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Stochastic Programming for the Green Transition: Model Composition and Decomposition

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The green transition poses many challenges following the introduction of renewable energy sources (RES) and sector coupling (e.g. integrating heat and power). Decision makers need to apply more complex models and to better account for uncertainty, often stemming from the non-dispatchable nature of important RES.

While solution techniques for stochastic programs are available and demonstated in academia, many hurdles slow the application of these in day-to-day analyses, as both models and algorithms are hard modify, and require significant tailoring to each new application or model to benefit from theoretical advances.
We propose a modular approach to modelling, facilitating the composition of different model components to cover a wide range of temporal and geographical scales, as well as different formulations for technology descriptions.

In particular, by semantically encoding the time structure of a problem, using a utility library (TimeStruct), we not only formulate complex time structures with ease, but also allow analysts to construct models with compatible time structures to enable linking of models.

Decomposition techniques can be applied to existing models by linking models providing a node-based interface to build generic decomposition on top of other models (see e.g. Plasmo).

In contrast, we propose exploiting the already encoded time structure to enable automatic decomposition based on TimeStruct and develop algorithms that can be applied across multiple models that build on this library.
We demonstrate automatically applying Benders decomposition based on the encoded time structure on optimization models from different domains:

1. Developing zero emission energy systems in the Arctic
2. Composing green product portfolios in the fertilizer industry

Authors: HELLEMO, Lars (SINTEF); Dr FLATBERG, Truls (SINTEF)

Orateur: HELLEMO, Lars (SINTEF)

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