Additional material for optimization

The following material offers additional insights into optimization for a variety of topics. This is list is not exhaustive and only tries to provide first steps on where to start looking. I am also a firm believer in alternative ways of presenting content (blogs, YouTube etc.), as I they have different lingo and focus than traditional papers and books.

# General

* Boyd and Vandenberghe – Convex Optimization [[book](https://web.stanford.edu/~boyd/cvxbook/bv_cvxbook.pdf), [YouTube](https://youtu.be/McLq1hEq3UY)]: The single most well-known resource in optimization. The book is quite page-turner (730 pages), so may be a bit heavy to start, but the lecture series on YouTube is excellent and in my opinion the single best introduction to optimization.
* “Optimization in the real world” [[blog](http://www.optimisationintherealworld.co.uk/blog/)]: An easily accessible blog about practical optimization examples. There is no code, but nice problem descriptions and you can get a good feel for the applicability of optimization.
* The YouTube channel of Gurobi [[link](https://www.youtube.com/user/GurobiVideos)]: The videos provide a very nice introduction to many general themes in optimization, and are mostly very accessible. They do show code sometimes, but it does not go too much into detail.
* Ben-Tal and Nemirowski – Modern Convex Optimization [[book](https://www2.isye.gatech.edu/~nemirovs/Lect_ModConvOpt.pdf)]: One of the toughest books on this list, it is fairly math heavy but quite complete.

# Linear programming

* AIMMS Linear Programming Tricks [[book chapter](https://opensolver.org/opensolverwordpress2/wp-content/uploads/2016/11/AIMMS3OM_LinearProgrammingTricks.pdf)]: This is a very easy and accessible overview for how to model linear programming problems. It does not provide much theory but is a very useful practical reference guide.
* Miller – An introduction to linear programming [[paper](https://www.researchgate.net/publication/228826174_An_introduction_to_linear_programming)]: A good overview over LP in particular. It also covers some solution methods and also touches upon binary variables, so it is in my opinion an easy first intro to linear programming.
* MIT – Linear programming [[YouTube](https://www.youtube.com/watch?v=WwMz2fJwUCg)]: I really like the clarity and vigour of this guy, also on other topics.

# Mixed-integer programming

* AIMMS Mixed-Integer Programming Tricks [[book chapter](https://download.aimms.com/aimms/download/manuals/AIMMS3OM_IntegerProgrammingTricks.pdf)]: This is a very easy and accessible overview for how to model mixed-integer linear programming problems. It does not provide much theory but is a very useful practical reference guide.
* Article by Gurobi [[link](http://www.gurobi.com/resources/getting-started/mip-basics)]: A great easy overview over MIPs, and especially how to solve them.
* A lecture by Zico Kolter [[YouTube](https://www.youtube.com/watch?v=kz3LbGSATo4)]: This is basically what I presented to you in the course, just focused exclusively on theory. After the course you should be able to follow this and pick up a few things as well.

# Nonlinear programming

* The MOSEK cookbook [[link](https://docs.mosek.com/modeling-cookbook/index.html)]: The best resource on how to use cones for modelling. If you ever go nonlinear, look there first. It’s that good.
* Floudas – Nonlinear and Mixed-Integer Optimization [[Amazon link](https://www.amazon.com/Nonlinear-Mixed-Integer-Optimization-Fundamentals-Applications-ebook/dp/B00134XJPK/ref=sr_1_1?keywords=Nonlinear+and+Mixed-Integer+Optimization+floudas&qid=1560368074&s=gateway&sr=8-1)]: For general nonlinear programming, this is one of the best fundamental overviews out there. It is a bit dated (from 1995), but the general principles still hold and Floudas was a very gifted writer.
* Jyllands Posten article [[link](https://jyllands-posten.dk/premium/indland/ECE11380568/skatteministeriet-har-regnet-paa-den-optimale-pris-for-en-pakke-cigaretter/)]: They calculate the optimal price for a pack of cigarettes. Funnily enough, they write: “Man kunne tro, at højere afgifter giver flere penge i statskassen, men sådan forholder det sig ikke. Dels fordi flere vil holde op med at ryge, hvis cigaretter bliver dyrere, og dels fordi grænsehandlen vil vokse markant.” [One could think, that higher taxes would bring more money in for the state, but that’s not how it works. Partly, because more people would stop smoking, if cigarettes become too expensive, and partly because the border trading would increase significantly]. So they just looked at the economics of it.

# Duality

* Pandey – Lagrange multipliers with visualizations and code [[blog post](https://towardsdatascience.com/lagrange-multipliers-with-pictures-and-code-ace8018dac5e)]: This is the best introductory explanation of duality that I know. Period. It goes right to the core and explains the fundamentals in a clear and concise way.
* Rockafaller – Conjugate Duality and Optimization [[book](https://sites.math.washington.edu/~rtr/papers/rtr054-ConjugateDuality.pdf)]: One of the most comprehensive treatments of duality out there. If you cannot find your answer in here, good luck.
* Kjeldsen – History of KKT conditions WWII [[link](http://web.math.ku.dk/~moller/undervisning/MASO2010/KKKThistory.pdf)]: A good historical overview over how the KKT conditions came to be. At some point it veers off towards the war, but before that it is really nice.

# Graph theory

* Sarada Herke [[YouTube channel](https://www.youtube.com/channel/UCV8tyRakGZuXUwD-wYH1yGg)]: She is a post-doc in Australia working on graph theory, and this is the easiest and most accessible entry point you will ever find to graph theory. A lot of stuff is covered very easily, but nonetheless rigorously.
* Trudeau – Introduction to Graph Theory [[Amazon link](https://www.amazon.com/Introduction-Graph-Theory-Dover-Mathematics/dp/0486678709/ref=sr_1_4?crid=2E20H0HMGYAP3&keywords=reinhard+diestel+graph&qid=1560368663&s=gateway&sprefix=reinhard+diest%2Caps%2C224&sr=8-4)]: I read this book as an undergraduate and it is quite accessible for a “layman”, but does require some thinking; I guess no book on graph theory will ever be light reading. Can recommend it though, especially for the conceptual level.
* Diestel – Graph Theory [[Amazon link](https://www.amazon.com/Graph-Theory-Graduate-Texts-Mathematics/dp/3662536218/ref=sr_1_1?crid=2E20H0HMGYAP3&keywords=reinhard+diestel+graph&qid=1560368663&s=gateway&sprefix=reinhard+diest%2Caps%2C224&sr=8-1)]: Probably the most famous book in graph theory. This is the real deal, so brace yourself. However, if you dare to dive in there it is really worth it.

# SpaceX rockets

* Lars Blackmore’s website [[link](http://larsblackmore.com/losslessconvexification.htm), [main paper](http://larsblackmore.com/iee_tcst13.pdf)]: He is now the “[Principal Mars Landing Engineer](https://www.linkedin.com/in/ACoAAAAIvpoBRyt_RFLGIKWf5FI6Da7yeifQirs/)”[[1]](#footnote-1) at SpaceX, and was before that with the [Jet Propulsion Laboratory](https://en.wikipedia.org/wiki/Jet_Propulsion_Laboratory) for NASA. The main paper describes in the most complete way how the specifics of the controller work.
* G-FOLD description [[link](https://www.lpi.usra.edu/meetings/marsconcepts2012/pdf/4193.pdf)]: An early start on the work for landing spacecrafts on Mars. Gives a good idea without equations of what is going on.
* CVXGEN [[link](https://cvxgen.com/docs/index.html)]: The software they use to automatically generate C code for the solution. Note that it cannot do SOCP out of the box, but they say it is pretty trivial.
* Press release by QZ [[link](https://qz.com/915702/the-spacex-falcon-9-rocket-you-see-landing-on-earth-is-really-a-sophisticated-flying-robot/)]: This is a press release QZ did which is very high level, but if you know how to read between the lines, you see optimization written all over.
* Stephen Boyd’s Ørsted lecture at DTU [[link](https://www.youtube.com/watch?v=729iymN3jqA)]: It’s pretty general, but he does say some stuff about SpaceX.

# Other resources

* OR Stackexchange [[link to private beta](https://or.stackexchange.com/users/login?ssrc=beta&returnurl=%2f)]: This is a newly establish stack exchange webpage for operations research (i.e. optimization). It is really nice content and good people. If you have a question, just hammer it out there and somebody will answer you.
* Yet Another Math Programming Consultant [[blog](http://yetanothermathprogrammingconsultant.blogspot.com/)]: A blog with new posts every 1-2 weeks, it is written by a guy with decades of experience in practical optimization, and he shows you the real deal. I often read stuff here that serve as an inspiration in my work.
* OR in an OB world [[blog](https://orinanobworld.blogspot.com/?m=0)]: Probably the most famous blog in optimization, Prof. Rubin discusses a lot of different OR-related topics on an infrequent basis. I really enjoy his posts, which often are not overly mathematical and focus on the conceptual content.

1. Coolest job title ever [↑](#footnote-ref-1)