Demo proposal for TCMM 2014

Manopt, an open source toolbox for optimization on manifolds

Submitted by Nicolas Boumal (UCLouvain) and Bamdev Mishra (Université de Liège), July 29.

Dear organizers of the TCMM 2014 workshop,

We would like to propose a demo about Manopt: an open source Matlab toolbox: www.manopt.org.

Manopt is designed to help using and developing algorithms for optimization on manifolds (also known as Riemannian optimization). Riemannian optimization constitutes a class of optimization problems whereby one seeks to minimize an objective function over a smooth Riemannian manifold. Examples of typical manifolds arising in applications (many of which are machine learning applications) include the Stiefel manifold (orthonormal matrices), the Grassmann manifold (the space of linear subspaces), the group of rotations, the various manifolds of low-rank matrices, the manifold of strictly positive definite matrices, correlation matrices… This is not exhaustive. Of course, such problems are in general hard (most often, they are not convex), but the current state of the art teaches us that they can often be solved locally, with the same ease as for comparable *unconstrained* nonlinear optimization problems. The general idea is that, by working *intrinsically* on the smooth search space, the problem looks "as if" there were no constraints. Manopt is an implementation of a good portion of the current state of affairs in this vein, much of which is described in the monograph "*Optimization algorithms on matrix manifolds*", by Absil et al. (2008): http://press.princeton.edu/chapters/absil/.

The toolbox is recent (it was first released early in 2013). It is described in a recent paper published in the machine learning community: "*Manopt: a Matlab toolbox for optimization on manifolds*", by Boumal, Mishra, Absil and Sepulchre, JMLR 2014. It is well documented in-code and on the website (including a tutorial, a manual, a reference and example scripts) and ships with a variety of built-in algorithms and manifold descriptions. These combined reasons earned Manopt the 2014 ORBEL prize for OR software development. It has already been successfully used in multiple research projects, where it helped accelerate research and outperform competing algorithms. The user base is still modest, but we are bit by bit building a community, among other things via a forum on the project's website.

There exist a number of software packages for optimization on manifolds, but not is as comprehensive as Manopt. Most packages focus on one or two specific manifolds (typically, Stiefel or Grassmann). Some packages propose one generic solver (optimization algorithm), but without built-in collection of manifold implementations. Such packages tend to be limited in their usage scope and are targeted at specialists. On the contrary, Manopt ships with multiple solvers, multiple manifolds and numerous helper tools (including some debugging facilities). The documentation and examples are aimed to get beginners up to speed in a short time.

It is our hope that if we have the opportunity to showcase Manopt as a demo at TCMM, this would contribute to increase interest in Riemannian optimization in the machine learning community and that it could help expand our user base.

Format of the demonstration

THIS IS THE DIFFICULT THING TO THINK OF. I'll brainstorm about it tomorrow. If you have some ideas, let them come! I was thinking : we can explain what RO is about; showcase the example scripts in action; give a tour of the documentation/ the website to hint at cool stuff; help out people who would like to install and test Manopt on their computers on the spot; perhaps do a 10 minute teaching on the whiteboard where we go from a math problem all the way to writing code live and running it. This would include the whole chain, including the daunting task of computing gradients ;), which is neat. Maybe that last bit should be put forward.

Equipment description

The presenters will come with personal laptops and a poster. If possible, it would be great to have at our disposal:

- At least one large screen to which a computer would be connected to display a fancy slideshow.
- A panel for the poster (A0 format, portrait: the typical conference format).
- A whiteboard, or other "presentation device" would be great.

Thank you for your time and consideration,

Yours sincerely,

Nicolas Boumal and Bamdev Mishra