

— Education —

Ph.D. in Computational Biology , Northwestern University, Chicago, USA	2022–2025
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
<i>With distinction</i>	
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, Mozejko 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. 2025
10.1038/s41587-025-02694-w
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. 2025
10.1007/s10096-025-05144-2
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. 2025
10.21105/joss.07698
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). 2025
10.1093/ofid/ofaf090
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. 2024
10.1038/s41590-024-01975-x
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. 2024
10.1038/s41590-024-01914-w
Markov NS, Ren Z, Senkow KJ, Grant RA, Gao CA, Malsin ES, Sichizya L, Kihshen H, Helmin KA, Jovicic 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). 2023
10.1172/jci170682
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. 2023
10.1038/s41591-023-02327-2
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). 2023
10.1038/s41746-023-00819-6
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. 2022
10.1038/s41416-022-02066-0
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. 2022
10.1165/rcmb.2021-0341le
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 RG, 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/accel.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, Kirichenbuechler 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. Systems Biology for Infectious Diseases Annual Meeting.	September 2024
Cellular and molecular biomarkers of successful responses to therapy in severe pneumonia, including COVID-19. CZI Single-Cell Biology 2022 Annual meeting. Recording	November 2022
Poster: Integrative analysis of longitudinal clinical and single-cell RNA-seq data predicts outcomes in patients with severe SARS-CoV-2 pneumonia CSHL Biological Data Science Meeting.	November 2022
Circuits between infected macrophages and T cells in SARS-CoV-2 pneumonia. American Thoracic Society Allergy, Immunology and Inflammation (All) assembly journal club. Recording	June 2021

— Awards and grants —

Driskill Research Award	2025
American Heart Association Predoctoral Fellowship Machine learning approaches to predict outcomes and complications in ICU patients. 24PRE1196998 (\$67000)	2024–2026
Northwestern Institute on Complex Systems Data Science Fellow (\$12500)	2022

— Work experience —

Ph.D. researcher , Division of Pulmonary and Critical Care Medicine, Feinberg School of Medicine, Northwestern University, Chicago, USA <ul style="list-style-type: none"> 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., <i>bioRxiv</i>, 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 	2022–2025
Research data analyst, bioinformatics , Division of Pulmonary and Critical Care Medicine, Feinberg School of Medicine, Northwestern University, Chicago, USA <ul style="list-style-type: none"> 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 <i>Nature</i> 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 	2019–2022
Head of maintenance tools development group , Yandex, Moscow, Russia <ul style="list-style-type: none"> 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 	2014–2017
Full-stack software engineer , Yandex, Moscow, Russia <ul style="list-style-type: none"> Automated deploy workflows of system administrators for better consistency and transparency Deployed and maintained various web-services to improve employees' workflows 	2007–2014
Software engineer , Art. Lebedev Studio, Moscow, Russia <ul style="list-style-type: none"> Supported and developed Samsung Russia website, including new features and database management 	2006–2007

— Teaching experience —

Biological Science Teaching Assistant, Northwestern University	2024
<ul style="list-style-type: none">• 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	