# Logbook summary doc

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| **Word docs (in logbook files folder)** | **Description** |
| Literature review | Brief descriptions of all the papers I’ve read \* |
| Lotka Volterra in SINDy tests | SINDy in MATLAB solving the Lotka Volterra equations |
| pySINDy tests | Logbook of running examples from pysindy, solving lotka-volterra with SINDy, solving the (very simplified) rolling bearing equations in SINDy, solving 2nd order ODEs (normally, not SINDy), |
| Rolling bearing equations python | Solving 2nd law, changing forcing term (F) – constant, spring, damper, sinusoidal, and combinations |
| Deap examples | Example from DEAP github (symbolic regression paper) |
| Building libraries | Examples of each library you can build in pysindy |
| Spring-mass-damper with noise | added noise to spring-mass-damper & sin system and solved, |
| Spring-damp-sin system noise investigation | Solving spring-damp-sin system in sindy-pi and ens-sindy with different noise levels  (turns out I was adding noise wrong – see *comparing sindy versions* doc) |
| Case western data in sindy | Using the case western data in sindy-pi and ens-sindy, normal and faulty |
| Comparing SINDy versions | Using the spring mass damper & sin system w/ and w/out noise in SINDy, SINDy-PI, ens-SINDy, abrupt-SINDy, SINDy-SA |
| Faulty data | Comparing the stitched case western fault data and the NASA bearing data  In SINDy, SINDy-PI, Ensemble-SINDy, and Abrupt-SINDy |

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| **PowerPoints** | **Description** |
| Summer Internship | Summary of all the work done chronologically |
| Symposium final | Presentation used at the internship symposium |

# Papers Read\*

1. Brunton, Steven L., Joshua L. Proctor, and J. Nathan Kutz. "Discovering governing equations from data by sparse identification of nonlinear dynamical systems." *Proceedings of the national academy of sciences* 113.15 (2016): 3932-3937.
2. Kaheman, Kadierdan, J. Nathan Kutz, and Steven L. Brunton. "SINDy-PI: a robust algorithm for parallel implicit sparse identification of nonlinear dynamics." Proceedings of the Royal Society A 476.2242 (2020): 20200279.
3. Karniadakis, George Em, et al. "Physics-informed machine learning." *Nature Reviews Physics* 3.6 (2021): 422-440.
4. Kostek, Robert. "Simulation and analysis of vibration of rolling bearing." *Key Engineering Materials*. Vol. 588. Trans Tech Publications Ltd, 2014.
5. Quade, Markus, et al. "Sparse identification of nonlinear dynamics for rapid model recovery." *Chaos: An Interdisciplinary Journal of Nonlinear Science* 28.6 (2018): 063116.
6. Fasel, Urban, et al. "Sindy with control: A tutorial." *2021 60th IEEE Conference on Decision and Control (CDC)*. IEEE, 2021.
7. Naozuka, Gustavo T., et al. "SINDy-SA: Enhancing Nonlinear System Identification with Sensitivity Analysis." (2022).
8. Fasel, Urban, et al. "Ensemble-SINDy: Robust sparse model discovery in the low-data, high-noise limit, with active learning and control." *Proceedings of the Royal Society A* 478.2260 (2022): 20210904.
9. Sadoughi, Mohammakazem, et al. "A deep learning-based approach for fault diagnosis of roller element bearings." *2018 Annual Conference of the Prognostics and Health Management Society*. Vol. 10. No. 1. 2018.
10. Smagala, A., and K. Kecik. "Nonlinear model and simulation of a rolling bearing." *IOP Conference Series: Materials Science and Engineering*. Vol. 710. No. 1. IOP Publishing, 2019.
11. Zhao, Ziqiang, Xuebin Yin, and Wenzhong Wang. "Effect of the raceway defects on the nonlinear dynamic behavior of rolling bearing." *Journal of Mechanical Science and Technology* 33.6 (2019): 2511-2525.
12. Manzi, Matteo, and Massimiliano Vasile. "Discovering unmodeled components in astrodynamics with symbolic regression." *2020 IEEE Congress on Evolutionary Computation (CEC)*. IEEE, 2020.
13. Azari, Abigail R., et al. "Incorporating physical knowledge into machine learning for Planetary Space Physics." *Frontiers in Astronomy and Space Sciences* 7 (2020): 36.
14. Da Poian, Victoria, et al. "Science Autonomy and Space Science: Application to the ExoMars Mission." *Frontiers in Astronomy and Space Sciences* (2022): 95.
15. McGovern, Amy, and Kiri L. Wagstaff. "Machine learning in space: extending our reach." *Machine Learning* 84.3 (2011): 335-340.
16. Lee, Christopher. "Automated crater detection on Mars using deep learning." *Planetary and Space Science* 170 (2019): 16-28.
17. Dattilo, Anne, et al. "Identifying exoplanets with deep learning. ii. two new super-earths uncovered by a neural network in k2 data." *The Astronomical Journal* 157.5 (2019): 169.
18. Kashinath, K., et al. "Physics-informed machine learning: case studies for weather and climate modelling." *Philosophical Transactions of the Royal Society A* 379.2194 (2021): 20200093.
19. Corbetta, Matteo. "Application of sparse identification of nonlinear dynamics for physics-informed learning." *2020 IEEE Aerospace Conference*. IEEE, 2020.
20. Jung, Dawoon. "Recent Machine Learning Applications in Space." *IEEE Potentials* 39.4 (2020): 34-38.
21. Ono, Masahiro, et al. "Machine learning for planetary rovers." *Machine Learning for Planetary Science*. Elsevier, 2022. 169-191.

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| **.pdf file** | **Description** |
| Neural networks and SINDy explanation | Handwritten notes on basic neural network structure and the maths of SINDy |

# Other resources

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| *From Jennifer Blair in regards to simulating faulty bearings* | | |
| **Name** | **Link** | **Description** |
| NASA bearing dataset | <https://www.kaggle.com/datasets/vinayak123tyagi/bearing-dataset> | This dataset record bearings ‘breaking’ over time, so you see the fault develop and progress. |
| Pybearing | <https://github.com/mksadoughi/pybearing> | A python library which simulated faults by adding fault frequencies together |
| ROSS | <https://ross.readthedocs.io/en/stable/> | A python library which lets you simulate motor components like bearings by building (almost) a virtual 3D model (you define the components, how they couple together and the material parameters and it simulates how this would react to external driving forces). |
| Rolling Element Bearing Fault Diagnosis | <https://uk.mathworks.com/help/predmaint/ug/Rolling-Element-Bearing-Fault-Diagnosis.html> | MATLAB example using an external dataset to investigate bearing faults |
| Using Simulink to Generate Fault Data | <https://uk.mathworks.com/help/predmaint/ug/Use-Simulink-to-Generate-Fault-Data.html> | A Simulink tutorial that simulate a rolling bearing |
| Sensor Fault Modelling E Balaban | <https://ieeexplore.ieee.org/abstract/document/5297818> | A paper on simulating faulty bearings |
| *YouTube videos* | | |
| SINDy YouTube series | [Sparse Identification of Nonlinear Dynamics (SINDy): Sparse Machine Learning Models 5 Years Later!](https://www.youtube.com/watch?v=NxAn0oglMVw&ab_channel=SteveBrunton) | A video series on YouTube explaining the SINDy method by one of the authors of the original paper |
| [Sparse Nonlinear Dynamics Models with SINDy, Part 2: Training Data & Disambiguating Models](https://www.youtube.com/watch?v=8-hoWTJwmrE&ab_channel=SteveBrunton) |
| [Sparse Nonlinear Dynamics Models with SINDy, Part 3: Effective Coordinates for Parsimonious Models](https://www.youtube.com/watch?v=1vrsBg92Xzo&ab_channel=SteveBrunton) |
| [Sparse Nonlinear Dynamics Models with SINDy, Part 4: The Library of Candidate Nonlinearities](https://www.youtube.com/watch?v=MmMNQe_EtCw&ab_channel=SteveBrunton) |
| [Sparse Nonlinear Dynamics Models with SINDy, Part 5: The Optimization Algorithms](https://www.youtube.com/watch?v=pY2iJnngk4g&ab_channel=SteveBrunton) |
| SINDy-PI YouTube video | [SINDy-PI: A robust algorithm for parallel implicit sparse identification of nonlinear dynamics](https://www.youtube.com/watch?v=sP8JXF9_wAs&ab_channel=SteveBrunton) | A YouTube video explain SINDy-PI (same channel as above) |
| PySINDy tutorials | <https://www.youtube.com/watch?v=SfIJiuJ38W0&list=PLN90bHJU-JLoOfEk0KyBs2qLTV7OkMZ25> | Links to a playlist of 8 videos that form a tutorial for how to use the pysindy toolbox (same channel as above) |