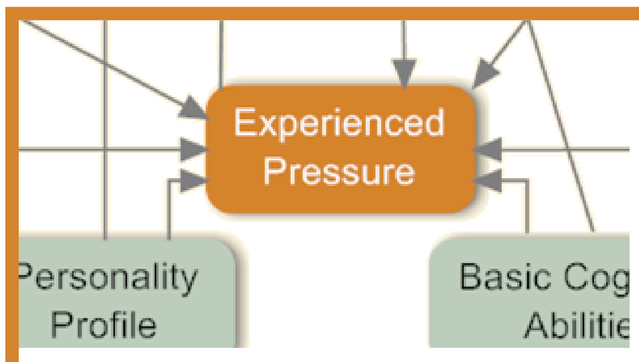

validation of an agent model for human work pressure

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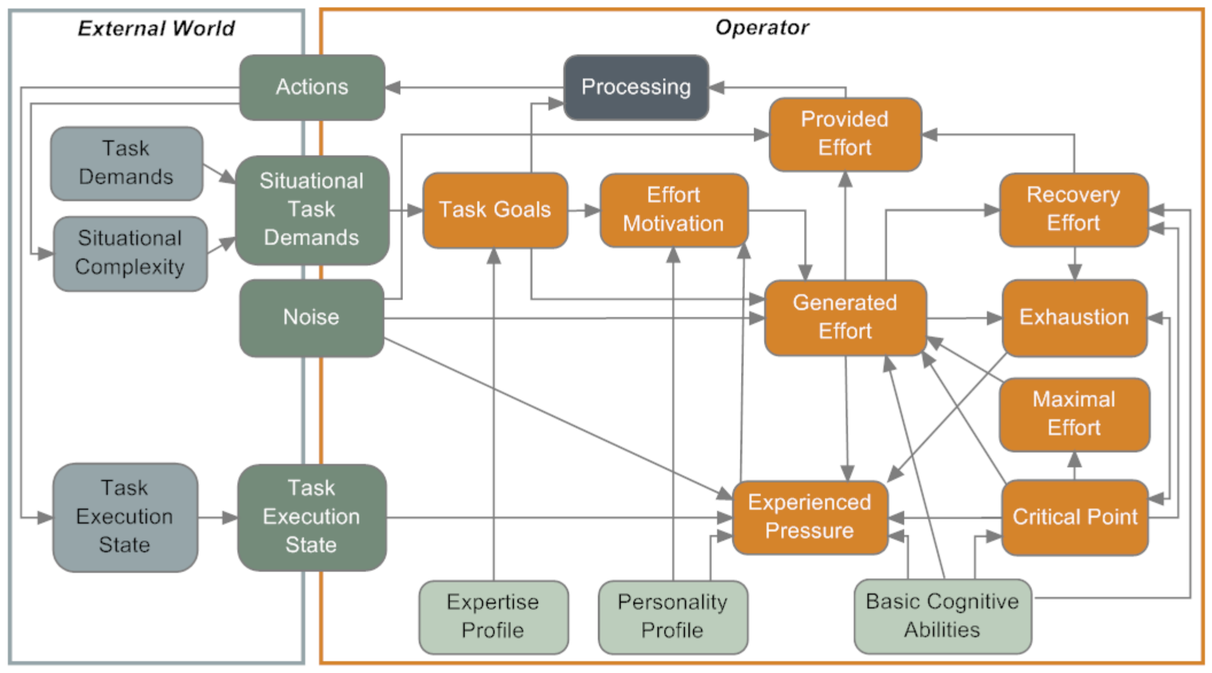
introduction.

Human performance can seriously degrade under demanding tasks. To improve performance, agents can reason about the current state of the human, and give the most appropriate and effective support. To enable this, the agent needs a work pressure model, which should be valid. This paper concerns the validation of an existing work pressure model.

work pressure model.

The agent model for the Functional State of a human represents the dynamical state of a person when performing a certain task. States such as experienced pressure, motivation and exhaustion of the person are predicted, but also the performance quality and the amount of generated effort to the task.



experiment.

In the experiment the main task is a shooting game where objects (friends and enemies) fall down. The purpose is to shoot the enemies before they hit the ground.

- 31 participants, 18 male 13 female, mean age of 26
- 2 factor within subjects design: task demands varied
- input for the model:
  - NEO-PI-R and NEO-FFI personality questionnaires
  - two reaction time tests and one calculation test
  - situational demands and performance quality

estimation of parameters.

Using the data from the experiment, 27 parameters were estimated using two methods: a gradient-based approach and simulated annealing, an approach based on probabilistic search.

gradient-based parameter estimation (GB)

input: initial values of the parameters θ^1; maximal number of iterations itmax; satisfactory error value err_sat; matrix of the input values U; matrix of the output values Z

output: maximum likelihood estimate θ_{ML}

simulated annealing (SA)

input: initial randomly selected values of the parameters; computational budget C; observed human behaviour B

output: best estimate of parameter settings θ_{BE}

table 1. Root mean square errors of estimation

error range		**< 0.1**	**[0.1, 0.25)**	**[0.25, 0.4)**	**> 0.4**
Subjects in condition 1	GB	11	1-10, 12, 14-31	-	-
	SA		30	1, 2, 12, 14-16, 20, 22-29, 31	3-8, 10, 11, 18, 19, 21
Subjects in condition 2	GB	2, 5, 8, 10, 11, 13, 17, 20	1, 3, 4, 6, 7, 9, 12, 14-16, 18, 22-31	19, 21	-
	SA	22	7, 16, 20, 21, 24. 25, 27, 30	2, 17, 28, 31	1, 3-6, 8-13, 15, 18, 19, 23, 26, 29

table 2. Cross validation

error range	**< 0.1**	**[0.1, 0.25)**	**[0.25, 0.4)**	**> 0.4**
GB	11	2-10, 12, 14-20, 24-30	1, 21, 22, 31	23
SA	-	7, 16, 21, 22, 27, 30	2, 3, 12, 15, 18, 20, 24, 25, 28, 31	1, 4-6, 8-11, 19, 23, 29

verification of properties.

The model has also been validated with logical verification. Three properties have been identified that are entailed by the work pressure model and verified against the empirical data. The language used for this is Temporal Trace Language (TTL).

Properties checked against empirical data traces:

- performance quality decreases in case a high task level is experienced: **60%** of traces satisfied
- performance quality increases or stays the same in case a low task level is experienced: **45%** of traces satisfied
- when task level is lower, performance quality is higher: **60.7%** of traces satisfied

summary.

First, experiments have been designed and conducted, whereby measurements related to the work pressure model have been performed.
Next, this data has been used to obtain appropriate parameter settings for the model, describing the specific subject.
Finally, the work pressure model, with the tailored parameter settings, has been used to predict human behavior to investigate predictive capabilities of the model.
The results have been analyzed using formal verification.