

Decision making under deep uncertainty

a tentative taxonomy of approaches

Decision-making under deep uncertainty

1. **Decision support** – the aim of decision advise is to facilitate learning about a problem and potential courses of action, not to dictate the right solution. This entails a shift from *a priori* to *a posteriori* decision analysis.
2. **Adaptive plans** – plans should be designed from the outset to be adapted over time in response to how the future is actually unfolding
3. **Exploratory scenario thinking**– the future is uncertain and cannot be probabilistically constrained, we need systematic what-if analysis of the future which serves as a test bed for candidate strategies

Decision Support

Decision aiding can be defined as the activity of one who, in ways we call scientific, helps to obtain elements

of **answers to questions**

helping to **clarify a candidate decision** with the aim to increase coherence of actual decisions and goals and/or systems of values

Constructive

co-construct problem and solutions at the same time through joint sense making

The analyst learns about the client's problem, and the client learns about the formal representation of his problem

Consent / consensus

Decision Support

Premature aggregation is at the root of all evil

Aggregations

- Over states of the world → expected value
- Over objectives → MCDA / CBA
- Over actors → social planner, GDP
- Over time → Discounting
- Over space → Risk transfers

- Aggregation is a loss of information → decision myopia
- Many aggregations are theoretically problematic (e.g. Arrow's impossibility theorem)
- Many aggregations are a source for contestation

Adaptive Plans

Protective adaptivity

Protect a basic plan against vulnerabilities through contingency planning and monitoring

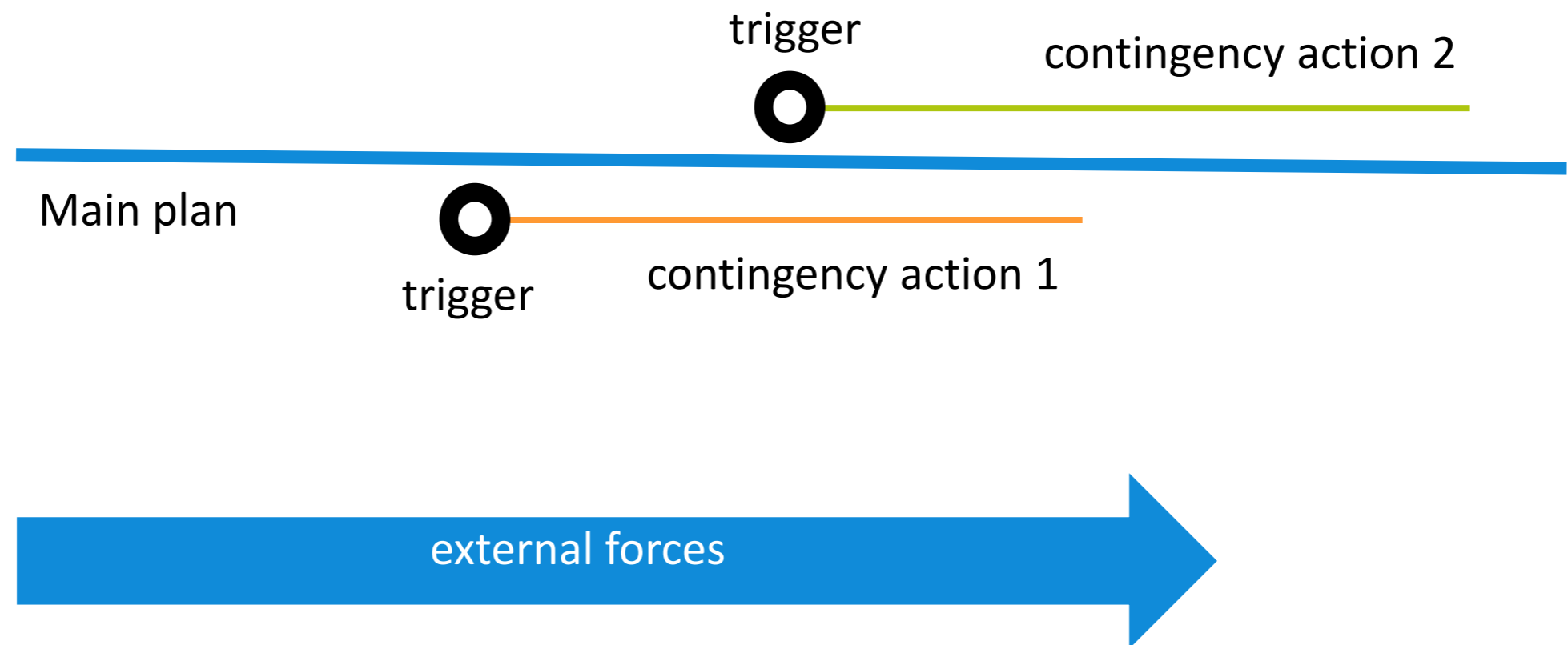
Examples: adaptive policy making, assumption based planning, robust decision making

Dynamic adaptivity

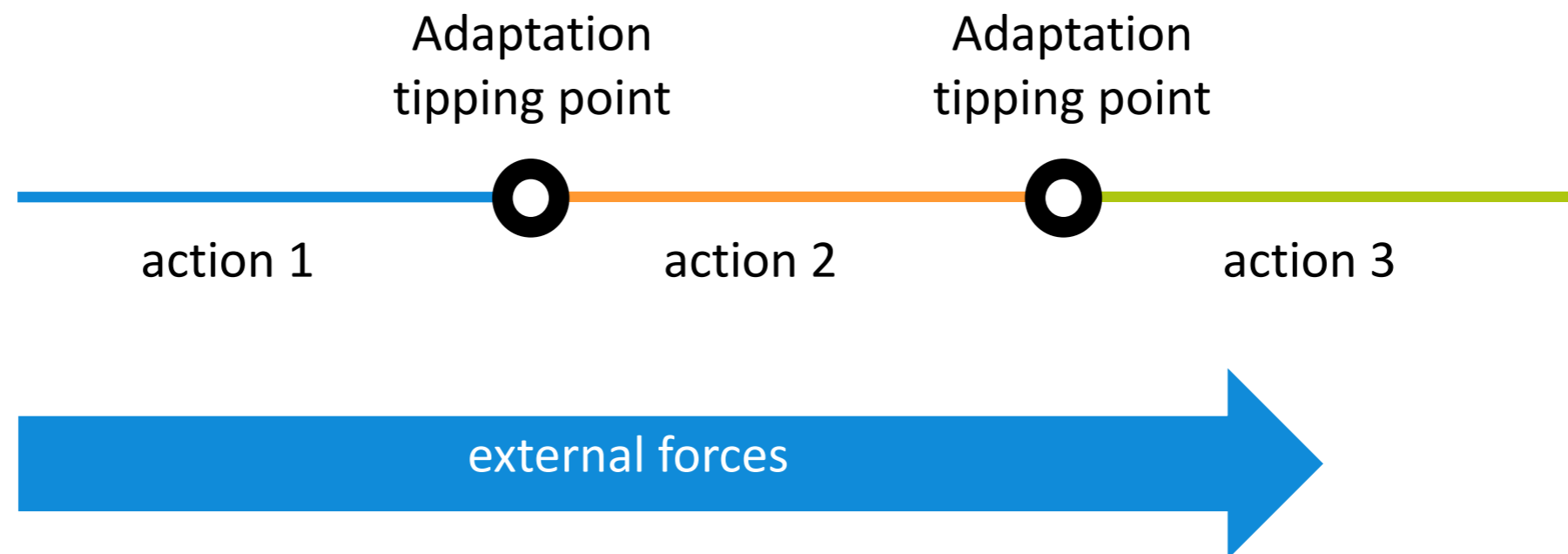
Transform system functioning through sequencing of actions over time and careful monitoring

Examples: adaptive pathways, adaptive management

Protective adaptivity



Dynamic adaptivity



Exploratory scenario thinking

Decision support processes that employ scenarios, as opposed to probabilistic forecasts, to characterize deep uncertainty will help decisionmakers consider a wider range of futures and attributes, and this broader vantage will encourage the choice of more robust options that perform reasonably well in a wide range of futures.

Why use models?

Argument from complexity

Because the system of interest is often complex, there is a need supplement human reasoning

Complex systems are sensitivity to initial conditions (both parameters and structure)

Argument from uncertainty

When confronted with uncertainty, instead of making an assumption, explore systematically the consequences of alternative assumptions in order to identify differences that make a difference

from **Predict** and **Act** to **Explore** and **Adapt**

from **predict** to **explore**

Scenario discovery (Bryant & Lempert 2010)

Robust multi-objective optimization (Kwakkel et al. 2015)

Info-Gap decision theory (Ben Haim, 2001; Hall et al. 2012)

Adaptation tipping points (Kwadijk et al 2010)

Decision scaling (Brown et al. 2012; LeRoy Poff et al. 2015)

from **act** to **adapt**

Assumption-Based Planning (Dewar et al.1993)

Adaptive Policymaking (Kwakkel et al 2010)

Dynamic Adaptive Policy Pathways (Haasnoot et al. 2013)

Robust Decision Making (Lempert & Collins 2007)

Policy architecture

Protective adaptativity

Protect basic plan against contingencies

Dynamic adaptivity

Sequencing of alternatives conditional on observed future

Generation of alternatives

Exploration

global or local sampling

Search

(many objective) optimization

Prespecified

Expert opinion, standardized

Iterative

stress test and refine

Generation of scenarios

Exploration

global or local sampling

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Prespecified

Expert opinion, standardized

Robustness measures

Regret

comparing alternatives

Satisficing

individual alternatives

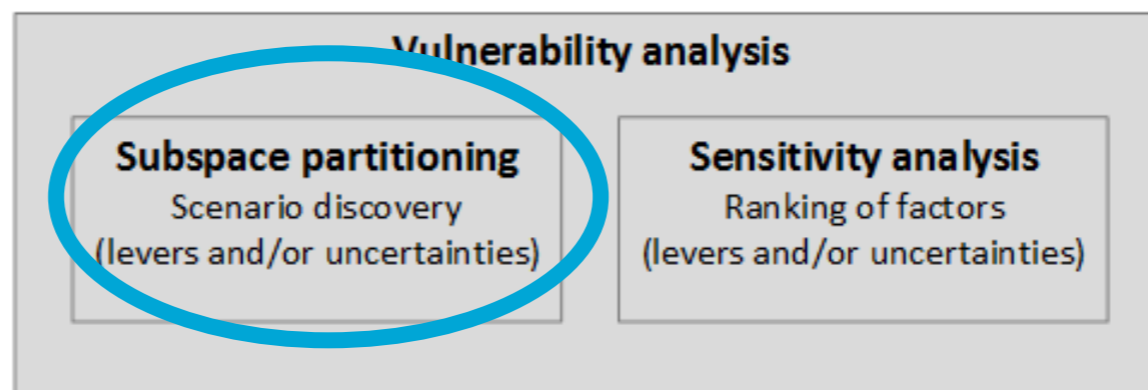
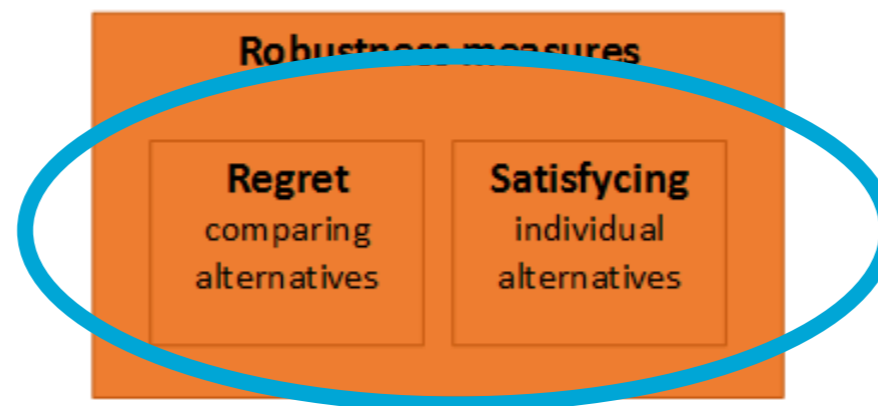
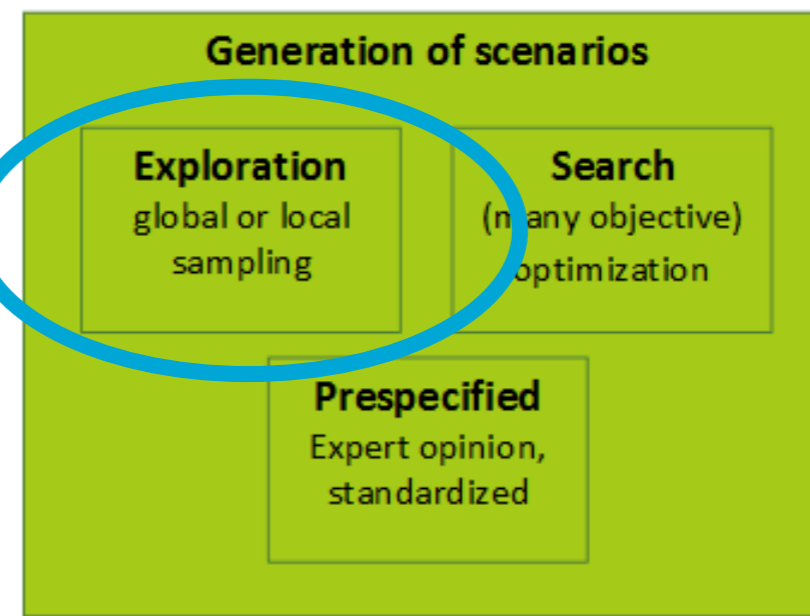
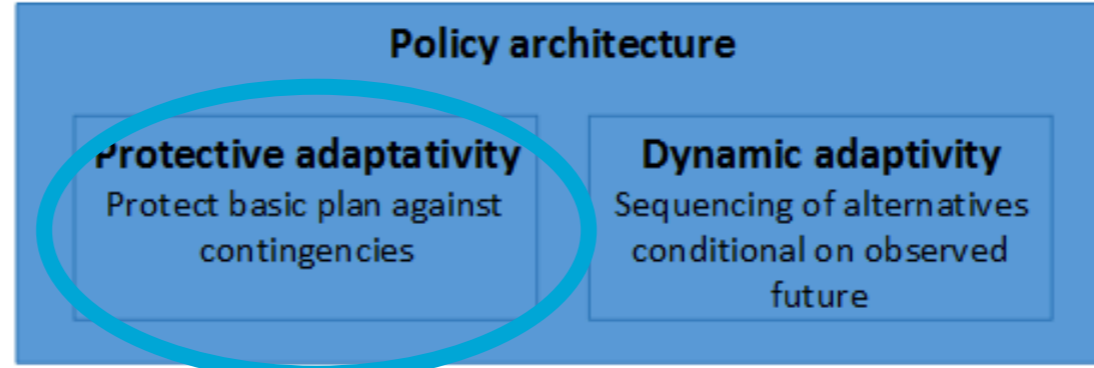
Vulnerability analysis

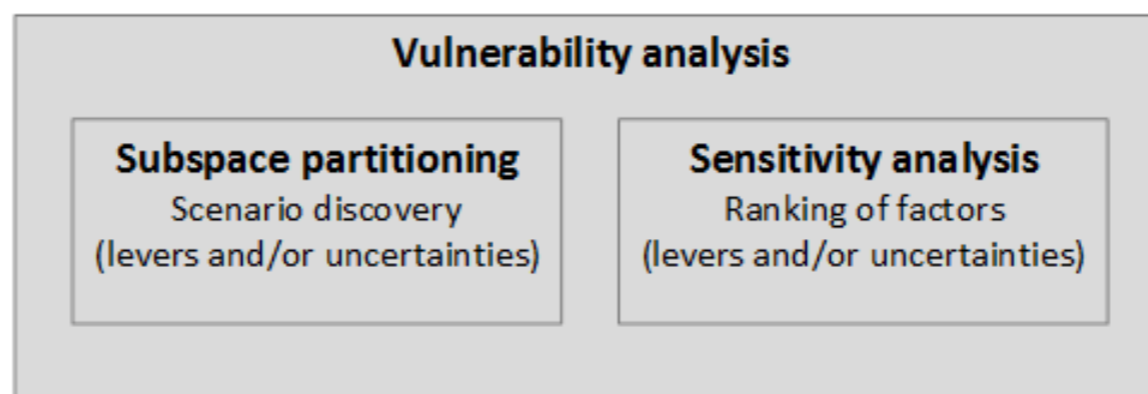
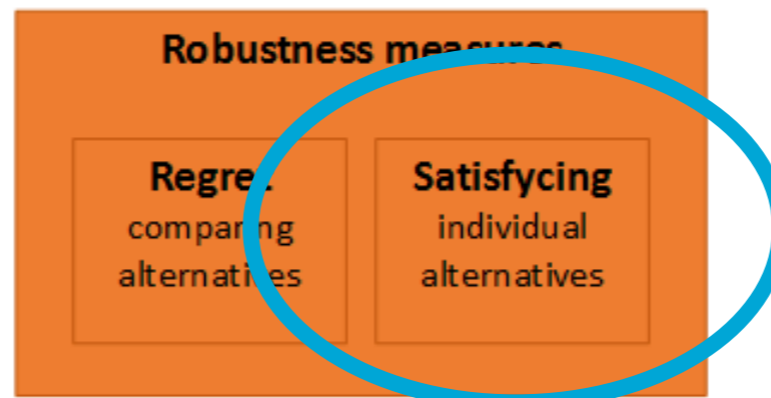
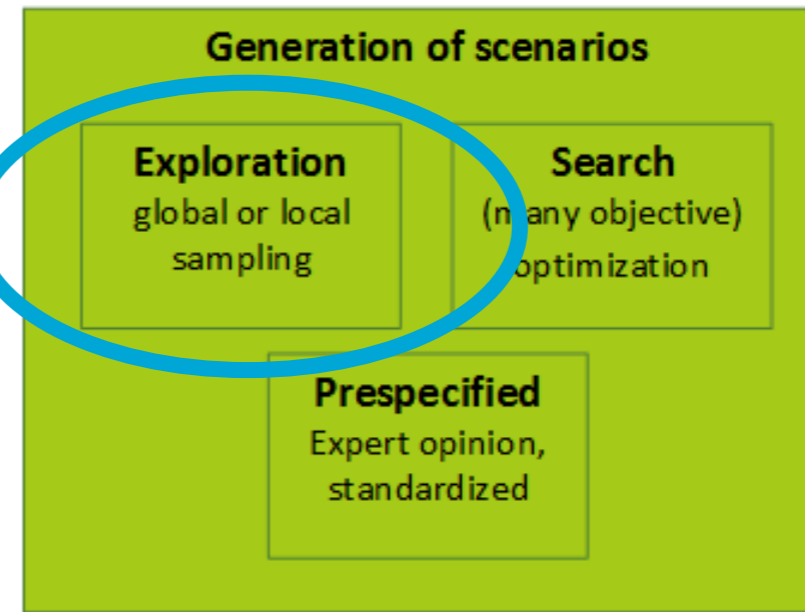
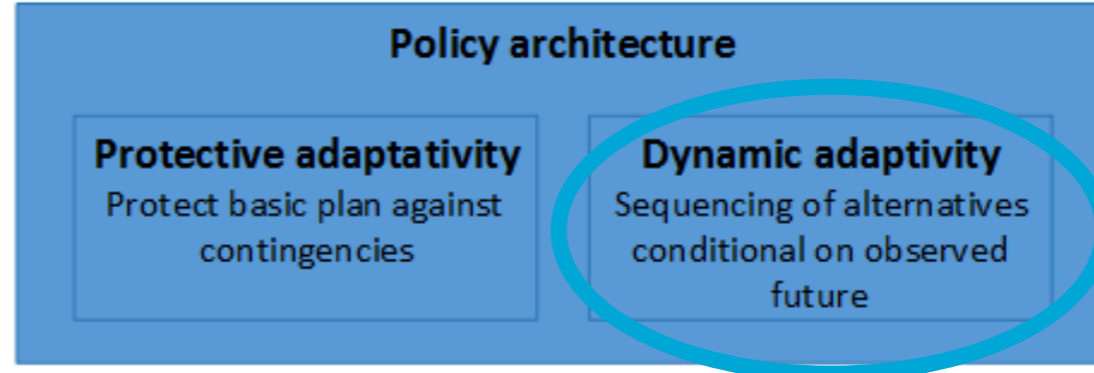
Subspace partitioning

Scenario discovery (levers and/or uncertainties)

Sensitivity analysis

Ranking of factors (levers and/or uncertainties)





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Looking forward

Canonical approaches (e.g. RDM, MORDM, DAPP) are recipes. Recipes are great if you are learning to cook, but once mastered you can creatively recombine them as well as adapt them to your taste, skill, and what is available.

Research is needed to understand better what ingredients are used in the various recipes, which ingredients go well together, and how ingredients align with the specific context.