Nikolay S. Markov

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Education

Ph.D. in Computational Biology, Northwestern University, Chicago, USA 2022–2025 (expected in December)
Driskill Graduate Program in Life Sciences
Advisors: Dr. Alexander Misharin, Dr. Rosemary Braun.

M.S. in Bioinformatics, Newcastle University, Newcastle upon Tyne, UK 2017–2018
With distinction
Advisors: Dr. Jaume Bacardit (Newcastle University),
Dr. Alexander Misharin (Northwestern University).

Undergraduate coursework in Biology, Moscow State University, Moscow, Russia 2003–2006
Genetics major

Publications

(*denotes equal contribution)

1. Preprints (5)

26 Profibrotic monocyte-derived alveolar macrophages as a biomarker and therapeutic target in systemic sclerosis-associated interstitial lung disease. *bioRxiv*. 10.1101/2025.08.07.669006 2025
Markov NS*, Esposito AJ*, Senkow KJ, Schleck M, Cusick L, Yu Z, Sokolenko YV, Diaz E, Jonasson E, Swaminathan S, Lu Z, *[…47 more…]*, Dapas M, Richardson C, Perlman H, Lam AP, Gottardi CJ, Budinger GS, Misharin AV, Hinchcliff ME

25 Development of a pilot machine learning model to predict successful cure in critically ill patients with community-acquired pneumonia. *medRxiv*. 10.1101/2025.07.14.25331407 2025
Zhu M, Liao W, Peltekian A, **Markov NS**, Kang M, Rasmussen LV, Stoeger T, Walunas TL, Misharin AV, Singer BD, Budinger GRS, Wunderink RG, Agrawal A, Gao CA

24 Machine learning analysis of electronic health records identifies interstitial lung disease and predicts mortality in patients with systemic sclerosis. *medRxiv*. 10.1101/2025.06.02.25328786 2025
Peltekian AK, Grudzinski KM, Bemiss BC, Dematte JE, Richardson C, **Markov NS**, Carns M, Aren K, Field NS, *[…11 more…]*, Gao CA, Wunderink RG, Budinger GS, Choudhary A, Misharin AV, Agrawal A, Esposito AJ

23 *In silico* perturbations provide multivariate interpretability in predicting post-lung transplant outcomes. *medRxiv*. 10.1101/2024.10.19.24315817 2024
Luo L, Możejko M, **Markov NS**, Peltekian A, Mohsin S, Carns M, Cooper P, Lysne J, Joudi A, Betensley A, Bemiss BC, Myers C, Bharat A, Tomic R, Arunachalam A, Szczurek E, Budinger GS, Misharin AV, Subramani MV

22 Neutrophil percentages in bronchoalveolar lavage fluid: implications for diagnosing bacterial pneumonia in patients with immunocompromise and neutropenia. *medRxiv*. 10.1101/2024.05.04.24306709 2024
Grudzinski KM, Fenske S, Peltekian A, **Markov NS**, Pawlowski A, Kang M, Walter JM, Pickens CI, Nadig NR, Agrawal A, Singer BD, Wunderink RG, Gao CA

2. Peer-reviewed research articles (21)

21 Developing and validating machine learning models to predict next-day extubation. *Sci. Rep.* 15(1). 10.1038/s41598-025-12264-4 2025
Fenske SW, Peltekian A, Kang M, **Markov NS**, Zhu M, Grudzinski K, Bak MJ, Pawlowski A, Gupta V, Mao Y, Bratchikov S, Stoeger T, Rasmussen LV, Choudhary AN, Misharin AV, Singer BD, Budinger GRS, Wunderink RG, Agrawal A, Gao CA, NU SCRIPT Study Investigators

20 Defining and benchmarking open problems in single-cell analysis. *Nat. Biotechnol.* 43(7):1035-1040. 10.1038/s41587-025-02694-w 2025
Luecken MD, Gigante S, Burkhardt DB, Cannoodt R, Strobl DC, **Markov NS**, Zappia L, Palla G, Lewis W, *[…39 more…]*, Pisco AO, Saez-Rodriguez J, Wulsin D, Pinello L, Saeys Y, Theis FJ, Krishnaswamy S

19 Antibiotic de-escalation patterns and outcomes in critically ill patients with suspected pneumonia as informed by bronchoalveolar lavage results. *Eur. J. Clin. Microbiol. Infect. Dis.* 44(8):1861-1871. 10.1007/s10096-025-05144-2 2025
Zhu M, Pickens CI, **Markov NS**, Pawlowski A, Kang M, Rasmussen LV, Walter JM, Nadig NR, Singer BD, Wunderink RG, Gao CA, The N. U. SCRIPT Study Investigators

18 funkyheatmap: visualising data frames with mixed data types. *Journal of Open Source Software* 10(108):7698. 10.21105/joss.07698 2025
Cannoodt R*, Deconinck L*, Couckuyt A*, **Markov NS***, Zappia L, Luecken MD, Interlandi M, Saeys Y†, Saelens W†

17 An observational cohort study of bronchoalveolar lavage fluid galactomannan and *Aspergillus* culture positivity in patients requiring mechanical ventilation. *Open Forum Infectious Diseases* 12(3). 10.1093/ofid/ofaf090 2025
Gao CA, **Markov NS**, Pickens C, Pawlowski A, Kang M, Walter JM, Singer BD, Wunderink RG

16 Profibrotic monocyte-derived alveolar macrophages are expanded in patients with persistent respiratory symptoms and radiographic abnormalities after COVID-19. *Nat. Immunol.* 25(11):2097-2109. 10.1038/s41590-024-01975-x 2024
Bailey JI, Puritz CH, Senkow KJ, **Markov NS**, Diaz E, Jonasson E, Yu Z, Swaminathan S, Lu Z, Fenske S, Grant RA, Abdala-Valencia H, *[…10 more…]*, San Jose Estepar R, San Jose Estepar R, Washko GR, Shilatifard A, Sznajder JI, Ridge KM, Budinger GRS, Braun R, Misharin AV, Sala MA

15 Distinctive evolution of alveolar T cell responses is associated with clinical outcomes in unvaccinated patients with SARS-CoV-2 pneumonia. *Nat. Immunol.* 25(9):1607-1622. 10.1038/s41590-024-01914-w 2024
Markov NS, Ren Z, Senkow KJ, Grant RA, Gao CA, Malsin ES, Sichizya L, Kihshen H, Helmin KA, Jovisic M, Arnold JM, *[…9 more…]*, Simons LM, Rios-Guzman E, Misharin AV, Wunderink RG, Budinger GRS, Singer BD, Morales-Nebreda L, The NU SCRIPT Study Investigators

14 Machine learning links unresolving secondary pneumonia to mortality in patients with severe pneumonia, including COVID-19. *Journal of Clinical Investigation* 133(12). 10.1172/jci170682 2023
Gao CA*, **Markov NS***, Stoeger T*, Pawlowski A, Kang M, Nannapaneni P, Grant RA, Pickens C, Walter JM, Kruser JM, Rasmussen L, Schneider D, Starren J, Donnelly HK, Donayre A, Luo Y, Budinger GS, Wunderink RG, Misharin AV, Singer BD

13 An integrated cell atlas of the lung in health and disease. *Nat. Med.* 29(6):1563-1577. 10.1038/s41591-023-02327-2 2023
Sikkema L, Ramírez-Suástegui C, Strobl DC, Gillett TE, Zappia L, Madissoon E, **Markov NS**, Zaragosi L, Ji Y, Ansari M, Arguel M, *[…79 more…]*, Schiller HB, Tata PR, Schultze JL, Teichmann SA, Misharin AV, Nawijn MC, Luecken MD, Theis FJ

12 Comparing scientific abstracts generated by ChatGPT to real abstracts with detectors and blinded human reviewers. *npj Digital Med.* 6(1). 10.1038/s41746-023-00819-6 2023
Gao CA, Howard FM, **Markov NS**, Dyer EC, Ramesh S, Luo Y, Pearson AT

11 Loss of alcohol dehydrogenase 1B in cancer-associated fibroblasts: contribution to the increase of tumor-promoting IL-6 in colon cancer. *Br. J. Cancer* 128(4):537-548. 10.1038/s41416-022-02066-0 2022
Villéger R, Chulkina M, Mifflin RC, **Markov NS**, Trieu J, Sinha M, Johnson P, Saada JI, Adegboyega PA, Luxon BA, Beswick EJ, Powell DW, Pinchuk IV

10 Expression of *ACE2*—a key SARS-CoV-2 entry factor—is not increased in the nasal mucosa of people with cystic fibrosis. *Am. J. Respir. Cell Mol. Biol.* 67(1):132-137. 10.1165/rcmb.2021-0341le 2022
Sala MA*, **Markov NS***, Politanska Y, Abdala-Valencia H, Misharin AV, Jain M

09 Age-related differences in the nasal mucosal immune response to SARS-CoV-2. *Am. J. Respir. Cell Mol. Biol.* 66(2):206-222. 10.1165/rcmb.2021-0292oc 2022
Koch CM, Prigge AD, Anekalla KR, Shukla A, Do Umehara HC, Setar L, Chavez J, Abdala-Valencia H, Politanska Y, **Markov NS**, Hahn GR, Heald-Sargent T, Sanchez- Pinto LN, Muller WJ, Singer BD, Misharin AV, Ridge KM, Coates BM

08 Local and systemic responses to SARS-CoV-2 infection in children and adults. *Nature* 602(7896):321-327. 10.1038/s41586-021-04345-x 2021
Yoshida M, Worlock KB, Huang N, Lindeboom RGH, Butler CR, *[…34 more…]*, NU SCRIPT Study Investigators, Budinger GRS, Donnelly HK, **Markov NS**, Lu Z, *[…9 more…]*, Jolly C, De Coppi P, Smith CM, Misharin AV, Janes SM, Teichmann SA, Nikolić MZ, Meyer KB

07 UCSC Cell Browser: visualize your single-cell data. *Bioinformatics* 37(23):4578-4580. 10.1093/bioinformatics/btab503 2021
Speir ML, Bhaduri A, **Markov NS**, Moreno P, Nowakowski TJ, Papatheodorou I, Pollen AA, Raney BJ, Seninge L, Kent WJ, Haeussler M

06 Resetting proteostasis with ISRIB promotes epithelial differentiation to attenuate pulmonary fibrosis. *Proceedings of the National Academy of Sciences* 118(20). 10.1073/pnas.2101100118 2021
Watanabe S, **Markov NS**, Lu Z, Piseaux Aillon R, Soberanes S, Runyan CE, Ren Z, Grant RA, Maciel M, *[…8 more…]*, Jain M, Sznajder JI, Morimoto RI, Reyfman PA, Gottardi CJ, Budinger GRS, Misharin AV

05 Aging imparts cell-autonomous dysfunction to regulatory T cells during recovery from influenza pneumonia. *JCI Insight* 6(6). 10.1172/jci.insight.141690 2021
Morales-Nebreda L, Helmin KA, Torres Acosta MA, **Markov NS**, Hu JY, Joudi AM, Piseaux-Aillon R, Abdala-Valencia H, Politanska Y, Singer BD

04 Circuits between infected macrophages and T cells in SARS-CoV-2 pneumonia. *Nature* 590(7847):635-641. 10.1038/s41586-020-03148-w 2021
Grant RA*, Morales-Nebreda L*, **Markov NS***, Swaminathan S, Querrey M, Guzman ER, Abbott DA, Donnelly HK, Donayre A, *[…21 more…]*, Bharat A, Gottardi CJ, Budinger GRS, Misharin AV, Singer BD, Wunderink RG, The NU SCRIPT Study Investigators

03 Lung transplantation for patients with severe COVID-19. *Sci. Transl. Med.* 12(574). 10.1126/scitranslmed.abe4282 2020
Bharat A, Querrey M, **Markov NS**, Kim S, Kurihara C, Garza-Castillon R, Manerikar A, Shilatifard A, Tomic R, Politanska Y, Abdala-Valencia H, Yeldandi AV, Lomasney JW, Misharin AV, Budinger GRS

02 Impaired phagocytic function in CX3CR1^{+} tissue-resident skeletal muscle macrophages prevents muscle recovery after influenza A virus-induced pneumonia in old mice. *Aging Cell* 19(9). 10.1111/acel.13180 2020
Runyan CE, Welch LC, Lecuona E, Shigemura M, Amarelle L, Abdala-Valencia H, Joshi N, Lu Z, Nam K, **Markov NS**, McQuattie-Pimentel AC, Piseaux-Aillon R, Politanska Y, Sichizya L, Watanabe S, Williams KJ, Budinger GRS, Sznajder JI, Misharin AV

01 A spatially restricted fibrotic niche in pulmonary fibrosis is sustained by M-CSF/M-CSFR signalling in monocyte-derived alveolar macrophages. *European Respiratory Journal* 55(1):1900646. 10.1183/13993003.00646-2019 2019
Joshi N, Watanabe S, Verma R, Jablonski RP, Chen C, Cheresh P, **Markov NS**, Reyfman PA, McQuattie-Pimentel AC, Sichizya L, Lu Z, Piseaux-Aillon R, Kirchenbuechler D, Flozak AS, Gottardi CJ, Cuda CM, Perlman H, Jain M, Kamp DW, Budinger GS, Misharin AV

Invited talks and meetings

Poster: Machine learning and single-cell genomics identify distinct pathogen-specific host responses in patients with severe pneumonia. September 2025
AI in Molecular Biology Keystone Symposium.

Distinct pathogen-specific host responses in patients with severe pneumonia. March 2025
Systems Biology Consortium for Infectious Diseases Lecture Series.

Host response in severe pneumonia is pathogen-specific. September 2024
Systems Biology for Infectious Diseases Annual Meeting.

Cellular and molecular biomarkers of successful responses to therapy in severe pneumonia, including COVID-19. November 2022
CZI Single-Cell Biology 2022 Annual meeting. Recording

Poster: Integrative analysis of longitudinal clinical and single-cell RNA-seq data predicts outcomes in patients with severe SARS-CoV-2 pneumonia November 2022
CSHL Biological Data Science Meeting.

Circuits between infected macrophages and T cells in SARS-CoV-2 pneumonia. June 2021
American Thoracic Society Allergy, Immunology and Inflammation (AII) assembly journal club. Recording

Awards and grants

Driskill Research Award 2025

American Heart Association Predoctoral Fellowship 2024–2026
Machine learning approaches to predict outcomes and complications in ICU patients.
24PRE1196998 ($67000)

Northwestern Institute on Complex Systems Data Science Fellow ($12500) 2022

Work experience

Ph.D. researcher, Division of Pulmonary and Critical Care Medicine, 2022–present
Feinberg School of Medicine, Northwestern University, Chicago, USA

- Led 4 large collaborative projects with 500+ patients and multimodal data to publication
- Acquired external funding for my training (AHA predoctoral fellowship)
- Authored and co-authored 18, including 4 first/co-first, publications or preprints
- Led analysis of scRNAseq patient samples in the context of their clinical course with novel machine learning approach (clustering of patient-day representations and late fusion)
- Identified cell population as a biomarker and potential therapeutic target of ILD in SSc (Markov et al., *bioRxiv*, 2025)
- Consulted 7 Northwestern grad students, postdocs and faculty on deep learning, data science and data visualization, including setting up and training in paw tracking on videos for mouse experiments

Research data analyst, bioinformatics, Division of Pulmonary and Critical Care Medicine, 2019–2022
Feinberg School of Medicine, Northwestern University, Chicago, USA

- Created data processing pipelines, data exploration and management infrastructure for the division
- Delivered analytical insights from scRNAseq and other data to principal investigators for 7 publications
- Formulated activated T cell↔macrophage circuit in *Nature* 2021, which supported successful clinical trials of Auxora in COVID-19 (NCT04345614)
- Supported grant writing for U19, R01 and other NIH grants for the division, resulting in $5M+ funding
- Hired and trained incoming data analysts to grow the team and replace myself

Head of maintenance tools development group, Yandex, Moscow, Russia 2014–2017

- Managed a team of 6 engineers: hiring, mentoring, resolving conflicts, improving performance
- Synthesized internal customers' needs into technical roadmaps for supporting web-services
- Owned various web-services to improve employees' workflows

Full-stack software engineer, Yandex, Moscow, Russia 2007–2014

- Automated deploy workflows of system administrators for better consistency and transparency
- Deployed and maintained various web-services to improve employees' workflows

Software engineer, Art. Lebedev Studio, Moscow, Russia 2006–2007

- Supported and developed Samsung Russia website, including new features and database management

Teaching experience

Biological Science Teaching Assistant, Northwestern University 2024

- Presented weekly lecture recap and experimental objectives
- Supervized lab sessions for 22 students
- Graded assignments and provided detailed written feedback

Summer Students Program 2022 at Division of Pulmonary and Critical Care Medicine 2022

Co-mentored 1 college student in automated image analysis. Helped develop project goals, methodology and results interpretation

Summer Students Program 2020 at Division of Pulmonary and Critical Care Medicine 2020

Co-mentored a group of 4 college students on a bioinformatics project. Contributed to project's design, teaching R programming environment, single-cell RNA-seq experimental technology and analysis

Introduction to Python, Introduction to Pandas and Matplotlib 2020

Small introductory lecture series during Data Science Nights at NICO, Northwestern University

Introduction to Programming, Newcastle University, Newcastle upon Tyne, UK 2017

Unofficial 5-lecture course for fellow students

Introduction to Computer Science with Python 3, Yandex, Moscow, Russia 2013

Logical and mathematical problems with strict proofs for high-school students in python

Miscallaneous

Open Problems for Single-Cell Analysis 2021–present

Initial jamboree contributor and label projection task leader. https://openproblems.bio

Contributor to open-source software 2018–present

Seurat, CellBrowser, biopython, funkyheatmap, statannotations, scanpy, CellBender

Programming languages

Python, R, Java, C++, Ruby, Perl. Linux. Latex. HTML, JavaScript.
Github: https://github.com/mxposed