Master Study: Mathematics and Machine Learning

This draft of study plan consists of mathematical lectures that have a close connection to machine learning. You will study numerical and stochastic analysis as well as algorithmical and computational topics. By taking data-driven modules from computer science you gain additional insight into and knowledge about machine learning from that perspective.
This is a more theoretical approach to machine learning than it takes place in computer science. It is not a master program mathematics for data science (or machine learning) but a specialisation inside the regular mathematics master.
It would in particular open up possibilities for PhD-studies in machine learning in many research groups. But it would as well show a broad understanding of and view into data analytics that would be of interest to companies.

Area E (for 16 or 23 CP)

If offered, take a course with Prof. Garcke in the summer semester
F4E1: Foundation in Numerical Mathematics: Scientific Computing II (Summer term)
V4E2 Numerical Simulation (Summer term)

With other lecturers from the INS usually start with Scientific Computing I (winter term) in
F4E1: Foundation in Numerical Mathematics: Scientific Computing I (Winter term)
since Scientific Computing II (Summer term) often depends on SC I.

For further courses, it would depend on lecturer and the specific content
V4E1 Numerical Algorithms (Winter term)
V4E2 Numerical Simulation (Summer term)
or
Advanced / Selected Lecture Courses

Area F (for 16 or 23 CP)

F4F1 Foundations in Probability & Stochastic Analysis: Stochastic Processes (Summer term)
V4F2 Markov Processes (Winter term)

Stochastic & Markov Processes are better suited than
F4F1 Foundations in Stochastic Analysis (Winter term)
V4F1 Stochastic Analysis (Summer term)

Optionally Advanced/Selected Lectures can be suitable, e.g. topics such as random matrices, optimal transport, analysis on probability spaces, ...

Area B (for at least 9 CP)

F4B1 PDE and Functional Analysis (important and helpful also for other lectures in E/F)
V4B5: Real and Harmonic Analysis
Optionally Advanced/Selected Lectures can be suitable, e.g. Sobolev Spaces, Geometric Optimal Control, Analysis on Metric Spaces

Other mathematical lectures (if Functional Analysis already taken in Bachelor) for example:
Area C: V4C2 Approximation Algorithms

Two Seminars (for 12 CP)

either in Numerical Mathematics and Scientific Computing or Applied Probability

Master Thesis (30 CP) + Thesis Seminar (6 CP)

Optional Modules (24 CP)

Further courses from the above

Practical Lab Numerical Simulation (ideally ML, if offered, but others also useful) (9 CP)

from Computer Science, e.g. (all 6 CP)
Intelligent Learning and Analysis Systems: Machine Learning
Intelligent Learning and Analysis Systems: Data Mining and Knowledge Discovery
Data Science and Big Data
Data Mining and Machine Learning Methods in Bioinformatics
Cognitive Robotics
Robot Learning
Foundations of Graphics
Technical Neural Nets
Advanced Learning Systems
Learning from Non-Standard Data

Requirements for Master: 48 + 24 + 12 + 36 = 120 CP

- Lecture modules from 3 of 6 areas with at least 23CP, 16 CP and 9 CP each, 48 CP in total
  - there are lectures 4+2 SWS → 9CP, Advanced 4 SWS → 7 CP & Selected 2 SWS → 5 CP
  - a maximum of one foundation per area can be taken
- Elective modules: 24 CP, for internships or minor subject
- Seminars 12 CP, corresponds to 2 seminars
- Master thesis + accompanying seminar (30 + 6 CP)