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ACTOR ACTOR INTER-ACTION [AAI]

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Dedicated to those who gave us the prior experience and the inspiring ideas to develop the view offered in this book..

Preface

An AAI Course Program: This text presents a short, condensed version of an analysis using the AAI (Actor-Actor Interaction) paradigm, which can be handled within one semester term of a master program. But even this short version tries to bring together such diverse topics like *Human-Machine Interaction (HMI)*, *Systems Engineering (SE)*, *Artificial Intelligence (AI)*, *Cognitive Science (CogS)* and *Philosophy of Science (PhS)* in one coherent framework. This text is intended to introduce a complete process from starting with a problem, analyze the problem in an AAI manner, test the result and stop.

Web Site This small text is located as one sub-topic at the main website `https://www.uffmm.org/`.

Terminology: HCI - HMI - AAI From the history of computer after the World War II[1] one can see that the development of the computer hardware induced steadily new ways of usages of computers, which simultaneously induced new requirements for the professional users of a computer. In the early beginnings it was a challenge to have the right programming languages for coding ideas and to enable more human like interfaces. This was the age of *HCI (Human Computer Interaction)*. The then occurring spreading of computer technology in more and more areas of everyday working environments induced a change from interactions with typical computers only to interactions with technical environments in general, where the computer is now an embedded technology, hided in the environment. This was the age of HMI (Human Machine Interaction). The further development of *Artificial Intelligence (AI)*, especially in its diminished format of *Machine Learning (ML)*, transformed the *classical* machine concept into a new, *smart* machine concept, which turned the boundaries between man and machines into a fuzzy matter, where the concept of an actor can now mean some robot, some smart program as well as a human person. This is the age of *AAI (Actor-Actor Interaction)*.

[1] For a first introduction see the two human-computer interaction handbooks from 2003 and 2008, and here especially the first chapters dealing explicitly with the history of HCI (cf. Richard W.Pew (2003) , which is citing several papers and books with additional historical investigations (cf. p.2), and Jonathan Grudin (2008) . Another source is the 'HCI Bibliography: Human-Computer Interaction Resources' (see: `http://www.hcibib.org/`), which has a rich historical section too (see: `http://www.hcibib.org/hci-sites/history`).

Richard W. Pew. Introduction. Evolution of human-computer interaction: From memex to bluetooth and beyond. In J.A. Jacko and A. Sears, editors, *The Human-Computer Interaction Handbook. Fundamentals, Evolving Technologies, and emerging Applications*. 1 edition, 2003; and Jonathan Grudin. A Moving Target: The Evolution of HCI. In A. Sears and J.A. Jacko, editors, *The Human-Computer Interaction Handbook. Fundamentals, Evolving Technologies, and emerging Applications*. 2 edition, 2008

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The 'All in One View'

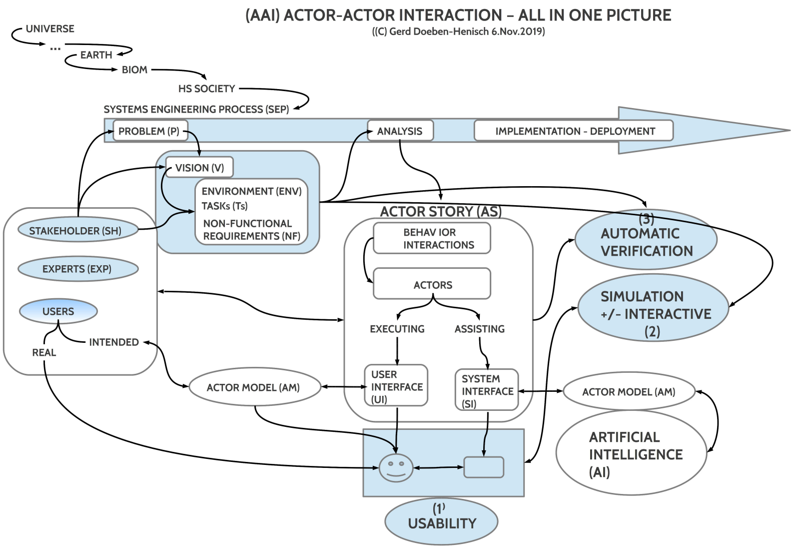

Figure 1.1: AAI analysis, the 'All in One View'

The figure 1.1 shows in one view all the topics which will be covered in the AAI paradigm as proposed in this text.

FIND A SOLUTION: The whole machinery of the *Actor-Actor Interaction Analysis* – short: AAI analysis – is rooted in the idea to find an *optimal solution* for a *given problem*. This solution has to be given as a physical something which mimics the intended *interface* of a technical system in a way, that a *real user* can *test* the interface by trying to *solve a given task* in a *given environment*. To qualify an interface as *optimal* requires some *objective benchmarking* in a way, which everybody can accept and repeat. This kind of benchmarking is usually called *usability test* and it is nothing else then a special kind of *measurement*. In the usability test someone *compares* an X to be measured with an Y which serves as an accepted *norm*, as an accepted *standard*.[1] During an usability test a real user is interacting with a real something of an intended interface of a technical system. The primary subject for the measurement is given by this *sequence of interactions* which represent the *behavior* of the user as well as of the interface. But what are the standards for comparison?

[1] The international accepted measurement standards are managed by the *BIPM: Bureau International des Poids et Mesures* which is associated with many member states (see URL: `https://www.bipm.org/en/about-us/`)

ANNOUNCEMENT OF A VISION: The primary standard is given by that *vision*, which a stakeholder – which can be a large group – has announced as the answer to a *problem*, which he hast stated before. The vision has to include certain *tasks* which should be possible to be done by certain *actors* in a certain *environment*, further characterized by some *non-functional requirements (NFRs)*. Such non-functional requirements calling for general properties like 'being save', 'working in real-time', 'being competitive in a certain market', and the like.

ELABORATE THE VISION: The vision is a first *sketch*, a first *outline*, a very *broad direction* where to go, but it is not yet clear enough for an exact specification. This has to be done from a group of *experts* which have enough experience, knowledge, and communication skills to *translate* the vision step wise into a more concrete description, such that the description worked out within an AAI analysis finally can be used as that *standard* needed for the usability test.

ACTOR STORY (AS): The more concrete specification has to be realized as a collection of *basic facts* where each basic fact can be decided as *being true* or being *not true* or judged as being *not decidable* with regard to the before selected environment. Such facts have to be organized as sets of facts where one set represents a *state*.[2] With regard to states one has to assume *basic functional units* which describe basic transformations between two consecutive states S and S': By *deletion* a fact from S will not occur anymore in S'. By *creation* a fact F not yet in S will occur in S'. There can be more than one functional unit operating on a state S to transform S into a consecutive state S'. A sequence of states and transformations of the states defined by functional units is called here an *actor story (AS)*. The functional units can be interpreted as *interactions* caused by *actors* which are part of a state. The set of all interactions represents the *behavior* of the actors.

[2] often also called *situation*, *scenario* or *scene*.

BENCHMARKING REFERENCES AND USABILITY STANDARD: With an actor story used as a *standard* for a usability test the experts can measure the observable behavior of the participating actors and they can infer some hard facts as basis for their judgments. But this usability measurement is not the whole story. While *usability* is one central property for a new product or service, there are some *more factors* which determine a more general concept of *success* from the point of view of the stakeholder. A short – possibly not complete – list is given here:

1. The *actor story* as standard for the usability test specifies which *tasks* have to be done in which concrete decidable way. This includes the *completeness* of a task, the *error density*, as well as the *performance*.

2. The *response of some real test persons* represent the *satisfaction of the intended users* whether there subjective feeling matched sufficiently well with regard to their role in the elaborated actor story.

3. The *response of the stakeholder* represents the *satisfaction of the stakeholder* whether his vision has been *matched sufficiently well* with

regard to the elaborated actor story. Part of this satisfaction is associated with the before stated *non-functional requirements*, whether these are fulfilled in the *whole* actor story, not in a few states only.

4. The *response of the market* which indicates the reception of the new product/ service. This can be completely independent of the before mentioned dimensions.

ACTORS - ASSISTING AND EXECUTING: While in the past the distinction between the interface of the system and the human user has been the predominant view, it makes today more and more sense to talk of *actors* with the new distinction between the *assisting* actor – the classical interface of the technical system – and the *executing actor* – the classical human user. Using different *functional roles* one can view these roles as *slots* which can be *filled* with different kinds of real entities as long as they can provide the functionality which the role requires.

ACTOR MODELS (AM): The new formal rigor in the description of the actor story allows a new enhancement of the actor story by introducing *additionally* so called *actor models (AM)*. While an actor story provides only a *3rd-person view* of the participating actors by describing their *observable behavior* it can be helpful or even necessary to be able to describe the *internal functionality* of an actor to enable some *additional rationality* in the understanding of the processes. The interaction between the actor story and the participating actor models is determined by the individual interface of an actor: everything the actor story states about the behavior of an actor in a certain situation has to be provided by the internal functionality of the actor model. But as soon as the behavior of an actor will be *determined by its internal functionality* this can induce a *surplus* of *possible behavior* compared to that behavior which is specified by the actor story. In case of *deterministic* actors this can be managed in most cases, but with *truly learning actors*[3] the generated behavior can surpass that behavior which is specified in the actor story. This transforms the specifications of the actor story into a somewhat *fuzzy* space of possible events.

[3] this is at least the case with human actors!

BIOLOGICAL - NON-BIOLOGICAL:

The primary reference for the modeling of the internal functionality of an actor is given by the actor story which follows the vision of the stakeholder. There is no specific need for a certain type of modeling as long as the primary reference will be matched. In case of human actors it can be of help to follow the empirical structures of biological systems in the modeling of the internal functionality of the actor if it is important to match the behavior of real persons as close as possible. But even if this claim is an issue it is not completely defined what kind of a formal model will serve this requirement best. This ambiguity results from the fact that the *behavior based* sciences, the *physiology (including the brain) based* sciences, as well as the *phenomenological* sciences are not yet unified today. These three views coexist one besides the other and it is not clear when and how a more fruitful integration will happen in the future.

ARTIFICIAL INTELLIGENCE (AI): Today the *mainstream* induces the impression that *smart* machines are already there and that these will in the future improve steadily until a point, where the homo sapiens[4] seems to be without a further point. This text here will advocate the stance that this opinion is completely wrong. The property of a machine of being more and more fast and simultaneously of being able to process more and more data is impressive, but does not touch any of the big problems which have to be solved today and in the near future. Nevertheless with the explicit introduction of actor models in the AAI paradigm one can *include* all the nice topics of *artificial intelligence (including machine learning)* into the actor models. The actor story is then a formally defined environment for the behavior of the introduced smart actors. The instrument of the actor story allows therefore the *integration* of *human and non-human actors* with artificial intelligence in one coherent framework.

[4] 'home sapiens' is the branding for that kind of life form which appeared in Africa about 600.000 years ago, and spreaded then about 50.000 years ago from there throughout the world. We all are descendants from them. (cf. Krause et.al. (2019))

Thomas Krause, Johannes; Trappe. *Die Reise unserer Gene: Eine Geschichte über uns und unsere Vorfahren*. Ullstein Buchverlag, Berlin, 5th edition, 2019

(INTERACTIVE) SIMULATION (IS): An actor story as such is already a *dynamic* concept dealing with transformations of states by applying functional units. Mathematically an actor story is a *graph* which can be interpreted as the *execution graph of an automaton*. If one takes this implicitly defined automaton as a *simulator* one can easily define an actor story as a *simulation*.This allows a better understanding of the space of possible states, especially in complex cases. A *stakeholder* can understand more and probably quicker, and in a *usability test* one can provide more realistic tests. To turn a normal simulation into an *interactive* one is straightforward. This opens new applications to use an actor story also for *training* and *learning*.

AUTOMATIC VERIFICATION (AV): If one takes the actor story as a graph one can use it within an *automatic verification setting* too.[5] This allows the analysis of very big and complex cases in a purely automatic and fast way. While normal simulations can reach quickly the timely limits of the performance of human users, an automatic verification can work without a human person interrupting the process and can search the complete search space for a given level of computation to find *all* possible answers. This feature – here called the *Greek oracle function (GOF)* – can probably become the most important feature for all practical applications .

[5] See e.g. Baier and Katoen (2008)

Christel Baier and Joost-Pieter Katoen. *Principles of Model Checking*. MIT Press, Cambridge (MA), 1th edition, 2008

IMPLEMENTATION: The next phase in the systems engineering process after the AAI analysis is the *logical design phase* to prepare the *implementation phase*. The input for these two consecutive phases is given by the requirements for the expected behavior of the system. Having a complete actor story at hand one has all specifications which are necessary. In case of actor models one has an extension of this specification because the internal functionalities of the actor models at least realize the format of a logical specification like those needed in the logical design phase or – depending from the overall framework – the internal functionalities of the actors are already part of the final implementation.

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