope projection" and a status indicator "Active project" with "Updates monthly". Below the title, the project is attributed to three users: Евгений Алексеевич Нурминский, Dmitrii Romashko, and Dmitry Zhilenkov. A "Goal" section describes the project's aim to develop projection algorithms and solve a least-norm problem in convex polytopes. To the right of the goal, a statistics table shows:

Updates	9	0 new
Recommendations	0	0 new
Followers	0	0 new
Reads	51	0 new

A "Show details" link is provided below the statistics. Below the project description, there are tabs for "Project log", "References (16)", and "Questions". Two blue buttons, "Add research" and "Add update", are visible, along with a dropdown menu.

A prominent notification box in the center of the page states: "Your collaborator's update is pending". It is assigned to "Dmitrii Romashko" and includes a circular progress indicator with the text "Update pending". Below this notification are two buttons: "Add update now" and "Reassign Reschedule".

The bottom of the screenshot shows the Windows taskbar with system icons and the time "04:10 UTC".

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 —
 $[z, \text{reps}, \text{iter}, \text{lmb}, \text{kvec}, R, \text{info}] = \text{ptp}(X, \text{maxit}, \text{eps}, \text{verbose}, \text{kvec0}, R0)$

- 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: $X = \text{co}\{\dots\} \cap \{Ax \leq b\}$;
- Shifted cone projection: $X = a + \text{Co}\{\hat{x}^1, \hat{x}^2, \dots, \hat{x}^N\}$;
- Dynamic decomposition:
 $X = \text{co}\{X_1, X_2, \dots, X_K\}, \bigcap_{k=1}^K X_k = X$;
- and so on ...

Collaborators welcome !