Geophysical Research Abstracts
Vol. 20, EGU2018-19266, 2018
EGU General Assembly 2018

Comparing many-objective robust decision making and multi-objective robust optimization for the lake problem

Jan Kwakkel and Marc Jaxa-Rozen
Delft University of Technology, Delft, Netherlands (j.h.kwakkel@tudelft.nl)

Methods for decision making under deep uncertainty (DMDU) have attracted increasing interest in the context of problems such as climate adaptation, and more generally for the management of environmental systems. In contrast to “predict-then-act” management, DMDU methods aim to identify policies which are robust to uncertain future conditions. In addition, the management of complex systems typically involves meeting multiple performance objectives. DMDU methods which have been used for this purpose include many-objective robust decision making (MORDM) (Kasprzyk, Nataraj, Reed, & Lempert, 2013), and many-objective robust optimization (RO) (Watkins & McKinney, 1997; Kwakkel et al., 2015). MORDM is used to generate multiple policy alternatives and assesses their robustness a posteriori across multiple states of the world, while many-objective RO directly optimises the robustness of alternatives.

Although the relative performance of these methods depends on the nature of the problem and solution, their efficacy has not yet been compared in the literature. To this end, we compare both methods using two variants of the stylized lake problem (Carpenter, Ludwig, & Brock, 1999): an intertemporal optimization version which represents static planning without endogenous feedback (Ward, Singh, Reed, & Keller, 2015), and a direct policy search (DPS) variant which includes a closed-loop control strategy (Quinn, Reed, & Keller, 2017). Our comparison focuses primarily on the degree to which both approaches are able to produce robust solutions across multiple states of the world.

The results indicate that results found through MORDM do retain their robustness reasonably well in case of the DPS formulation of the problem, but poorly when applied to the intertemporal version. RO performs well on both variants, but creates substantial runtime constraints. As such, developing a hybrid approach which combines strengths of both methods would be a promising avenue for future work. In addition, runtime concerns for RO can possible be mitigated by developing a more systematic approach for selecting an appropriate set of scenarios over which robustness is evaluated.

References

Carpenter, S. R., Ludwig, D., & Brock, W. A. (1999). Management of eutrophication for lakes subject to potentially irreversible change. Ecological Applications, 9(3), 751–771.

Kasprzyk, J. R., Nataraj, S., Reed, P. M., & Lempert, R. J. (2013). Many objective robust decision making for complex environmental systems undergoing change. Environmental Modelling & Software, 42, 55–71. https://doi.org/10.1016/j.envsoft.2012.12.007

Kwakkel, J.H., Haasnoot, M., Walker, W.E., 2015. Developing Dynamic Adaptive Policy Pathways: A computer-assisted approach for developing adaptive strategies for a deeply uncertain world. Climatic Change 132(3) 373-386.

Quinn, J. D., Reed, P. M., & Keller, K. (2017). Direct policy search for robust multi-objective management of deeply uncertain socio-ecological tipping points. Environmental Modelling & Software, 92, 125–141. https://doi.org/10.1016/j.envsoft.2017.02.017

Ward, V. L., Singh, R., Reed, P. M., & Keller, K. (2015). Confronting tipping points: Can multi-objective evolutionary algorithms discover pollution control tradeoffs given environmental thresholds? Environmental Modelling & Software, 73, 27–43. https://doi.org/10.1016/j.envsoft.2015.07.020

Watkins, D., & McKinney, D. (1997). Finding Robust Solutions to Water Resources Problems. Journal of Water

Resources Planning and Management, 123(1), 49–58. https://doi.org/10.1061/(ASCE)0733-9496(1997)123:1(49)