Seven Research Contributions in HCI

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ABSTRACT

Research in human-computer interaction (HCI) addresses both technological and human-behavioral concerns. It follows that the contributions made in HCI are usually separately familiar to engineering, design, or the social sciences, but rarely brought together under one roof. The seven research contribution types covered here are (1) empirical, (2) artifact, (3) methodological, (4) theoretical, (5) benchmark/dataset, (6) survey, and (7) opinion. Of course, some research articles make more than one type of contribution. The goal of this paper is to give researchers insight into the contribution types found in HCI papers, and to provide examples for further reading. I do not claim that the chosen examples are the “best of breed;” rather, they are examples with which I am familiar and that I feel illustrate a given contribution.

Author Keywords
Contributions, methods, research, science, invention.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

1. EMPIRICAL CONTRIBUTIONS

Empirical research contributions consist of new findings based on systematically gathered data. Empirical contributions may be quantitative or qualitative (or mixed), and usually follow from scientific studies of various kinds (e.g., laboratory, field, ethnographic, etc.). In HCI, the purpose of empirical contributions is to reveal formerly unknown insights about human behavior in relation to information or technology. Empirical research methods commonly used in HCI include formal experiments, field experiments, field studies, interviews, focus groups, surveys, usability tests, case studies, diary studies, ethnography, contextual inquiry, experience sampling, and automated data collection (e.g., sensing, logging).

How Empirical Contributions Are Evaluated

Empirical contributions are considered trustworthy when the methods that produce them are executed with rigor and precision. “The devil is in the details” in empirical work. Identifiable confounds and biases must be avoided in studies of all types. If methods are sound and findings important, empirical contributions should be judged favorably.

Examples of Empirical Contributions


2. ARTIFACT CONTRIBUTIONS

Artifact contributions in HCI describe inventions, which include new systems, architectures, tools, techniques, or designs that reveal new opportunities, enable new outcomes, facilitate new insights or explorations, or impel us to consider new possible futures. Artifact contributions are, by definition, dependent upon never-before-seen inventions that are instantiated as prototypes, sketches, mockups, demos, or other envisionments, and are often but not always at least partially functional. Artifacts tend to be one of three types: systems, techniques, or designs.

Novel systems, including architectures, tools, and toolkits, provide new knowledge by showing how to accomplish new things formerly impossible, or how to accomplish formerly possible things more easily (e.g., Dixon, Gajos, Greenberg, Myers, Patel, Wobbrock).

Novel interaction techniques provide new ways of inputting information or controlling systems, usually striving to be reusable across myriad platforms or situations (e.g., Baudisch, Grossman, Kristensson).

Novel designs may be prototypes, sketches, mockups, demos, or other envisionments whose purpose is to convey or motivate new possible futures (e.g., Kane, Schwesig, Wigdor). With new designs, form is the priority over function.

How Artifact Contributions Are Evaluated

Artifact contributions are often accompanied by empirical evaluations but they do not have to be. New systems, architectures, tools, and toolkits are often evaluated in a holistic fashion on the basis of what they make possible and how they do so. Interaction techniques, on the other hand, are almost always evaluated precisely and quantitatively, as human performance is central to understanding the merits of most interaction techniques. New designs, in general, are evaluated according to how compelling, how richly painted, and how informed is their vision. Designs are often presented as results of competing tradeoffs resolved by sound theoretical, conceptual, or empirical means. Designs that are deeply implemented may also be considered systems and evaluated as such.

Examples of Artifact Contributions


3. METHODOLOGICAL CONTRIBUTIONS

Methodological research contributions add to or refine the methods by which researchers or practitioners carry out their work. Research methods enable scientists to make new discoveries. Practitioner methods enable designers and engineers to apply their skills to greater effect. Entirely new methods of either sort are infrequent; method variations are more common.

How Methodological Contributions Are Evaluated

Methodological contributions are evaluated largely on the basis of the utility of the new or improved method. Demonstrating the utility of a method often requires empirical validation. Such validation may be formal in nature (e.g., an experiment in which one of two groups uses the new method, while the other group uses an extant de facto method), or a case study (e.g., where the method is applied in a particular setting and outcomes are analyzed and reported). The goal of validating a methodological contribution is to convince readers that the new method or method improvement is useful, valid, and reliable for its intended purpose. As the method is to be used by others, it must be described well enough to be employed by researchers or practitioners, including with warnings of its pitfalls and shortcomings.

Examples of Methodological Contributions


4. THEORETICAL CONTRIBUTIONS

Theoretical contributions consist of new or improved concepts, definitions, models, principles, or frameworks. These thought-vehicles may be quantitative or qualitative in nature, and structured so as to be useful in the pursuit of future knowledge. Theories are built over time, and in some fields (e.g., psychology, physics), after repeated validation, theories may attain the status of laws. Theories are both descriptive and predictive in nature; that is, they reveal the essential features of what is (descriptive) while accurately foretelling what will be (predictive). Theories must be explanatory in nature. They must not only state that a relationship holds, but why it holds the way it does. Scientific theories must also be falsifiable; they must assert something...
that may or may not be true. If a theory cannot be falsified even in principle, it is not a scientific theory. Theoretical contributions significantly advance our understanding of phenomena by providing inherently reusable constructs and ways of thinking about phenomena of interest.

How Theoretical Contributions Are Evaluated

Theoretical contributions are evaluated based on their novelty, importance, descriptive power, and predictive power. A theory that accounts well for observed data from a specific situation but has no ability to generalize to a new situation is inherently limited. Such a theory may be “over-fit” to the observed data. Conversely, a theory that is so broad it can account for anything probably does not contain any real descriptive power. It lacks specifics and is “under-fit.” For these and other reasons, theory validation is almost always accompanied by empirical work, although such work occasionally precedes and give rise to theory.

Examples of Theoretical Contributions


5. BENCHMARK / DATASET CONTRIBUTIONS

Benchmarks or datasets are infrequent contributions in HCI, but they do occur. A benchmark or dataset contribution provides a new and useful corpus, often accompanied by an analysis of its characteristics, for the benefit of the research community. Benchmarks are offered along with standard tests to facilitate cross-project comparisons. Datasets enable evaluations of common data repositories by new algorithms, systems, or methods. Benchmark or dataset contributions are more common in the artificial intelligence, algorithms, operating systems, and database communities, to name a few.

How Benchmark / Dataset Contributions Are Evaluated

A benchmark or dataset contribution is judged favorably the extent to which it supplies the research community with a much-needed corpus against which to test future innovations. Also, benchmarks or datasets should be accompanied by explanations of how the benchmark was created or how the data was gathered, in what ways it is (or is not) representative, and common procedures to employ with it. Often, benchmarks or datasets are published with new tools that enable researchers to work with the new corpus. Where new methods or tools are released with new data, benchmark or dataset contributions may be part of methodological or artifact contributions as well.

Examples of Benchmark / Dataset Contributions


6. SURVEY CONTRIBUTIONS

Survey contributions are attempts to review and synthesize work done in a research field with the goal of exposing trends, themes, and gaps. Survey contributions take a step back (and often a step up), organizing the literature on a particular topic and reflecting on what it means. Often, survey contributions are conducted after a topic has reached a certain level of maturity. It is not uncommon for surveys to be over fifty pages in length, with references numbering in the hundreds. The journal ACM Computing Surveys is exclusively devoted to publishing survey contributions in computing. In HCI, the journal Foundations and Trends in HCI regularly publishes survey contributions.

How Survey Contributions Are Evaluated

To be effective, survey contributions must not be mere laundry lists of prior work. Rather, they must review and synthesize this work, extracting emergent themes and trends, identifying gaps where new opportunities lie. Surveys are judged on their completeness, depth, organization, maturity, synthesis, and fairness. Surveys are also judged favorably the extent to which they uncover promising new areas for future work.

As an example, consider the stated scope of ACM Computing Surveys: “To present new specialties and help practitioners and researchers stay abreast of all areas in the rapidly evolving field of computing. Computing Surveys focuses on integrating and adding understanding to the existing literature. It does not publish ‘new’ research. Instead, it focuses on integrating the existing literature and putting its results in context. Surveys … must develop a framework or overall view of an area that integrates the existing literature. Frequently, such a framework exposes topics that need additional research. Basically, a survey article answers the questions, ‘What is currently known about this area, and what does it mean to researchers and practitioners?’ It should supply the basic knowledge to enable new researchers to enter the area, current researchers to continue developments, and practitioners to apply the results.”

Examples of Survey Contributions


7. OPINION CONTRIBUTIONS

Papers making opinion contributions seek to change the minds of readers through persuasion. Although the term “opinion” might suggest a less-than-scientific effort, in fact, opinion contributions, to be persuasive, must draw upon many of the above contribution types to advance their case, especially empirical results. Opinion contributions are considered a separate contribution type not because they lack scientific bases, but because of their goal, which is to persuade rather than to just inform. Along with persuasion, the goal of opinion contributions is to compel discussion, reflection, and even dissertation or a change of course for the field. Opinion articles advance a specific point of view more overtly than articles from other contribution types.

How Opinion Contributions Are Evaluated

Opinion contributions are evaluated on the credibility and use of their supporting evidence and examples, on their fair consideration of alternate perspectives, and on the strength of their articulated position. Opinion contributions should focus on topics of interest to a broad community, and should therefore have widespread appeal. Often opinion contributions appear in semi-scholarly venues such as ACM Interactions to reach a wide audience.

Examples of Opinion Contributions


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