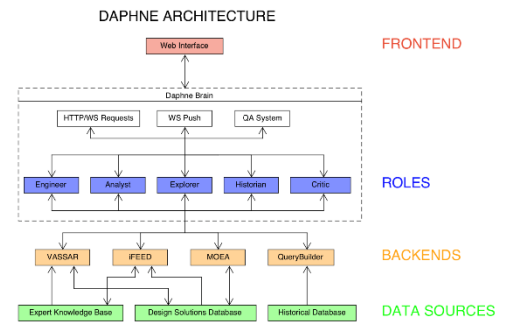


Research Task / Overview

Previous studies have shown that cognitive assistants greatly improve human-AI performance in design space exploration tasks. However, these studies also suggest that using cognitive assistants may hinder human learning. Because problem specific knowledge plays a role in the user's ability to find optimal solutions, a cognitive assistant that also fosters human learning is desirable. This brings us to the task at hand: developing a cognitive assistant agent that effectively fosters human learning and therefore increases user performance.

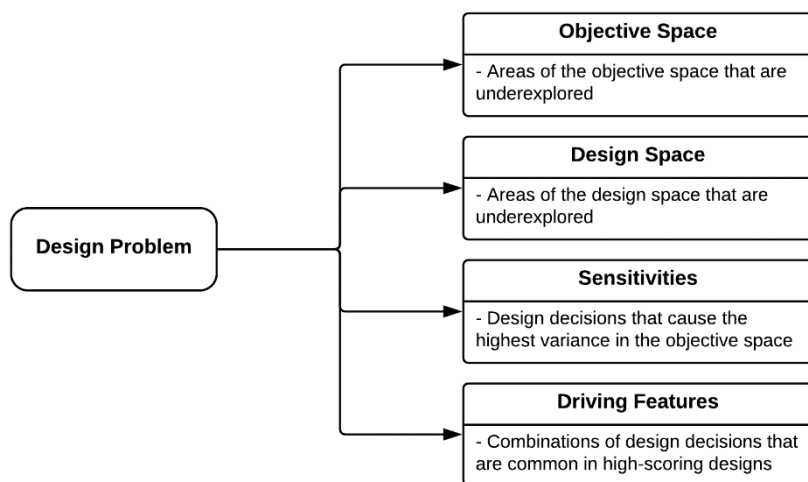
Goals & Objectives

The Daphne Virtual Assistant is an intelligent assistant specializing in architecting Earth observing satellite systems. Past studies on Daphne have shown that while it does help engineers find better DSM designs, it has not been found to foster human learning. Our goal is to create and implement a "Teacher" Agent in Daphne that fosters human learning and increases user performance through smart data summarization, just-in-time notifications, natural language explanations, and interactive visual aids.



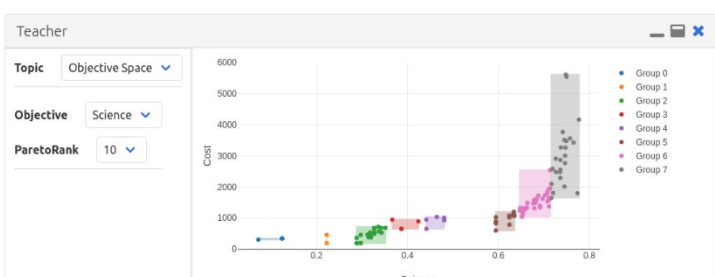
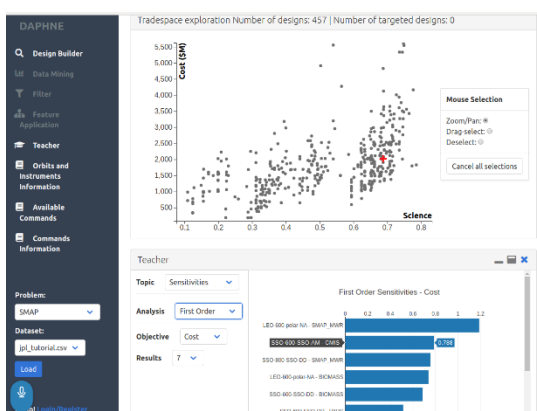
Teacher Agent Implementation

Problem Decomposition: Much like any traditionally taught subject, the Teacher Agent breaks down a design problem into different topics. This allows the teacher agent to realize and target weak points in the user's knowledge. The topics are shown below.



Teaching Methods: The Teacher Agent has two main teaching strategies

1. **Verbal:** The Teacher Agent proactively provides information about the design problem via verbal suggestions and design score explanations. For example, if the Teacher Agent finds useful information about an unexplored area of the design space, it will explain this area to the user.
2. **Visual:** Users can also interact with the Teacher Agent through a Teacher UI. This UI has four different sections, each one dedicated to providing the user information about one of the design problem topics listed above.



Pilot Study

Goal: To validate whether the Teacher Agent can foster human learning while increasing user performance, a pilot study was conducted at Texas A&M.

Hypotheses:

- H1) Test subjects using Daphne along with the Teacher Agent will produce a set of architectures with a higher hyper-volume than those that use Daphne without the Teacher Agent.
- H2) Users will learn more about the design problem when using the Teacher Agent with Daphne than users that use Daphne without the Teacher Agent.

Population: Nine graduate students at Texas A&M participated in this pilot study (6 male, 3 female). Three of these students were undergraduates and the other six were graduate students, all of which are pursuing Aerospace Engineering degrees.

Procedure: Each was tasked with designing a DSM (Distributed Spacecraft Mission) for monitoring Soil Moisture. The task goal was to find the best possible set of designs in terms of science and cost (maximizing the hyper-volume of the set of designs in the objective space).

Measures: To determine how much each candidate learned about the problem at hand, a test of 40 questions was administered at the end (10 questions per problem topic).

Experimental design: Counter-balanced within-subjects experiment. Each task and test was administered twice, once using only Daphne and once using Daphne with the Teacher Agent.

Future Research

To effectively teach a student, teachers must know and tailor their material to the student's level of understanding. In a similar way, the Teacher Agent could tailor its verbal suggestions and UI information to each user's level of expertise. Borrowing from the intelligent tutoring systems literature, expertise can be modeled by estimating an ability parameter for each user by means of an iterative question/answering process and Bayesian update.

Contacts/References

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[1] A. Viros Martin and D. Selva "From design assistants to design peers: Turning Daphne into an AI companion for mission designers," in *AIAA SciTech 2019 Forum*