Head:	Dr. A. Kouvelas / Dr. M. Makridis
Topic:	**Unveiling the relationship between antifragility and derivatives**
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Registration:	www.ivt.ethz.ch/en/studies/downloads/assignments.html#registration

Description:

The novel concept of antifragility was first proposed in 2012 by Nassim Taleb, a mathematical statistician and also the author of *The Black Swan*. Since then, the concept has been gaining popularity in the risk management community across different disciplines. Antifragility provides insights into designing systems that can benefit from disruptions and perform better under growing volatility and randomness. Its counterpart concept, fragility, can be dated even earlier in a work in 2010 on complexity theory, showing a cascading effect of interdependent variables in complex networks.

In terms of transportation, major cities worldwide experience problems with their road transportation systems, and the continuous increase in traffic demand presents a substantial challenge to the optimal operation of urban road networks and the efficiency of traffic control strategies. As road transportation systems can be mathematically proven to be fragile systems, antifragile traffic control strategies need to be developed to tackle future demand and disruptions and their cascading consequences.

Studies have shown that by considering the derivatives (1st derivative equals the change rate, while the 2nd derivative is the change rate of change rate, etc.) in a reinforcement learning algorithm, the systems can be empowered with antifragile properties. However, while the models of road transportation systems, such as MFD, are confined to a certain non-linear profile, the impact of the system dynamics, whether it is a linear, quadratic, or cubic function, on the efficacy of adding derivatives into the algorithm is yet unknown.

The goal of this thesis is to explore the possible coupling effect between different system dynamics and the order of derivatives so that for an antifragile traffic control design, the right number of degrees can be chosen to induce antifragility, yet not lead to an excessive amount of required computing resources.

Remarks:	Individual work recommended
Credits:	8-11 ECTS for bachelor/project thesis
Recommended lectures:	103-0414-10L Verkehr GZ 103-0849-00L Multivariate Statistik und Machine Learning
Additional information:	Programming skills in Python are required Experience with Deep Learning or Reinforcement Learning is a plus Interested students may directly contact linghang.sun@ivt.baug.ethz.ch