

AI Assisted Scenario Building for Sustainable Development

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Abstract

In order to concretely exemplify how AI can potentially assist in scenario building we study a specific problem in scenario building: How diverse scenario sets can be constructed? We find that a chatbot based on large language models already now performs relatively good on this task, and compare its results with a n analytical model. This could be good news for the scenario building community, because there is always a demand for developing more 'out of the box' scenarios which could surprise analysts and hence contribute to build a more robust and sustainable future.

Long-term scenarios play a pivotal role in research and policy for building a more sustainable future. Scenarios are used to forecast future greenhouse gas emissions, land-use change and climate change. A particularly important application is the combination of different trajectories of climate change with trajectories of societal change for the study of possible impacts of climate change as well as different adaptation options (O'Neill et al. 2020). In the context of biodiversity loss scientists have argued that transformative global scenarios are needed as tools for accelerating progress on sustainability goals (Pereira et al. 2020).

Building scenarios describing the societal development several decades into the future is a difficult task, and now this task has become even more difficult with the development of artificial intelligence (AI). The rapidly improving capability of AI and development towards Artificial General intelligence signals that AI has the potential to become a new general purpose technology with huge impacts on a wide range of sectors of society.

In this Science-Policy Brief we ask how AI could aid our efforts to build long-term scenarios for sustainability research. This is uncharted territory and the debate has just begun whether, and if so, how scenario builders should embrace advances in AI to assist in the generation of scenarios (Spaniol and Rowland 2023).

Could AI assist in expanding our thinking of possible futures?

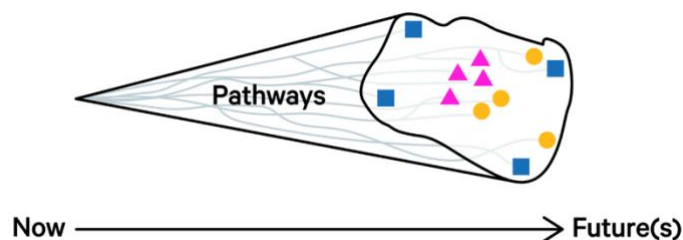
Although the number of scenarios developed in the context of sustainable development has increased dramatically over recent decades, it is well-known that the vast majority of these scenarios can be mapped onto a few 'scenario archetypes.' Scenario archetypes describe different general patterns of future developments, and the most used set of archetypes identifies six broad classes of scenarios (van Vuuren et al. 2012):

1. Business-as-usual
2. Economic optimism
3. Reformed markets
4. Regional competition
5. Regional sustainability
6. Global sustainable development

So, most scenario development processes tend to end up in sets of scenarios which can be mapped onto these six broad narratives. One might ask how representative this set of six scenarios is with regards to how the future might evolve. Do these six scenarios 'span the space of possibilities' broadly enough for building resilience?

One way to depict this is shown in Figure 1 below. This shows the so-called 'future cone' represents the evolution from 'now' (left in figure) to the future (right in figure). As time passes, more possibilities will emerge; the radius of the cone increases. All scenarios that fall within the base of the cone are possible. The scenarios are divided into three groups representing one narrow set (triangles), one unbalanced set (circles) and one diverse set (cubes).

Figure 1. Schematic illustration of how the future might evolves along many different pathways



Data source: Adapted from Carlsen et al., 2024.

The question is: How can diverse scenario sets be effectively identified? Could AI assist in this? It is often argued that AI could enhance these efforts by enabling processing larger amounts of data and seeing patterns

of future development beyond human capacity. But how can we move a bit beyond this general statement and structure how, and where in the scenario building process AI can assist scenario builders?

Let's compare an analytical approach to assess scenario set diversity, i.e. how different scenarios in a set are, with a large language model (LLM). We use the Shared Socioeconomic Pathways (SSPs) developed by the climate change research community as a set of scenarios. These are five global narrative storylines describing different possible development pathways to the year 2100. Using a quantitative method called Scenario Diversity Analysis (Carlsen et al., 2016), the distances between pair of scenarios can be calculated as:

Table.

	SSP1	SSP2	SSP3	SSP4	SSP5
SSP1		3,7	5,6	3,9	3,9
SSP2			3,9	2,2	4,6
SSP3				3,7	5,5
SSP4					4,8

Now, let's ask ChatGPT3.5:

Question: Can you compare [two] texts [more] qualitatively?

ChatGPT: Certainly! Let's compare the two texts qualitatively.

...

Based on these comparisons:

- Text 1 and Text 5 are more similar to each other, focusing on sustainable development, though with different approaches.
- Text 3 stands out as more dissimilar, focusing on nationalism and slow development.
- Text 4 and Text 2 are more similar to each other, discussing economic inequality and environmental concerns, though with different emphases and contexts.

We see that ChatGPT correctly identify that SSP2 and SSP4 are close (2,2 in the quantitative analysis). It also identifies that SSP1 and SSP5 are close; and indeed SSP5's closest neighbour is SSP1, but SSP1 is slightly closer to SSP2. It also scores relatively good with regards to SSP3. This is the scenario which is second most dissimilar to all other scenarios (slightly after SSP5). The analysis with ChatGPT took less than 15 minutes to perform, and in this relative short time – and without prior knowledge about more sophisticated

techniques for assessing scenario sets – we could identify similar patterns as the analytical method.

Concluding remarks

In order to concretely exemplify how AI can potentially assist in scenario building we have briefly studied how diverse scenario sets can be constructed. We find that a chatbot based on large language models already now performs relatively good. This could be good news for the scenario building community, because there is always a demand for developing more 'out of the box' scenarios which could surprise analysts and hence contribute to build a more robust and sustainable society. One potential risk using AI tools in research and policy-processes is lack of transparency. This is a topic already under discussion in the scenario building community (Carlsen, Klein, and Wikman-Svahn 2017), and this can become even more complicated if we are constructing scenarios with tools which are in almost every case seen so far impossible to track, and indeed repeat. Reproducibility of scientific results is a cornerstone of the scientific method and during the last decade we have seen intense discussion on this topic, mostly in psychology and medicine, but also in economics. And this was before AI entered the scene. We need to have a transparent discussion on transparency when engaging more with AI in the scientific process.

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