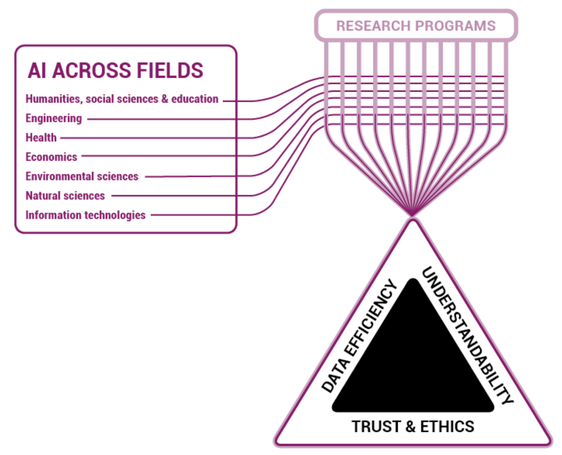
FCAI Finnish Center for Artificial Intelligence

fcai.fi

Easy and privacy-preserving modeling tools (Highlight A)

Developing AI is still difficult and time-consuming, especially for probabilistic approaches. Many of FCAI's research contributions are about making it easier. FCAI Highlight Program A exists to make sure this research has quantifiable impact for people building AI in industry and academia.



Highlight objectives

AI has uniquely narrow gap between fundamental and applied research: the advances in AI methods are rapidly taken into use in industry and other research fields.

This requires AI methods that are

1. **Easy enough** to be used by **wide audience**
2. Easily **accessible** as (open-source) software
3. Computationally **reliable** and addressing the **real needs**

FCAI takes this seriously. This Highlight exists to make sure the fundamental research carried out in Research Programs is taken into use. Its main objective is to measure and maximize the impact of FCAI research on the process of probabilistic AI development.

We focus on

1. Principles for improving the (typically interactive) modeling workflow (R1, R5)
2. Tools for building probabilistic AI models (probabilistic programming, efficient inference) (R1)
3. Tools for building AI that links to existing domain simulators (R2)
4. Tools that make possible privacy-preserving inference for existing probabilistic models (R4)

Methodologies

Highlight A builds integrally on the Research Programs that develop solutions addressing the key problems in current modeling pipelines.

Modeling principles

R1: Formulation of Bayesian modeling workflow and development of specific algorithms and methods for different stages of that process, such as prior specification, inference, decision-making, and model checking. Development of probabilistic programming systems.

R2: Fundamental algorithms for simulator-based inference.

R4: Differential privacy guarantees for probabilistic inference

R5: Collaborative human-AI model design, human aspects in modeling workflows

Practical tools

FCAI contributes to a range of already established modeling tools, but additionally works on large number of smaller software projects, typically building on top of tools with existing userbase.

Stan
Leading probabilistic programming language

brms
R package for generalized multi-level models using Stan

ELFI
Leading tool for simulator-based inference

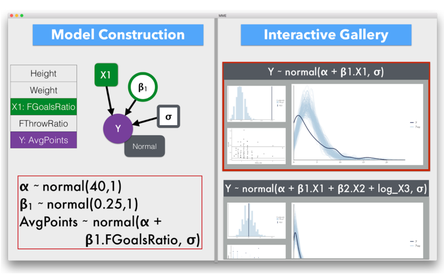
Research results

Examples of ongoing research in R1–R5 on lowering the expertise requirements for the modeler.

Modeling made easy

R5: Kashyap Todi, Pedram Daee, Antti Oulasvirta

Interactive tool for domain experts without modelling expertise. AI assists by intelligent querying, feedback, and suggestions, to extract knowledge, facilitate model exploration and construction, and support learning and understandability.



Bayesflow

R1: Paul Bürkner, Aki Vehtari

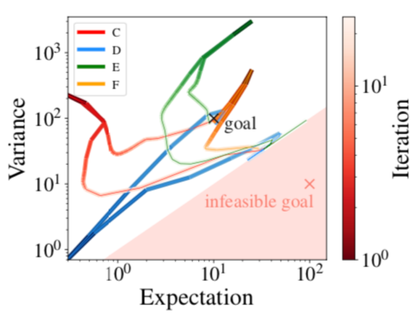
Software-assisted Bayesian workflow for interpretable models. AI acts as statistical expert supporting a domain expert developing a reproducible model in an interactive R scrpting environment.

```
library(bayesflow)
bayesflow("example_analysis")

bf_next_steps()
  Supply the data: bf_set_data

bg_set_data("example_data.csv")
  Initial variable types set
  Use bf_get_var_types and bf_set_var_types
  to check and change them

bf_next_steps()
  Define analysis goal: bf_set_goal

bf_set_goal(goal_effect(x = treatment, y=y))
   Initial model is:
    formula = y ~ treatment
    family = poisson(log)
```

Prior predictive elicitation

R1: Marcelo Hartmann, Tomasz Kuśmierczyk, Arto Klami

Automatic selection of prior distributions for predictive Bayesian models and interactive elicitation of expert's knowledge for interpretable models, based on prior predictive distribution.



Impact

At the core of Highlight A are means for measuring and maximizing the impact of our research

1. Are the tools being used?
2. Do they help solving important problems? (in REAL WORLD)
3. How strong is the community involvement?
4. Are they actually easy to use? (for REAL PEOPLE)

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FCAI is a nation-wide competence center for Artificial Intelligence in Finland, initiated by Aalto University, University of Helsinki, and VTT Technical Research Centre of Finland. FCAI is one of the six Academy of Finland Finnish flagships.

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