Final Presentation: Applied Optimization for Inverse problem

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Agenda:

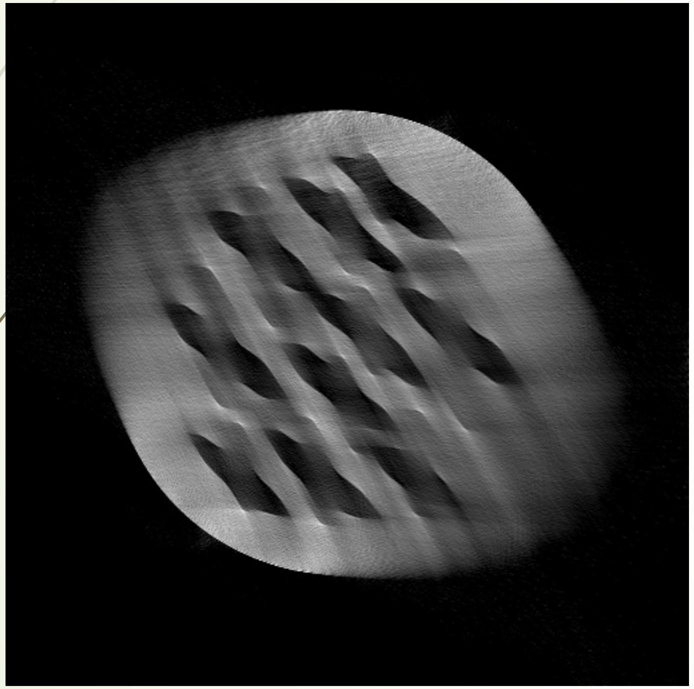
- Methods that works well for me .
- Methods that works alright for me.
- Methods that does not work not too well/ at all for me.
- Overview and surprising results.
- Things that I like/ dislike about the course.
- Conclusion.

Acronym

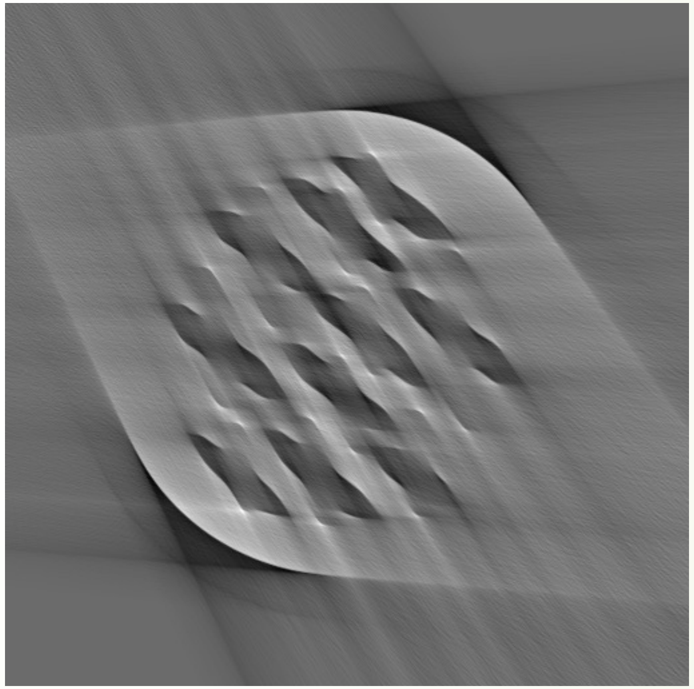
- ADMM – Alternating Direction Methods of Multiplier
- FPGM – Fast Proximal Gradient Method
- POGM – Proximal Optimized Gradient Methods
- TV – Total Variation
- ISTA – Iterative Shrinkage-Thresholding Algorithm
- bb1/bb2 – Barzilai-Borwein 1&2
- CG - Conjugate Gradient
- GD - Gradient Descent

Methods that works well for me

- Challenge dataset 7c, Limited angle tomography (60°), filtered

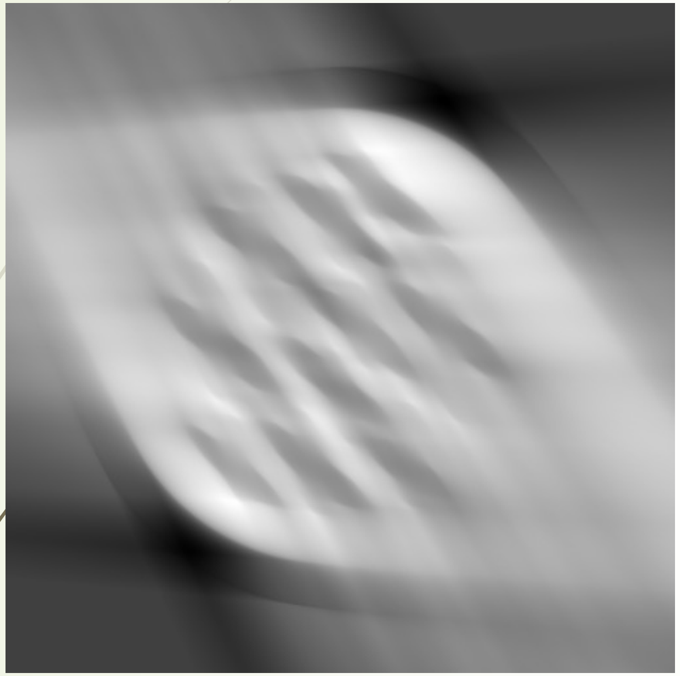


ISTA, tau=0.01 (Best)



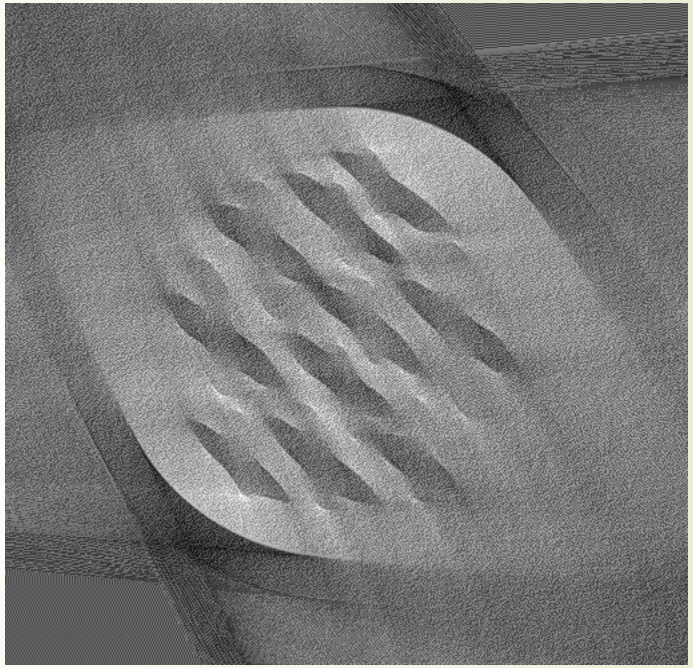
BB2, L2 norm, beta=5

Methods that works alright for me



FPGM, L2 norm, beta=5

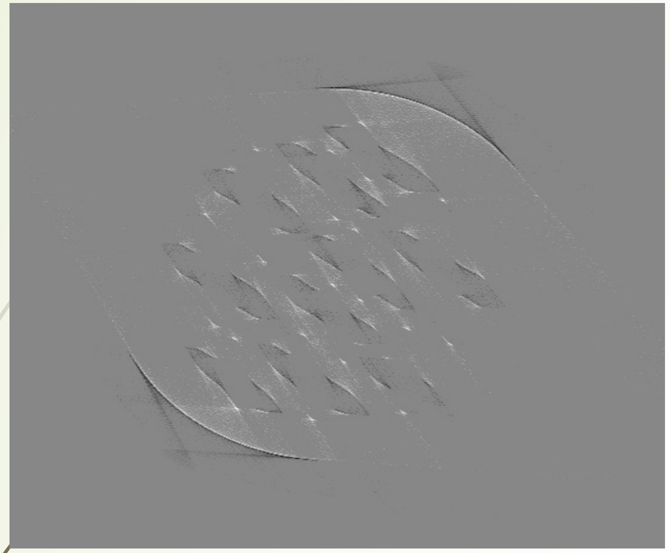
POGM, L2 norm, beta=10



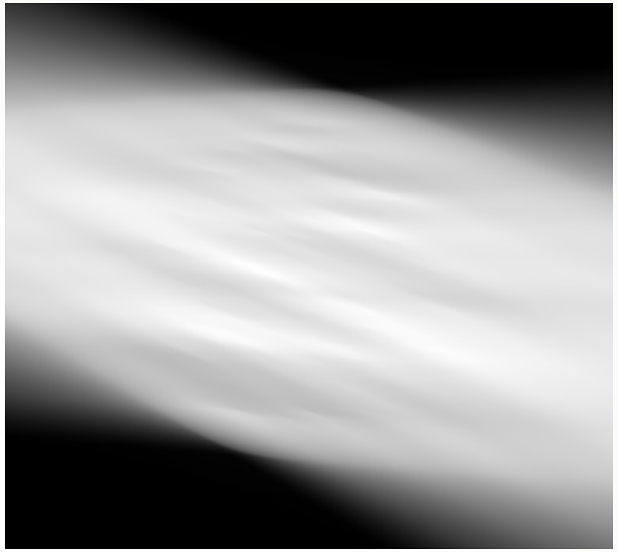
Subgradient, TV, tau=0.01, variable step length 1/k

- **Others - OGM1, vanilla GD + regularization**

Methods that does not work not too well /at all



ADMM, L1, tau=0.001



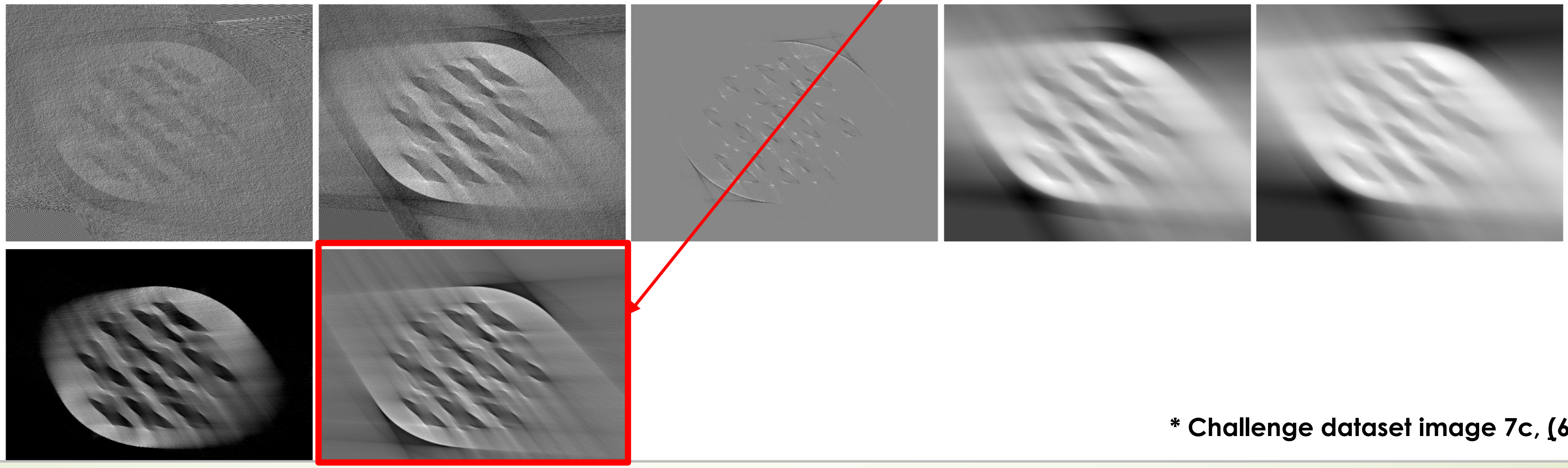
(30°) ADMM, TV , tau=0.001

- **Does not work – CG, Proximal Gradient method and variants with Elastic Net, Landweber, ISTA with too high/ low regularization (>10 or <1e-3)**

Overview and surprising results

Experiment	Optimization Algorithm	Proximal Operator/ Regularization	Parameters	iterations (Until convergenve)	running time (seconds)
1	Subgradient	TV	τ=0.01, fixed α_k=0.01	5000	70.0524640083313
2	Subgradient	TV	τ=0.01, variable $\alpha_k = \frac{1}{k}$ (k=5000)	5000	74.77692556381226
3	ADMM	l^2-norm squared and l^1-norm	τ=0.001, $\lambda = \frac{0.95\tau}{L^2}$ (k=5000)	5000	95.65959763526917
4	FPGM	l^2-norm squared	β=5, $\alpha_k = \frac{1}{L}$	5000	48.26965141296387
5	POGM	l^2-norm squared	β=10, $\alpha_k = \frac{1}{L}$	24	0.26660776138305664
6	ISTA	l^1-norm	τ=0.01, $\alpha_k = \frac{1}{L}$	10000	105.28181767463684
7	bb2	l^2-norm squared	β=5	28	1.8306841850280762

table 2



* Challenge dataset image 7c, (60°)

Things that I like/ dislike about the course

Like:

- Breath
- Learning about forward and Inverse problem
- Thinking in terms of operator
- Working knowledge of optimization method at a low level

Dislike:

- Hectic workload - ~1-3 days to understand and organize; ~1 day to implement and experiment; ~0.5 – 1 day to compile results and reporting. (On average > 27 hours recommended)
- Vague requirement

Conclusion

- Reconstruction results heavily depends on parameterization of algorithm.
- Parameterization is based on guessing and trial and error. (unsystematic)
- Verifying algorithm is *at least* correct