

# Advanced Combinatorial Test Suites (ACTS) for Testing Software

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11

**Developers of large data-intensive software often notice** an interesting phenomenon: when the number of customers serviced by an application jumps dramatically, applications that have operated for months without trouble suddenly develop previously undetected errors. In such cases, the newly added customers often have account records consisting of an oddball combination of values and/or an unusual combination of user preferences that had not been seen before. Some of these rare combinations trigger faults that have escaped previous testing and extensive use. Combinatorial testing can be used to efficiently find errors, and find them early in the software's life-cycle.

Combinatorial software testing is a means of ensuring trustworthy software in business, industrial, medical, scientific, and transport systems. It is often difficult or impossible to characterize all possible interactions of software parameters let alone test them. Combinatorial testing is based on the observation that not all parameters are involved in every interaction fault and that most interaction faults involve only a few parameters. A NIST study of actual faults showed that: (1) most faults involved a single parameter; (2) a smaller proportion of faults resulted from interactions between values of two parameters; and (3) progressively fewer interaction faults involved 3, 4, 5, and 6 parameters. The goal of this project was to advance the technology from pair-wise to higher order testing and to demonstrate successful applications.

NIST developed a software tool to generate test suites for high strength testing under the name of ACTS (Advanced Combinatorial Test Suites). The NIST-ACTS team has distributed copies of ACTS to US government agencies and global corporations. The team published five papers in refereed publications and two magazine articles. In 2009, the team plans to continue enhancing ACTS and investigate its use in computer security applications, GUI based applications, web-applications, and for optimization and testing of simulations of complex systems.

The software was released using an open source model. After the initial planned distribution of 176 copies of the NIST-ACTS, word-of-mouth aided by email resulted in a more than four-fold increased distribution of the software to interested parties world-wide. Feedback and continuing requests for the system to program manager, Dr. Raghu Kacker, of NIST's Information Technology Laboratory indicates that ACTS has been enthusiastically accepted by an international user community and that NIST/ITL's technology transfer effort for the beta test version has achieved a level of success that far exceeded original expectations.

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