Abstract

Decompilation is the process of reverse engineering a binary program into an equivalent source code representation with the objective to recover high-level program constructs such as functions, variables, data types, and control flow mechanisms. Decompilation is applicable in many contexts, particularly for security analysts attempting to decipher the construction and behavior of malware samples. However, due to the loss of information during compilation, this process is naturally speculative and thus is prone to inaccuracy. This inherent speculation motivates the idea of an evaluation framework for decompilers.

In this work, we present a novel framework to quantitatively evaluate the inference accuracy of decompilers, regarding functions, variables, and data types. Within our framework, we develop a domain-specific language (DSL) for representing such program information from any "ground truth" or decompiler source. Using our DSL, we implement a strategy for comparing ground truth and decompiler representations of the same program. Subsequently, we extract and present insightful metrics illustrating the accuracy of decompiler inference regarding functions, variables, and data types, over a given set of benchmark programs. We leverage our framework to assess the correctness of the Ghidra decompiler when compared to ground truth information scraped from DWARF debugging information. We perform this assessment over a subset of the GNU Core Utilities (Coreutils) programs and discuss our findings.

A Framework for Assessing Decompiler Inference Accuracy of Source-Level Program Constructs

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Chapter 1

Introduction

1.1 Context and Background

In an increasingly digital world, cybersecurity has emerged as a crucial consideration for individuals, companies, and governments trying to protect their information, financial assets, and intellectual property. Of the many digital threats, various forms malware continue to pervade the digital landscape and thus remain a key concern for security analysts. One approach for combating malware involves attempting to deconstruct and reason about the malware itself. Understanding the functionality and behavior of malware samples may aid a security analyst in identifying methods to thwart or disable the malware's effects on a target system and similar systems.

Although simple in concept, the act of reverse engineering and reasoning about malware proves to be a steep challenge. The primary issue is that access to high-level malware source code is almost never available and, thus, any reasoning about the malware must be derived from the malware sample itself. Another issue is that malware authors often leverage obfuscation techniques to mask the intention and behavior of malware samples. To evade antivirus tools using signature-based detection, malware authors may employ techniques such as dead-code insertion, register reassignment, subroutine reordering, instruction substitution, code transposition, and code integration []. To complicate semantic binary code analysis of malware samples, malware authors may leverage compile-time strategies such as stripping and compiler optimizations []. Although we have discussed these obfuscation strategies in the context of malware, these techniques may be also leveraged by developers or companies attempting to dissuade binary code analysis of proprietary software.

Despite the challenge of binary code analysis, there exist many tools that attempt to glean high-level semantic information from binary code samples. A *disassembler* takes binary code as input and produces architecture-specific assembly code as output. Many challenges and considerations exist in the disassembly process - particularly for stripped binary code - such as discerning code from data and locating function boundaries []. One invariant in the disassembly process, however, is that the mapping from assembly instructions to binary instructions and vice-versa is always one-to-one. A *decompiler* takes this reverse mapping process one step further by translating binary code into an equivalent high-level source code representation. The decompilation process is inherently speculative since high-level information such as function boundaries, variables, data types, and high-level control flow mechanisms are lost when a program is compiled. With this, the decompiler must infer enough high-level structure for useful analysis without being overly aggressive and consequently blurring the program's intent. Many decompiler tools are currently in use by the reverse engineering community. Commercial decompiler tools include IDA Pro [] and JEB3 []. Popular open-source decompiler frameworks include Ghidra [], RetDec [], and Radare2 [].

1.2 Research Problem

Due to the number of decompiler tools as well as the imprecise nature of decompilation, a generalized and extensible quantitative evaluation framework for decompilers is critical. Existing work by Liu and Wang [] proposes an evaluation technique to determine whether recompiled decompiled programs are consistent in behavior to their original binaries. This technique, although useful, does not offer any insight into the inference accuracy of decompilers with respect to high-level program constructs such as functions, variables, and data types. The inference accuracy of the these high-level constructs are important for analysts to gain an understanding of the analyzed program.

1.3 Research Objectives

Targeting the current gap in the literature outlined in the previous section, this paper presents a novel framework for quantifying and assessing the accuracy of decompiler tools. To prove our concept, we apply our framework to the Ghidra decompiler and subsequently discuss our findings. The primary objectives achieved by this work are as follows:

- 1. We define a domain-specific language (DSL), written in Python, for expressing high-level program information such as functions, variables, and data types. This is serves as a language-agnostic medium whereby we can translate program information extracted from a decompiler or a ground-truth source.
- We extend our DSL to compare program information representations from different sources.
 A common use case is to compare ground-truth program information to decompiler-inferred program information.
- 3. Leveraging the comparison logic in (2), we define a set of quantitative metrics to measure the accuracy of function, variable, and data type inference.
- 4. We develop a translation module in Python that uses DWARF debugging information from a binary program to generate a ground-truth program information representation in our DSL.
- 5. We utilize the Ghidra Python API to implement a translation module, taking a Ghidra decompilation of a binary program as input and producing a program information representation in our DSL.
- 6. Using our developed language, metrics, and translation modules, we quantitatively assess the accuracy of the Ghidra decompiler when compared to ground-truth program information obtained from DWARF debugging information. We perform this analysis using the set of GNU Coreutils programs as benchmarks. We present the evaluation results and discuss additional findings and takeaways.

1.4 Evaluation Summary

We use our evaluation framework to perform an assessment of the Ghidra decompiler (version 10.2) over 105 GNU Core Utilities (version 9.1) benchmark programs compiled with GCC (version 11.1.0). We evaluate Ghidra with no optimizations under three compilation cases of the benchmark programs - (1) stripped, (2) standard (not stripped, no DWARF symbols added), and (3) debug (DWARF symbols included) - to determine how the level of information provided in the binaries affects recovery and inference performance of functions, variables, and data types by Ghidra.

Our function recovery analysis reveals that Ghidra successfully recovers 100% of the 18139 functions under the stripped and standard compilation conditions across all benchmarks. In the debug compilation case, Ghidra successfully identifies all functions but fails to decompile four functions in the *factor* program due to a type resolution error. Upon further analysis, we conclude this is a bug in the Ghidra decompiler.

Analysis of high-level variable recovery shows that the recovery accuracy of variables of primitive data types (char, int, float, pointer) is significantly higher than the recovery accuracy of complex (aggregate) types (array, struct, union), particularly in the stripped and standard compilation cases when no debugging information is present. Overall, we see a partial high-level variable recoveries percentages of 97.1%, 99.2%, and 99.9% for the three compilation cases, respectively. The percentages of exact high-level variable matches for each of the compilation cases are 36.1%, 38.6%, and 99.6%, respectively.

Related to our high-level variable recovery analysis, we perform a "decomposed" variable recovery analysis. For the decomposition, we recursively decompose each variable into a set of primitive variables as they appear in memory. We then perform the comparison and evaluation similar to in the high-level analysis. We show that the partial recovery percentages for each of the stripped, standard, and debug compilation cases are 73.8%, 92.4%, and 98.0%, respectively. The exact match percentages over the decomposed variables are 24.6%, 25.0%, and 98.0% for each of the compilation cases, respectively. The lower recovery accuracy results in this decomposed analysis are explained by the decomposition of the variables with complex types, namely arrays, that

are partially or fully missed in the high-level analysis. These variables, when decomposed, result in an increase in the number of total missed variables. Analysis of decomposed variable recovery by data type shows that int (and char) variables are most accurately inferred, followed by pointer variables, with floating-point (float, double) variables showing the lowest recovery accuracy.

We perform a data bytes recovery analysis to determine the total percentage of data bytes that are found and missed across all ground truth variables by the decompiler. We discover that the bytes recovery percentages are 61.3%, 80.6%, and 99.5% for each the stripped, standard, and debug compilation cases, respectively.

Lastly, we perform an evaluation of the Ghidra decompiler's array recovery accuracy. We find that, for each the stripped, standard, and debug compilation cases, 36.2%, 71.6%, and 99.5% of ground truth array varnodes overlap with at least one associated decompiler-inferred array varnode, respectively. We find the average size (in bytes) discrepancies between compared ground truth and the decompiler variables to be 458.6, 239.0, and 9.42 for each of the compilation cases, respectively. With respect to the sizes of the ground truth arrays, the average array size error percentages for the array comparisons in each compilation case are 91.2%, 47.5%, and 11.0%, respectively.

Across our analyses, we observe that there is a clear relationship between the compilation configuration of the benchmark programs and the recovery accuracy of program constructs by the Ghidra decompiler. We find that, with respect to recovery of program constructs, the debug compilation case far outperforms the standard case, which moderately outperforms the stripped case. However, despite the relatively high recovery accuracy of the Ghidra decompiler in the debug case, we futher explore the causes of misses and partial misses in the debug case and find that Ghidra possesses a major limitation in expressing local variables tied to specific lexical scopes. A compiler such as GCC may reuse stack address space for variables associated with non-overlapping and non-nested lexical scopes. This is a problem for the Ghidra decompiler as we observe that all variable declarations are placed at the top level of the function, ultimately preventing these scope-specific variables from being precisely captured. From our manual analysis of the decompiled benchmark programs, we find that this is the cause of the majority of partially missed variables

and data bytes in the debug compilation case. This limitation certainly affects the stripped and standard compilation cases as well.

1.5 Contributions

The three key contributions of this work are as follows:

- 1. We develop a novel framework for evaluating decompiler tools based on the recovery accuracy of high-level program constructs, including functions, variables, and data types. This framework includes a domain-specific language (DSL), developed in Python, to represent and compare sources of high-level program information and their association with binary-level constructs. In addition, we devise quantitative metrics for expressing recovery accuracy of program constructs.
- 2. We leverage our framework to perform an in-depth evaluation of the Ghidra decompiler with respect to high-level function, variable, and data type recovery. This evaluation is performed over the GNU Core Utilities programs under three compilation conditions.
- 3. From our evalution of Ghidra, we discover and discuss the implications of two key issues present in the Ghidra decompiler.

1.6 Outline

The remainder of this paper is outlined as follows: In Section ??, we discuss related research and background concepts useful for the understanding of this work. Next, in Section ??, we detail our methodology for developing our evaluation framework. In Section ??, we present and discuss the results of applying our evaluation framework to the Ghidra decompiler. We conclude in Section ?? with a summary of our results, implications of our work, limitations, and future research directions.

Chapter 2

Background and Related Work

2.1 Software Reverse Engineering, Dissassembly, and Decompilation

Software reverse engineering (SRE) is the process of analyzing a software system with the intention to extract design and implementation information, particularly in situations where high-level source code is unavailable []. One common use case for this practice is to understand and deconstruct legacy code present in a software system where the source code has been lost. In this scenario, analysts could use SRE to understand this legacy code, determine its behavior, and ultimately decide how to reuse, patch, or replace the code. Another context for the use of SRE is computer security. Malware, or malicious programs, are nearly always present in binary form without their associated high-level source code. An analyst may use SRE to deconstruct the malware's logic, determine its behavior, and identify approaches to neutralize the malware and harden the host system for prevention of future attacks.

To perform SRE on a binary program, a critical first step is *disassembly*. This process takes binary code as input and produces assembly code as output. A key to this process is that binary and assembly instructions are always mapped one-to-one, and thus the main challenges lie in determining function boundaries and differentiating code, data, and metadata. Factors that contribute to these challenges include the following []:

- Data embedded in code regions
- Variable instruction size (on some architectures)
- Indirect branch instructions (the target of a branch instruction is not statically known)

- Functions without explicit 'CALL' references
- Position independent code sequences
- Manually crafted assembly code

The conversion of binary code to assembly code through disassembly is a desirable starting point in the process of SRE. However, program semantics are still often difficult to interpret and reason about at the assembly code level. This difficulty necessitates an even more speculative process, *decompilation*, that takes a binary program as input and produces a high-level source code representation of the input program's semantics, usually in C. Decompilation, therefore, involves the speculative inference of high-level language concepts such as control flow mechanisms, variables, and data types. Decompiler tools rely heavily on the disassembly process as a first step in their analysis, and therefore the challenges affecting disassembly also naturally affect decompilation. Additional factors that obfuscate the accuracy of decompilation are the following:

- Compiler optimizations
- Stripped debugging information and metadata

With these compounding challenges affecting the decompilation process, it is clear that decompiler tools operate under a great degree of nondeterminism and speculation. This fact highlights the need for a common evaluation framework for decompiler tools.

2.2 DWARF Debugging Standard

DWARF is a debugging file format used by many compilers and debuggers to support source-level debugging for compiled binary programs []. When specified flags (usually '-g') are present at compilation, DWARF-supporting compilers such as GCC and Clang will write DWARF debugging information to an output binary program or object file. A resulting binary executable can then be loaded into a DWARF-supporting debugger such as GDB to debug the target binary program

with references to line numbers, functions, variables, and types in the source-level program. The DWARF standard is source language agnostic, but generally supports equivalent representations for constructs present in common procedural languages such as C, C++, and Fortran. In addition, DWARF is decoupled from any architecture, processor, or operating system. The generalizability of DWARF debugging information makes it a prime candidate for extracting "ground truth" information about a particular binary program, regardless of the specifics of the source language, architecture, processor, or operating system. DWARF is leveraged in this work to scrape ground-truth information about target binary programs. This information is subsequently used to evaluate the accuracy of the output produced by a target decompiler.

2.3 Ghidra Reverse Engineering Framework

Ghidra, created and maintained by the National Security Agency Research Directorate, is an extensible software reverse engineering framework that features a disassembler, decompiler, and an integrated scripting environment in both Python and Java []. We use the Ghidra decompiler in this work to demonstrate our decompiler evaluation framework.

2.4 Related Work

In the 2020 paper *How Far We Have Come: Testing Decompilation Correctness of C Decompilers* by Liu and Wang [], the authors present an approach to determine the correctness of decompilers outputting C source code. They aim to find decompilation errors, recompilation errors, and behavior discrepancies exhibited by decompilers. To evaluate behavioral correctness, they attempt to recompile decompiled binaries (after potential syntax modifications) and use existing dynamic analysis techniques such as fuzzing to find differences in behavior between the recompiled and original programs. The objective of our work differs as we aim to evaluate decompiler inference of high-level structures such as functions, variables, and data types. Accurate inference of high-level structures enables easier understanding of decompiled programs by analysts; however, accurate be-

havior is also necessary to ensure that the decompiled representation is consistent with the original program. Hence, both of these works evaluate important aspects of decompiler correctness.

The review *Type Inference on Executables* by Caballero and Lin (2016) provides a comprehensive summary of recent literature on techniques used for variable discovery and type inference. In addition, the authors present various software reverse engineering (SRE) tools and frameworks in terms of their inputs, analysis types, output formats, and use cases. In essence, this work surveys the a set of decompiler tools and characterizes them based on their purported capabilities. The purpose of our work, on the contrary, is to objectively determine the correctness of decompiler tools based on their inference accuracy of high-level program constructs.

Chapter 3

Methodology

In this section, we discuss the design, construction, and evolution of our decompiler evaluation framework. To achieve this, we identify key objectives that we subsequently address in more detail in the following subsections. These objectives are as follows:

- 1. Express program information such as functions, variables, data types, and addresses in a common representation.
- 2. Programmatically capture a "ground truth" representation for a given program.
- 3. Programmatically scrape program information from decompiler tools, namely Ghidra.
- 4. Compare two program representations of the same program.
- 5. Formulate quantitative metrics for evaluating the accuracy of a decompiler.

3.1 Domain-Specific Language (DSL) for Program Information

In order to make our framework general and reusable, we devise a common domain-specific language (DSL) to represent program information such as functions, variables, data types, and addresses, as well as the relationships between them. This DSL must act as a bridge linking binary-level address information with the source-level structures such as functions, variables, and data types. Combining the information from these two layers of abstraction is, in essence, a mapping between binary-level and source-level structures. The accuracy of this mapping for a given decompiler is precisely the objective of our analysis.

[Figure representing how DSL can be constructed from many sources (DWARF, Ghidra, IDA Pro, etc.)]

The DSL we devised is entirely decoupled from the source of the program information. This allows any ground truth or decompiler source of program information to be translated into this common language and subsequently analyzed or compared with another source of program information. The core of our language is defined in Python and is compatible with Python (Jython or CPython) versions >= 2.7. We chose Python because the Ghidra framework supports custom Python scripts for querying and manipulating program information obtained from the disassembler and decompiler. In addition, the Python 'pyelftools' open-source library [] allows scraping DWARF debugging information directly from binary programs. This DWARF information can then be utilized to construct a "ground truth" representation of program information. We discuss this further in the next section.

3.1.1 DSL Definitions

In this section, we briefly describe the structure and relationships of the major constructs that comprise our DSL.

At the root of our DSL is the *ProgramInfo* type. The fields of this type include a list of global variables (*Variable* objects) and a list of functions (*Function* objects).

The *Function* type holds information about a function such as the name, the start PC address (*Address* object), the end PC address (*Address* object), a list of parameters (*Variable* objects), a list of local non-parameter variables (*Variable* objects), and the return type (*DataType* object).

The *Variable* type contains information about a source-level global variable, local variable, or parameter. A variable has a name, a data type (*DataType* object), and a list of address "live ranges". We consider a live range (*AddressLiveRange* type) to be the association of a variable's storage address with the PC address range where the storage location is valid for the variable. This "live range" concept allows for the expression of source-level variables that map to multiple underlying storage locations throughout their lifetime. Multiple live ranges may be associated with

a single variable when compiler optimizations are present.

The Address type represents any absolute or relative location referenced in a binary program. This could include a PC location, variable storage location, or a register. From an implementation perspective, Address is the base class with subclasses representing the different types of address constructions based on context. These Address subclasses include AbsoluteAddress, RegisterAddress, RegisterOffsetAddress, and StackAddress. Each address is associated with an AddressRegion. This type is used to manage ordering and comparison logic for addresses that fall within the same region.

The last main construct in our core DSL is *DataType*. This type is represents a source-level data type and is typically associated with a variable or a function return type. *DataType* is the base of a class hierarchy with subclasses representing particular data types. The subclasses include *DataTypeFunctionPrototype*, *DataTypeInt*, *DataTypeFloat*, *DataTypeUndefined*, *DataTypeVoid*, *DataTypePointer*, *DataTypeArray*, *DataTypeStruct*, *DataTypeUnion*. Although these defined types correspond to C-like data types, this language can easily be extended to support other data types present in other high-level programming languages. All data type objects contain a "size" field representing the number of bytes the given data type occupies in memory.

3.2 Capturing Ground Truth Program Information

With our DSL defined, we need a reliable method to extract "ground truth" information from a program and translate this information into our DSL. This "ground truth" information is intended to be used in a comparison with the program information obtained from a decompiler. Our framework is meant for evaluation and therefore we assume that we have access to the source code of benchmark programs to be used for the evaluation. With this assumption, we consider two options for extracting program information from a given source program.

The first option for extracting ground truth information is to parse the source code's abstract syntax tree (AST) and then use this AST to manually extract functions, variables, and data types. There are two major issues with this approach. First, parsing source code to an AST assumes a

particular source programming language which greatly reduces generality. Second, obtaining the AST alone does not offer any binary-level information that allows us to link binary-level addresses with the source-level structures.

The second, more favorable, approach to extracting ground truth program information involves leveraging debugging information optionally included in the binary by the compiler. The primary purpose of debugging information is to link binary-level instructions and addresses with source-level structures. This binary-level to source-level association is precisely what is needed to translate program information into our DSL. Since our framework is developed and targeted at Linux, we choose the DWARF debugging standard as the assumed debugging format for our framework. However, defining a translation module from another debugging format into our DSL is certainly possible and is an idea for future work. The DWARF debugging standard is supported by nearly all major Linux compilers and supports any source programming language (with possible extensions). These properties of the DWARF standard allow it to be used as a "ground truth" source of program information, decoupled from the source language or the compiler.

3.2.1 Translating DWARF to the DSL

Starting with a source-level program, we must perform the following steps to extract program information represented in our DSL. First, we compile the source program with the option to include debugging symbols. In our particular analysis we use the GCC compiler specifying the "-g" flag. Many other compilers also offer the option for compilation with the inclusion of DWARF debugging symbols. After we compile the program, we then extract the DWARF debugging information from the resulting binary. We utilize the 'pyelftools' Python library [] to perform this extraction. The extraction results in, among other information, a set of debugging information entries (DIEs). Together, these DIE records provide a description of source-level entities such as functions, variables, and data types in relation to low-level binary information such as PC addresses and storage locations. Each DIE contains the following important features:

• An offset uniquely identifying the DIE within its compilation unit. These offsets are how

DIEs reference other DIEs.

• A tag representing the "class" of the DIE. Example tags include "DW_TAG_subprogram",

"DW_TAG_variable", and "DW_TAG_base_type".

• A set of attributes specifying tag-specific properties of the DIE. Examples include "DW_AT_name",

"DW_AT_size", and "DW_AT_type".

The translation process from the DIE graph into our DSL is, at its core, a process of forming a

nested data structure (our DSL's *ProgramInfo* type) from a flattened one (a collection of DWARF

DIEs). To tackle this translation, we first define an intermediate representation (IR) language that

acts as a "flattened" analog to the constructs present in our DSL. Instead of each IR construct

directly containing the fields of other constructs, they instead contain fields that reference the IDs

of other constructs through a shared database. The responsibility of the database is to map unique

IDs to the flattened constructs. When all the IR constructs have been inserted into the database, the

database then recursively resolves the flattened IR structures into their associated DSL structures,

starting from the root *ProgramInfoStub* object, the IR analog to the *ProgramInfo* DSL type. This

process is complicated by the fact that some data types, particularly struct types, may be recursive

or mutually recursive, ultimately creating a cycle in the reference resolver. To address this, we

implemented a mechanism whereby each IR node is marked when it is visited. Future attempts to

resolve the same IR construct return with the existing object being resolved instead of attempting

to resolve the same reference again. With the IR defined and the resolution logic in place, we map

the DWARF DIE objects into our "flattened" IR and construct the IR object database. When all the

DIEs are processed and translated, we specify the *ProgramInfoStub* node as the root reference and

then execute our resolver algorithm to recursively generate the *ProgramInfo* object and subobjects

defined in our DSL. Our DWARF translation module consists of about 1000 lines of Python code.

The IR and resolver logic adds an additional 600 lines of code.

[DWARF parsing figure: DIEs -> IR -> DSL]

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3.3 Capturing Decompiler Program Information

In addition to capturing a ground-truth program representation in our DSL, we must construct a DSL representation of the program information obtained from a decompiler we wish to evaluate. Depending on the decompiler and the structure of its output, this process may take many forms, often involving querying APIs exposed by the decompiler framework. In all cases however, this shall involve defining a translation module from the decompiler output to the structures defined in the DSL. Hence, our framework can be employed on any decompiler assuming a translation module implementation.

3.3.1 Translating Ghidra Decompiler Output to the DSL

For our analysis of the Ghidra decompiler, we utilize the Ghidra scripting API to programmatically scrape and process information about the decompilation of target binary programs. The Ghidra scripting environment exposes its own collection of data structures and functions from which we obtain our information. Since the Ghidra scripting environment supports Python, we directly import and leverage our "flattened" IR (described in the previous section) and our DSL constructs to carry out the translation.

The strategy employed for the Ghidra translation is similar to that of our DWARF translation algorithm described in the previous section. We utilize the Ghidra API to obtain particular information about functions, variables, data types, and associated addresses gathered during the decompilation. Of particular use to our translation logic is the *DecompInterface* object exposed by the Ghidra API. This interface supports decompiling functions one at a time. Information inferred by each function's decompilation is used to update Ghidra's internal representation of the program information. By decompiling each of the functions extracted from Ghidra's disassembly analysis, we attempt to form a complete decompiled interpretation of the entire input program.

We use the same IR defined for the DWARF translation to accumulate flattened records corresponding to these program constructs in a database. From here, we run the same resolution algorithm on the IR constructs database to generate the root *ProgramInfo* object in our DSL. The

Ghidra-specific translation logic is implemented in roughly 900 lines of Python code.

Comparison of "Ground Truth" and Decompiler Program Information 3.4

After converting both the ground-truth and decompiler program information into our DSL repre-

sentation, we next formulate and implement a strategy to compare the two resulting *ProgramInfo*

objects. To achieve this, we create an extension of our DSL that defines data structures and func-

tions for capturing comparison information at different layers.

Data Type Comparison 3.4.1

Given two *DataType* objects and an offset between their start locations, we devise a method to

capture nuanced information about the comparison of the data types.

3.4.1.1 Definitions

We define the *metatype* of a data type to be general "class" of the given data type. These metatypes

include INT, FLOAT, POINTER, ARRAY, STRUCT, UNION, UNDEFINED, VOID, and FUNC-

TION_PROTOTYPE. We consider INT, FLOAT, POINTER, UNDEFINED, and VOID to be prim-

itive metatypes since they cannot be decomposed further. ARRAY, STRUCT, and UNION are con-

sidered *complex metatypes* since these types are formed via the composition or aggregation of

different members or subtypes. We consider the 'char' data type to be of the *INT* metatype with

size equal to one byte.

[Figure: Ariste type lattice]

A primitive type lattice [] is used to hierarchially relate primitive data types based on their

metatype, size, and signedness (if applicable). More general types are located higher in the lattice

while more specific types are located closer to the leaves. A type lattice may be used to determine

whether two primitive data types are equivalent or share a common parent type.

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[Figure: Subset relationship example(s)]

We next define a *subset* relationship between two data types. For a given complex data type X and another data type Y with a given offset (possibly 0) between the location of X and Y in memory, Y is considered a *subset* type of X if Y is equivalent to a "portion" of X, consistent with the offset between X and Y. For example, if X is an array, any sub-array or element of X such that elements are aligned and the element types are equivalent to X is considered a subset of X. If X is a struct or union, any sub-struct or member with proper alignment and equal constituent elements is considered a subset of X.

3.4.1.2 Comparison Logic

Suppose we have two *DataType* objects X (ground truth) and Y (decompiler) with offset k from the start of X to the start of Y. The goal is to compute the *data type comparison level* for the given comparison. The possible values for the comparison level are as follows, from lowest equality to highest equality:

* NO_MATCH: No relationship could be found between X and Y. * SUBSET: Y is a subset type of the complex type X. * PRIMITIVE_COMMON_ANCESTOR: In the primitive type lattice, primitive types X and Y share a common ancestor type. * MATCH: All properties of X and Y match including metatype, size, and subtypes (if applicable).

We first check the equality of X and Y. If X and Y are equal, we assign the *MATCH* comparison code. In the case that X and Y are both primitive types, we attempt to compute their shared ancestor in the primitive type lattice. If a common ancestor could be found, we assign *PRIM-ITIVE_COMMON_ANCESTOR*. If X is a complex type, we employ an algorithm to determine whether Y is a subset of X at offset k by recursively descending into constituent portions of X starting at offset k (sub-structs, sub-arrays, elements, members) and checking for equality with Y. If a subset relationship is found, we assign the *SUBSET* compare level. In all other cases, we assign the *NO_MATCH* compare level.

3.4.2 Variable Comparison

There are two main contexts where variable comparison occurs. The first context is at the top level, where the set of ground-truth global variables is compared to the set of decompiler global variables. The second context for variable comparison is within the context of a function when we compare parameters or local variables between the ground-truth and the decompiler. In either case, comparing sets of variables starts with the decomposition of each *Variable* object from the DSL into a set of *Varnode* objects in our extended DSL.

A *Varnode* ties a *Variable* to a specific storage location and the range of PC addresses indicating when variable lives at that location. The varnodes for a given variable are directly computed from the variable's live ranges discussed previously. In unoptimized binaries, it is the case that a single *Variable* shall decompose into a single *Varnode*.

With each variable decomposed into its associated varnodes, we next partition the varnodes from each the ground-truth and the decompiler based on the "address space" in which they reside. These address spaces include the *absolute* address space, the *stack* address space, and the *register offset* address space (for a given register). The *stack* address space is a special case of the *register offset* address space where the offset register is the base pointer which points to the base of the current stack frame.

For the set of varnodes in each address space, we first order them based on their offset within the address space. Next, we attempt to find overlaps between varnodes from the two sources based on their location and size. If an overlap occurs between two varnodes, we compute a data type comparison taking into account the offset between the start locations of the two varnodes. The data type comparison approach is described in the previous section.

Based on the overlap status and data type comparison of a ground-truth varnode X, one of the following *varnode comparison levels* will be assigned:

- NO_MATCH: X is not overlapped with any varnodes from the other source.
- OVERLAP: X overlaps with one or more varnodes from the other space, but the data type

comparisons are level NO_MATCH.

- *SUBSET*: X overlaps with one or more varnodes and each of its compared varnodes has data type comparison level equal to *SUBSET*. In other words, the compared varnode(s) make up a portion of X.
- *ALIGNED*: For some varnode Y from the other source, X and Y share the same location and size in memory; however, the data types of X and Y do not match. The data types comparison could have any compare level less than *MATCH*.
- *MATCH*: For some varnode Y from the other source, X and Y share the same location and size in memory, and their data types match exactly.

3.4.2.1 Decomposed Variable Comparison

The inference of variables with complex data types including structs, arrays, and unions proves to be a major challenge for decompilers. Recognizing this, we develop an approach to compare the sets of ground truth and decompiler variables (varnodes) in their most "decomposed" forms. An analysis of this sort helps to recognize how well a decompiler infers the primitive constituent components of complex variables. Furthermore, this allows us to recognize the aggressiveness and accuracy of complex variable synthesis from more primitive components.

[Figure: Example of "decomposing" complex varnode]

We first implement an approach to recursively strip away the "complex layers" of a varnode to its most primitive decomposition. This primitive decomposition produces a set of one or more primitive varnodes. For example, an array of elements is broken down into a set of its elements (decomposed recursively). A struct is broken down into a set of varnodes associated with each of its members (decomposed recursively). Unions present a special case since the members share a common, overlapping region of memory. Hence, to decompose a union, we transform it into an *UNDEFINED* primitive type with the same size as the union.

We apply this primitive decomposition to each varnode in the sets of ground truth and decompiler varnodes. With the two sets of decomposed varnodes, we leverage the same variable comparison approach described previously to compare the varnodes in these sets. The resulting comparison information is treated as a separate analysis from the unaltered varnode sets.

3.4.3 Function Comparison

The first step in function comparison is to determine whether each ground-truth function is found by the decompiler. We first order the functions from each source by the start PC address of the function. Next, we attempt to match the functions from the two sources based on start address. Any functions from the ground-truth that are not matched by a decompiler function are considered "missed". Functions the are found by the decompiler but absent from the ground-truth are considered "extraneous". For any missed functions, we consider its associated parameters, local variables, and data types to also be "missed".

For each "matched" function based on start PC address, we compute and store information including the return type comparison, parameter comparisons, and local variable comparisons. These sub-comparisons leverage the data type and variable comparison techniques described previously.

3.5 Quantitative Evaluation Metrics

In this section, we define quantitative metrics for evaluating the accuracy of the a given decompiler when compared to a ground-truth source. We rely on the function, variable, and data type comparison information discussed previously to extract these metrics. In the following sub-sections, we define sets of metrics that associated with tables seen in Section ??.

3.5.1 Functions

This set of metrics outlines the function identification performance of the decompiler.

- *Ground truth functions*: The number of functions present in the ground truth program representation.
- *Functions found*: The number of functions from the ground truth set that are identified by the decompiler.
- *Functions missed*: The number of functions from the ground truth set that are not identified by the decompiler.
- *Functions recovery fraction*: The fraction of ground truth functions found by the decompiler divided by the number of ground truth functions.

3.5.2 Varnodes

Recall that a *Varnode* is defined to be a source-level *Variable* tied to a single storage location for a range of PC addresses. In analyses of unoptimized binaries, the mapping of variables to varnodes is one to one. This set of metrics illustrates the decompiler's accuracy in recovering varnodes.

- *Ground truth varnodes*: The total number of varnodes present in the ground truth source.

 This includes varnodes associated with global and local variables from all functions.
- *Varnodes matched* @ *level LEVEL*: Each ground truth varnode is associated with a *varnode comparison level (NO_MATCH, OVERLAP, SUBSET, ALIGNED, MATCH)* during the comparison with the set of decompiler varnodes. This metric specifies the number of ground truth varnodes that are matched at the specified level.
- *Varnodes average comparison score*: For each *varnode comparison level*, we first linearly assign an integer representing the strength of the varnode comparison (*NO_MATCH* = 0, *OVERLAP* = 1, *SUBSET* = 2, *ALIGNED* = 3, *MATCH* = 4). We then normalize these scores to fall within the range zero to one. Then, for each ground truth varnode, we compute this normalized score. We take the average score over all ground truth varnodes to obtain the

resulting metric. This metric approximates how well, on average, the decompiler infers the ground truth varnodes.

- *Varnodes fraction partially recovered*: The fraction of ground truth varnodes with a match level greater than *NO_MATCH*.
- *Varnodes fraction exactly recovered*: The fraction of ground truth varnodes with a match level equal to *MATCH*.

We repeat this varnode analysis for the decomposed (primitive) set of varnodes resulting from recursively decomposing each of the high-level varnodes into its most primitive set of varnodes. We also repeat our analysis of the original set of varnodes filtered by metatype. The metatypes considered are *INT*, *FLOAT*, *POINTER*, *ARRAY*, *STRUCT*, and *UNION*. Lastly, we repeat the analysis of the decomposed varnodes when filtered by metatype. For this metatype analysis over the decomposed varnodes, we only consider the primitive metatypes *INT*, *FLOAT*, and *POINTER* since the varnodes are guaranteed to be primitive.

3.5.3 Data Bytes

These metrics look at the total number of data bytes from all variables recovered by the decompiler when compared to the ground truth source.

- *Ground truth data bytes*: The total number of data bytes captured from the ground truth source, derived from all global and local variables.
- *Bytes found*: The total number of data bytes recovered by the decompiler that overlap with data bytes found in the ground truth.
- *Bytes missed*: The number of data bytes present in the ground truth that were not recovered by the decompiler.
- *Bytes recovery fraction*: The fraction of ground truth data bytes found by the decompiler divided by the total number of ground truth bytes.

3.5.4 Array Comparisons

In this set of metrics, we aim to evaluate the accuracy of the array inference performed by the decompiler. We examine each array comparison made during the comparison of the ground truth with the decompiler and observe the discrepancies in length, size (bytes), dimensions, and element type. The following metrics are presented:

- *Ground truth varnodes (metatype=ARRAY)*: The number of ground truth varnodes with metatype of ARRAY.
- *Array comparisons*: The number of array comparisons made when comparing the ground truth with the decompiler. The decompiler may infer 0 or more array varnodes for each given ground truth array varnode.
- *Array varnodes inferred as array*: This measures how many ground truth array varnodes are compared to at least 1 decompiler-inferred array varnode.
- Array varnodes inferred as array fraction: Equivalent to Array varnodes inferred as array divided by Ground truth varnodes (metatype=ARRAY). This expresses the fraction of ground truth array varnodes that are associated with at least one decompiler array inference.
- Array length (elements) average error: For each array comparison, we find the absolute difference in the number of elements inferred by the decompiler as compared to the ground truth. We then average these differences over all array comparisons to arrive at this metric.
- Array length (elements) average error ratio: For each array comparison, we first find the absolute difference in the number of elements inferred by the decompiler as compared to the ground truth. We then divide this error by the length of the ground truth array to get the error as a ratio of the array size. The average of these ratios over all array comparisons produces this metric.
- Array size (bytes) average error: This metric is similar to Array length (elements) average error but measures the error in bytes instead of number of elements.

- Array size (bytes) average error ratio: This metric is similar to Array length (elements) average error ratio but computes the error in bytes instead of array elements.
- *Array dimension match score*: This metric is the number of array comparisons where the decompiler inferred the correct number of dimensions divided by the total number of array comparisons.
- Array average element type comparison score: Each data type comparison level is first mapped to an integer as follows: NO_MATCH = 0, SUBSET = 1, PRIMITIVE_COMMON_ANCESTOR = 2, MATCH = 3. We then normalize these values such that the range is scaled from 0 to 1. We refer to this as the data type comparison score. Then, for each array comparison, we compute the data type comparison score and subsequently average the scores across all array comparisons to generate this metric.

Chapter 4

Evaluation

To demonstrate our evaluation framework, we target the Ghidra decompiler (version 10.2). We use the GNU Core Utilities programs (version 9.1) as our set of benchmarks. For each of the benchmark programs, we evaluate the accuracy of Ghidra decompilation with the program compiled in three ways: (1) stripped, (2) standard (not stripped, no debugging symbols), and (3) DWARF debug symbols included. We use the results from each of these cases to discern how the amount of information included in the binary affects the Ghidra decompiler's inference accuracy. To limit the scope of our analysis, we only consider unoptimized binaries. We use the GCC compiler (version 11.1.0) to compile the benchmark programs. The architecture and operating system of the testing machine are x86-64 and Ubuntu Linux (version 20.04), respectively.

4.1 Setup

Prior to evaluation, we compile the 105 Coreutils benchmark programs with three compilation configurations: (1) stripped, (2) standard (not stripped, no debugging symbols), and (3) DWARF debug symbols included. For each program, we first extract the ground truth information from the binary with DWARF symbols included via our DWARF translation module. We then use our Ghidra translation module to extract the Ghidra decompilation information from the binaries compiled under each of the compilation configurations. At this point, all program information from the DWARF and Ghidra sources are represented as *ProgramInfo* objects in our DSL.

Next, for each program, we perform a comparison of the program information scraped from DWARF (from the "debug" binary including DWARF symbols) with the information obtained

Table 4.1: Summary of function recovery by compilation case

	Ground truth fi	inctions found	d Functions r	jissed Finctions recovery frac
	Cround	Function	Function	Function.
strip	18139	18139	0	1.0000
standard	18139	18139	0	1.0000
debug	18139	18135	4	0.9998

from the Ghidra decompilation of the programs under each of the compilation configurations. The information from these comparisons are expressed in the form of objects which contain comparison information about functions, variables, and data types compared between the DWARF and Ghidra sources.

With the comparisons computed for each program and compilation configuration, we use these comparisons to compute high-level metrics that summarize the performance of the Ghidra decompiler with respect to the given benchmarks and compilation configurations (stripped, standard, and debug).

4.2 Function Recovery

Tables ??, ??, and ?? in the appendix present function recovery metrics of each benchmark program under the three compilation configurations. Table ?? shows the summarization of the recovery statistics accumulated over all benchmark programs. We find that over the 18139 functions present in the ground truth, the stripped and standard compilation cases produce 100% function recovery while the debug case fails to recover four functions, resulting in a 99.9% recovery rate. Upon examination of Table ??, we find that all four functions missed are from the *factor* program.

To determine the cause of the missed functions, we further investigate the Ghidra decompilation of *factor* and find that each of the missed functions results in a decompilation error, "Low-level

Error: Unsupported data-type for ResolveUnion". This indicates that an error occurred when attempting to resolve a union data type within the decompilation of these functions. Since this error only occurs in the debug compilation case, it is clear that Ghidra's parsing and interpretation of DWARF information contributes to this error. This same union data type causing the error is successfully captured and represented in our ground truth program information and, thus, this is likely a bug within Ghidra's resolution logic.

In summary, we see that Ghidra successfully finds all functions for all compilation configurations. However, in the debug case, Ghidra's attempt to interpret and utilize DWARF information to resolve a union data type in the *factor* program results in a decompiler error for four functions. This error indicates a bug in Ghidra's DWARF parsing or union resolution logic.

4.3 High-Level Variable (Varnode) Recovery

To evaluate the variable (varnode) recovery accuracy of the Ghidra decompiler, we first measure the inference performance of high-level varnodes, including varnodes with complex and aggregate types such as arrays, structs, and unions. We further measure the varnode inference accuracy by metatype to decipher which of the metatypes are most and least accurately inferred by the decompiler. This analysis is performed under each compilation configuration (stripped, standard, and debug).

Tables ??, ??, and ?? in the appendix show the inference of high-level varnodes for each benchmark compiled with each of the compilation configurations. This data is summarized in Table ??. We find that Ghidra at least partially infers 97.2%, 99.3%, and 99.6% and precisely infers 36.1%, 38.6%, and 99.7% of high-level varnodes for each for the stripped, standard, and debug compilation cases, respectively. In addition, the varnode comparison scores for each compilation case are 0.788, 0.816, and 0.998, respectively. These metrics indicate that the standard compilation case slightly outperforms the stripped case in varnode inference while the debug compilation case results in significant improvements over both the stripped and standard cases, particularly in exact varnode recovery.

Table 4.2: Summary of high-level varnode recovery by compilation case

	Valnodesh	natched @ lev	al No MAICE	d Overlandes for Variodes for	is Jastifed @ leve	All City of Lever Astrode Co	onpaison scot	raction partially f	sed) pecovered decomply pecovered decomply
strip	139776	31280	0	231267	131593	0.586	0.738	0.246	
standard	40187	56605	0	303527	133597	0.703	0.925	0.250	
debug	10547	128	0	5	523236	0.980	0.980	0.980	

In Tables ??-??, ??-??, and ??-??, we show the inference performance of high-level varnodes for each benchmark, broken down by the metatype of the ground truth varnodes, and for all compilation configurations. We summarize this information in Table ??. From the stripped and standard compilation cases, we observe that varnodes with metatype *INT* are most accurately recovered when considering varnode comparison score, fraction partially recovered, and fraction exactly recovered. In the stripped case, the inference of *ARRAY* varnodes shows the worst performance with a varnode comparison score of 0.315. In the standard case, varnodes with metatype *STRUCT* are least accurately recovered with a varnode comparison score of 0.560, followed closely by *ARRAY* and *UNION*. We see that, for both the stripped and standard compilation cases, the complex (aggregate) metatypes, *ARRAY*, *STRUCT*, and *UNION*, show the lowest recovery accuracy with respect to varnode comparison score. Among the primitive metatypes, *FLOAT* shows the worst recovery metrics for these two compilation cases.

The debug compilation case demonstrates high relative recovery accuracy across varnodes of all metatypes when compared to the stripped and standard cases. Of the primitive metatypes, varnodes of the *FLOAT* metatype are perfectly recovered while varnodes of the *INT* and *POINTER*

Table 4.3: Summary of high-level varnode recovery by compilation case and metatype

		.*	natched etc	well to Mark	TH THE THE THE THE THE THE THE THE THE T	Rataled @ le	vel All Graff	Jan Parison sco Jan Parison sco Variodes f 1.000 0.994	re (0,1) raction partis
		Varnodes	Varnodes	Varnodes	Varnodes	Varnodes	Varnode	Varnodes	Varnodes
	INT	66	48	0	12204	8681	0.850	0.997	0.413
	FLOAT	0	56	0	113	22	0.632	1.000	0.115
	POINTE	E R5 3	4	0	5834	3513	0.839	0.994	0.374
p	ARRAY	729	597	565	19	228	0.315	0.659	0.107
	STRUC	Γ152	955	432	390	106	0.419	0.925	0.052
	UNION	0	2	4	10	0	0.625	1.000	0.000
	INT	23	48	0	12248	8680	0.851	0.999	0.413
	FLOAT	0	56	0	113	22	0.632	1.000	0.115
	POINTE	E R 44	4	0	5836	3520	0.840	0.995	0.374
andard	ARRAY	181	578	352	45	982	0.625	0.915	0.459
	STRUC	Γ1	762	257	777	238	0.560	1.000	0.117
	UNION	0	2	4	10	0	0.625	1.000	0.000
	INT	13	27	0	4	20955	0.998	0.999	0.998
	FLOAT	0	0	0	0	191	1.000	1.000	1.000
hu a	POINTE		0	0	1	9400	1.000	1.000	1.000
ebug	ARRAY	5	17	24	0	2092	0.986	0.998	0.978
	STRUC	Γ2	8	0	0	2025	0.996	0.999	0.995
	UNION		0	0	2	14	0.969	1.000	0.875

metatypes show exact recovery percentages of 99.8% and 99.9%, respectively. The complex (aggregate) metatypes, on average, display slightly lower recovery metrics than the primitive metatypes in the debug compilation case. The *ARRAY* metatype reveals the worst varnode comparison score at 0.986. The *UNION* metatype demonstrates the lowest exact match percentage at 87.5%.

Table 4.4: Summary of decomposed varnode recovery by compilation case

	Š	matched @ le	vel NO MAIC	Hadoled @ les	rathed @ let	al Alicated @ le	Jel MATCH.	re 10,11 Fraction partiali	A recovered
	Varnode	Varnode	Varnode	Varnodes	Varnode	Varnode	Varnode	Varnode	
strip	1000	1662	1001	18570	12550	0.788	0.971	0.361	-
standard	249	1450	613	19029	13442	0.816	0.993	0.386	
debug	23	52	24	7	34677	0.998	0.999	0.997	

4.4 Decomposed Variable (Varnode) Recovery

In this section, we repeat a similar varnode recovery analysis over all varnodes; however, we first recursively decompose each varnode into a set of primitive varnodes (see Section ??). We perform this analysis over all benchmarks for each of the three compilation cases.

Similar to the high-level varnode analysis, we show the inference of the decomposed varnodes for each benchmark and for each compilation configuration in Tables ??, ??, and ??. Table ?? summarizes this information. Naturally, we expect to see lower recovery metrics compared to the high-level varnode analysis since each complex varnode is now analyzed as a set of its constituent parts. Hence, a single "missed" high-level varnode is translated into a set of primitive varnodes, each "missed" in this analysis. We find this hypothesis to hold true across all compilation cases as each the varnode comparison score, varnodes fraction partially recovered, and varnodes fraction exactly recovered show lower values than in the high-level analysis. We see that the decomposed varnode comparison scores for the strip, standard, and debug compilation cases are 0.586, 0.703, and 0.980, respectively. The varnodes fraction partially recovered are 73.8%, 92.5%, and 98.0% while the varnodes fraction exactly recovered are 24.7%, 25.0%, and 98.0% across the compilation cases, respectively. Interestingly, in the stripped compilation case, we find that the number of

Table 4.5: Summary of decomposed varnode recovery by compilation case and primitive metatype

		<u> </u>	natched @ 18	well to MAI	CHI Variodes i	Rational Contraction of the Cont	nached @ le	Dannaison sc	ore 10.11 Fraction partial
		Varnodes	Varnodes	Varnode	Varnodes	Varnodes	Varnode	Varnode	Varnodes
	INT	132910	28812	0	217923	125159	0.586	0.737	0.248
strip	FLOAT	72	73	0	103	22	0.435	0.733	0.081
	POINTE	E R 6725	2057	0	13208	6332	0.591	0.763	0.224
	INT	40017	46846	0	290436	127505	0.707	0.921	0.253
standard	FLOAT	0	145	0	103	22	0.502	1.000	0.081
	POINTE	ER 32	9245	0	12955	5990	0.636	0.995	0.211
	INT	10533	124	0	4	494143	0.979	0.979	0.979
debug	FLOAT	0	0	0	0	270	1.000	1.000	1.000
	POINTE	ER 4	2	0	1	28305	0.999	1.000	0.999

"missed" decomposed varnodes (139937) exceeds the number of "exactly matched" decomposed varnodes (131719). This is largely due to the quantity of high-level *ARRAY* and *STRUCT* varnodes that are missed in the stripped case.

We split the decomposed varnodes by metatype and show these results in Tables ??-??, ??-??, and ??-??. We present the summary of these results over each compilation case in Table ??. The table shows that the stripped and standard compilation cases demostrate the poorest inference performance in terms of varnode comparison score for varnodes of metatype *FLOAT*. However, we find that the percentage of "missed" *INT* varnodes is worse than that of *FLOAT* in the standard and debug compilation cases, and is nearly the same in the stripped case. This may be explained by the prevalence of integer (or character) arrays in the Coreutils benchmark programs when compared to other array types. Recovery accuracy of the *POINTER* metatype is comparable to the *INT* metatype across the three compilation cases.

Table 4.6: Summary of data bytes recovery by compilation case

	Ground truth day	a byte's	nis ^s ed	Bytes recovery fraction
	Cround	Bytes found	Bytes trissed	Byleste
strip standard debug	1183691 1183691 1183691	725144 954105 1177221	458547 229586 6470	0.613 0.806 0.995

4.5 Data Bytes Recovery

Following from our varnode inference analysis, we next assess the accuracy of the Ghidra decompiler with regards to the total number of data bytes recovered across all varnodes. This analysis provides an important perspective on data recovery as the size of an improperly inferred varnode may result in a wide range in the number of misinferred bytes. For example, a large array and a single character are each represented by a varnode, but the quantity of data present in the array is much greater than that of a character. Hence, it is important to capture this nuanced view of data recovery.

In Tables ??, ??, and ??, we show the data bytes recovery metrics for each of the benchmark programs under each compilation case. We summarize the data bytes recovery for each of the compilation cases in Table ??. We see that Ghidra recovers 61.3%, 80.6%, and 99.5% of data bytes in the stripped, standard, and debug compilation cases, respectively.

4.6 Array Inference Accuracy

The last major analysis we perform targets the array inference accuracy of the Ghidra decompiler. We aim to measure metrics regarding the total number of arrays inferred, the length and size discrepancies of compared arrays, and the similarity of element types of compared arrays. We perform this analysis across the Coreutils benchmarks and for each compilation configuration,

Table 4.7: Summary of array recovery by compilation case

	Ground's	haray co	inodes inpairons Array var	Array war	dasatray Jasatray Array lengt	as atray from	dion derenge en s	si Artay sil	rorratio rage error e Oyles aver	rage error ratio	seate letter
strip	2138	823	774	0.362	134.695		458.575		0.979	0.781	
standard	2138	1579	1530	0.716	151.156	5.442	239.023	0.475	0.975	0.670	
debug	2138	2226	2128	0.995	9.416	0.110	9.416	0.110	1.000	1.000	

resuling in Tables ??, ??, and ?? located in the appendix. This information is summarized in Table ??, broken down by compilation configuration.

Across all benchmarks, there are 2138 ground truth arrays present. For each the stripped, standard, and debug compilation cases, the number of ground truth arrays recognized as arrays by the decompiler are 774 (36.2%), 1530 (71.6%), and 2128 (99.5%), respectively. We see that the numbers of array comparisons for each compilation case are greater than these metrics indicating that Ghidra infers some ground truth arrays to be more than one array.

From the array comparisons, we observe that the average absolute differential in array length (number of elements) for the stripped, standard, and debug compilation cases are 134.7, 151.2, and 9.4, respectively. When scaling these errors with respect to the length of the ground truth arrays in the comparisons, the error ratios are 2.84, 5.44, and 0.11 for the compilation cases, respectively. This reveals that, in the debug case for example, the lengths of decompiler-inferred arrays are off by an average of 9.4 elements and roughly 11% (greater or less than) of the size of the ground truth arrays they are compared to. These metrics, however, fail to capture whether the decompiler-inferred array has element types of the correct length. Thus, a similar analysis on the

size (number of bytes) errors yields errors and error ratios of 458.6 (0.91), 239 (0.47), and 9.41 (0.11) for each compilation case, respectively. This, for example, shows that arrays inferred in the standard compilation case have an average absolute byte differential of 239 and a relative error of 47% compared to the size of the ground truth array they are compared to.

In this analysis, we also capture a measure of the array dimension match score for each compilation case. This metric measures the fraction of array comparisons where the decompiler-inferred array has the same dimensionality (one-dimensional, two-dimensional, etc.) as the ground truth array. The stripped and standard compilation cases display dimensionality match ratios of greater than 97.4%, while the debug case shows 100% dimensionality inference accuracy.

The last portion of our array recovery analysis focuses on the element type inference accuracy of the decompiler-inferred arrays when compared to the element types of the ground truth arrays. We compute a data type comparison score between the element types from each array comparison and average these across all array comparisons derived from our benchmark programs. This data type comparison score is similar in concept to the varnode comparison score and is described in section XX. We find that decompiler-inferred arrays in the stripped, standard, and debug compilation cases show 0.781, 0.670, and 0.999 average element type comparison scores, respectively. The better performance demonstrated in the stripped case compared to the standard case appears to be a data artifact resulting from fewer array comparisons present in the stripped analysis.

4.7 Debug Compilation Case Discussion

Upon examination of our results thus far, the reader may wonder why the debug compilation case does not produce 100% recovery for varnodes and data bytes across all benchmarks. The same DWARF debugging information used to generate the ground truth program information is also provided to the Ghidra decompiler in this case and therefore, theoretically, Ghidra should be able to precisely capture the same program information.

We manually investigate this phenomenon over our benchmark programs and find that the cause of these recovery inaccuracies stems from the Ghidra decompiler's inflexibility in expressing local variables tied to lexical scopes. We find that the Ghidra decompiler output only lists variable declarations at the top level of the function and does not support declarations of local variables within lexical scopes. Instead, Ghidra attempts to move the declaration of these scope-specific variables to the top level of the function. Often, this behavior does not negatively influence the variable recovery of the given function. However, there are cases where multiple exclusive (not overlapping or nested) lexical scopes contain variable declarations. In many of these cases, the compiler recognizes the exclusivity of the lexical scopes and assigns the scope-specific variables to shared space on the stack since the variables shall never be instantiated simultaneously. The size of the shared region allocated by the decompiler is equivalent to the size of the largest variable in the set of scope-specific variables that share the region. In essence, this is equivalent to an implicit union formed by the compiler. The DWARF debugging standard and our DSL both possess the ability to express these overlapping scope-specific variables, but the Ghidra decompiler does not. From our observations, we find that Ghidra greedily captures and declares scope-specific variables at the top level of the function based on the order in which it recovers the variables. In the debug compilation case (utilizing DWARF information), Ghidra appears to only consider the first scopespecific variable mapped to a given address on the stack based on the order of the variables in the list of debugging information entries (DIEs) parsed from DWARF. The subsequent scope-specific variables associated with the given address are simply ignored, causing Ghidra to potentially miss several varnodes and data bytes. We consider this to be a shortcoming and an area of future improvement for the Ghidra decompiler.

Chapter 5

Conclusion

5.1 Summary of Methodology

To develop our decompiler evaluation framework, we outline and execute the following objectives:

- 1. Express program information such as functions, variables, data types, and addresses in a common representation.
- 2. Programmatically capture a "ground truth" representation for a given program.
- 3. Programmatically scrape program information from decompiler tools, namely Ghidra.
- 4. Compare two program representations of the same program.
- 5. Formulate quantitative metrics for evaluating the accuracy of a decompiler.

We devise and implement a common domain-specific language (DSL) for expressing the association of high-level program information such as functions, variables, and data types, with binary-level constructs such as addresses and storage locations. With our DSL, we develop a parser for extracting DWARF debugging information from binary programs and representing this information in our DSL. This information is to be used as a ground truth source of program information in comparisons with decompiler representations. Next, we leverage the Ghidra Python API to develop a translator module, taking Ghidra decompilation output as our input and translating the information into our DSL. With our parsing modules constructed for both our ground truth and

decompiler sources, we extend our DSL to support the comparison of two sources of program information parsed from a ground truth source and a decompiler source. We subsequently develop quantitative metrics for assessing and summarizing comparisons of program information sources.

5.2 Summary of Results

We utilize our developed framework to assess the recovery performance of the Ghidra decompiler (version 10.2) over the 105 GNU Core Utilities (version 9.1) benchmark programs. Using the GCC compiler (version 11.1.0), we compile the benchmarks with no optimizations under three separate compilation configurations: (1) stripped, (2) standard (not stripped, no DWARF symbols added), (3) debug (DWARF symbols included).

Our function recovery analysis reveals that Ghidra recovers 100% of the 18139 functions across all benchmarks in the stripped and standard compilation cases. In the debug case, we find four missed functions in total, all present in the *factor* benchmark program. We discover that the missed functions are all caused by a decompiler error resulting from a failure in resolving a union data type. We conclude that this is a bug in the Ghidra decompiler.

In our high-level varnode analysis, we find that the recovery accuracy of primitive (*INT*, *FLOAT*, *POINTER*) metatypes is greater than that of the complex (aggregate) metatypes (*ARRAY*, *STRUCT*, *UNION*) across all compilation cases. This finding follows from the fact that inferring complex varnodes involves an extra layer of speculation and inference involving the synthesis of low-level varnodes. In all compilation cases, the *ARRAY* metatype displays the greatest number of "missed" varnodes.

Our decomposed (primitive) varnode analysis demonstrates that Ghidra is least effective at inferring floating-point (metatype *FLOAT*) decomposed varnodes over the benchmark programs in the stripped and standard compilation cases. However, we see that Ghidra completely misses a larger fraction of decomposed varnodes with metatype *INT*. This is explained by the larger incidence of integer arrays in the Coreutils benchmark programs, which are more likely to be missed or only partially recovered as demonstrated in our high-level varnode analysis. We show that de-

composed varnodes of metatype *POINTER* are recovered comparably to those of metatype *INT*.

In our analysis of data bytes recovery summarized across all benchmarks, we find that the Ghidra decompiler shows 61.3% recovery in the stripped compilation case, 80.6% recovery in the standard case, and 99.5% recovery in the debug case.

Our array inference analysis illustrates that the compilation configuration of our benchmark programs has a significant impact on both array recovery and the inference accuracy of the arrays that are recovered. We find that, for each the stripped, standard, and debug compilation cases, 36.2%, 71.6%, and 99.5% of ground truth array varnodes overlap with at least one associated decompiler-inferred array varnode, respectively. We find the average size error ratio of the decompiler-inferred arrays with respect to the ground truth arrays to be 0.91, 0.47, and 0.11 for the compilation cases, respectively.

The function, variable, data bytes, and data type recovery analyses show clear recovery accuracy differentials between the three compilation cases. In general, we find that the debug case (DWARF symbols included) performs the best by a large margin, followed by the standard case which slightly outperforms the stripped case. Despite the decent recovery performance in the debug case, we seek an explanation for the decompiler still failing to capture a portion of the ground truth information, particularly varnodes and data bytes. We find that the Ghidra decompiler is limited in its ability to express overlapping stack variables gathered from non-overlapping, non-nested lexical scopes within the same parent function. This scenario arises when the compiler recoginizes the exclusivity of lexical scopes within a function and subsequently assigns scope-specific variables from these lexical scopes to the same address or region on the stack.

5.3 Limitations

The primary limitation of our framework in its current state is the lack of support for comparing and evaluating program information gathered from optimized binary programs. Our DSL supports the expression of program information from optimized binaries, but the comparison logic assumes certain properties about the program information to reduce the complexity of the analysis. Namely,

we assume that each high-level variable to be associated with a single storage location in memory for the purposes of comparison. In addition, we assume that the program counter (PC) "live range" of the variable is the entire PC range of the parent function for local variables and the entire program for global variables. In optimized binaries, these assumptions do not always hold. For example, optimizations may result in a single high-level variable being stored across a combination of stack locations and registers depending on the current instruction. In essence, optimizations introduce an additional temporal dimension that drastically increases the complexity of the analysis. Each live range of each variable would need to be considered, then a set of comparison "snapshots" would need to be performed based on the overlaps of the variable live ranges. An aggregation of these "snapshot" comparisons shall then be performed in such a way to evaluate the recovery of each of the high-level variables. Our current framework is built with this type of analysis in mind, but the scope of this work only considers the case of unoptimized binaries. Future work shall include the extension of the framework to support the evaluation of optimized binaries.

Another assumption in our analysis is that only non-parameter variables with stack and absolute (global) addresses are considered for comparison. This includes heap-allocated data which must be referenced by a pointer accessible from the current function. Our language and framework support the ability to represent register and register offset locations which shall be useful in future optimized analysis.

Another limitation in this work is our exclusive support for the DWARF debugging standard for extracting ground truth program information. However, as discussed previously, our framework can easily be extended to support the implementation of parsers for other debugging formats.

Regarding decompiler evaluation, our framework excels at assessing the recovery and inference of high-level program constructs. However, our framework lacks any form of behavioral analysis. Existing work by Liu and Wang [] showcases an approach to evaluating the behavioral correctness of decompiler outputs. A full decompiler analysis shall combine our structural analysis with the behavioral analysis demonstrated by this existing work.

The final noteworthy limitation in our work is that we use our framework to assess only the

Ghidra decompiler. We consider our framework to be the primary contribution of this research and therefore leave the analysis and comparison of other decompilers for future work.

5.4 Future Work

As discussed in the previous section, a major future work objective shall be to extend our framework to support optimized binaries. In addition, we shall use our framework to assess and compare the recovery performance of decompilers beyond Ghidra.

In our function recovery analysis, recall that the Ghidra decompiler fails to decompile four functions within the *factor* program only in the case where DWARF debugging symbols are included. We conclude from the error messages returned that the decompilation errors for these functions result from Ghidra's inability to resolve a particular union data type present in the program. Since this error does not occur for the other compilation cases of the *factor* program, we gather that the DWARF information scraped by Ghidra contributes to this error. With this observation, we recognize that a useful obfuscation strategy for binary programs may, instead of stripping all debugging symbols, be to include misleading and contradictory debugging information. Reverse engineering tools and decompilers analyzing a binary program with misleading debugging symbols included may produce incorrect outputs or potentially crash based on this erroneous information. This is certainly an area worthy of future research. In addition, the union resolution issue observed in our analysis shall be patched in the Ghidra framework.

In our assessment of the Ghidra decompiler, we observe that Ghidra does not successfully capture all ground truth variables and data bytes even in the case the DWARF debugging information is present. Upon further investigation, we discover this shortcoming is due to Ghidra's inability to express local variable declarations at the lexical scope level. Instead, Ghidra forces all local variables to be declared at the top level of the given function. This causes Ghidra to partially miss cases where the same stack address region is used by the compiler to store local variables declared in non-overlapping, non-nested lexical scopes within the same function. An area of future work shall be to modify the Ghidra decompiler to support the expression of more flexible local variable

constructs that are not required to be declared at the top level of a function.

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Appendix

Table 1: Function recovery (compilation = stripped)

		actions	3	N N
Ctic	jund truth fri	netion Functions found	Functions missed	d Functions recovery f
[152	152	0	1.000
b2sum	148	148	0	1.000
base32	128	128	0	1.000
base64	129	129	0	1.000
basename	111	111	0	1.000
basenc	171	171	0	1.000
cat	124	124	0	1.000
chcon	247	247	0	1.000
chgrp	216	216	0	1.000
chmod	214	214	0	1.000
chown	218	218	0	1.000
chroot	125	125	0	1.000
cksum	246	246	0	1.000
comm	126	126	0	1.000
cp	335	335	0	1.000
csplit	339	339	0	1.000
cut	126	126	0	1.000

Table 1: Function recovery (compilation = stripped)

	a stre	jions	્ઈ	s gery ⁽¹
Çst	and full fund	jiu Finctions found	Functions missel	S. Functions recovery f
date	208	208	0	1.000
dd	197	197	0	1.000
df	266	266	0	1.000
dir	484	484	0	1.000
dircolors	125	125	0	1.000
dirname	108	108	0	1.000
du	513	513	0	1.000
echo	105	105	0	1.000
env	126	126	0	1.000
expand	121	121	0	1.000
expr	323	323	0	1.000
factor	174	174	0	1.000
false	104	104	0	1.000
fmt	131	131	0	1.000
fold	116	116	0	1.000
groups	112	112	0	1.000
head	135	135	0	1.000
hostid	106	106	0	1.000
id	142	142	0	1.000
join	152	152	0	1.000
kill	112	112	0	1.000

Table 1: Function recovery (compilation = stripped)

	agi.	ijans	ું. -	\\
Çşí	ound truth func	functions found	Functions missed	s Functions lectorely f
link	106	106	0	1.000
ln	231	231	0	1.000
logname	106	106	0	1.000
ls	484	484	0	1.000
md5sum	132	132	0	1.000
mkdir	165	165	0	1.000
mkfifo	131	131	0	1.000
mknod	134	134	0	1.000
mktemp	120	120	0	1.000
mv	394	394	0	1.000
nice	110	110	0	1.000
nl	307	307	0	1.000
nohup	115	115	0	1.000
nproc	113	113	0	1.000
numfmt	159	159	0	1.000
od	172	172	0	1.000
paste	114	114	0	1.000
pathchk	110	110	0	1.000
pinky	124	124	0	1.000
pr	208	208	0	1.000
printenv	105	105	0	1.000

Table 1: Function recovery (compilation = stripped)

		. OU.5			
Cro	and truth func	jio' Functions found	Functions missed	Functions recove	
printf	138	138	0	1.000	
ptx	347	347	0	1.000	
pwd	115	115	0	1.000	
readlink	168	168	0	1.000	
realpath	174	174	0	1.000	
rm	234	234	0	1.000	
rmdir	124	124	0	1.000	
runcon	122	122	0	1.000	
seq	129	129	0	1.000	
sha1sum	133	133	0	1.000	
sha224sum	140	140	0	1.000	
sha256sum	140	140	0	1.000	
sha384sum	140	140	0	1.000	
sha512sum	140	140	0	1.000	
shred	181	181	0	1.000	
shuf	215	215	0	1.000	
sleep	118	118	0	1.000	
sort	349	349	0	1.000	
split	154	154	0	1.000	
stat	240	240	0	1.000	
stdbuf	135	135	0	1.000	

Table 1: Function recovery (compilation = stripped)

	•,1	9015		
Crc	jund truth functi	Functions found	Functions missed	Functions recover
stty	149	149	0	1.000
sum	142	142	0	1.000
sync	108	108	0	1.000
tac	310	310	0	1.000
tail	234	234	0	1.000
tee	124	124	0	1.000
test	147	147	0	1.000
timeout	130	130	0	1.000
touch	198	198	0	1.000
tr	149	149	0	1.000
true	104	104	0	1.000
truncate	114	114	0	1.000
tsort	125	125	0	1.000
tty	105	105	0	1.000
uname	107	107	0	1.000
unexpand	121	121	0	1.000
uniq	132	132	0	1.000
unlink	106	106	0	1.000
uptime	142	142	0	1.000
users	112	112	0	1.000
vdir	484	484	0	1.000

Table 1: Function recovery (compilation = stripped)

	Ground truth function	ns Functions found	Functions missed	Functions tecovery fraction
wc	152	152	0	1.000
who	138	138	0	1.000
whoami	106	106	0	1.000
yes	109	109	0	1.000

Table 2: Function recovery (compilation = standard)

		rions	, a ^{ff}			
	ruth fun	se found	as hissed	s setecovers		
Gre	and truth fur	finctions found	Functions missel	Simulians recovery fracti		
[152	152	0	1.000		
b2sum	148	148	0	1.000		
base32	128	128	0	1.000		
base64	129	129	0	1.000		
basename	111	111	0	1.000		
basenc	171	171	0	1.000		
cat	124	124	0	1.000		
chcon	247	247	0	1.000		
chgrp	216	216	0	1.000		
chmod	214	214	0	1.000		

Table 2: Function recovery (compilation = standard)

	مرئ	ions	>	, and
Ctr	and hull finct	Functions found	Functions missed	, Functions tecovery
chown	218	218	0	1.000
chroot	125	125	0	1.000
cksum	246	246	0	1.000
comm	126	126	0	1.000
cp	335	335	0	1.000
csplit	339	339	0	1.000
cut	126	126	0	1.000
date	208	208	0	1.000
dd	197	197	0	1.000
df	266	266	0	1.000
dir	484	484	0	1.000
dircolors	125	125	0	1.000
dirname	108	108	0	1.000
du	513	513	0	1.000
echo	105	105	0	1.000
env	126	126	0	1.000
expand	121	121	0	1.000
expr	323	323	0	1.000
factor	174	174	0	1.000
false	104	104	0	1.000
fmt	131	131	0	1.000

Table 2: Function recovery (compilation = standard)

	ؽ	lione,	>	, , , , , , , , , , , , , , , , , , ,
ÇK	Jund Huth funci	Functions found	Functions missed	Functions tecovery
fold	116	116	0	1.000
groups	112	112	0	1.000
head	135	135	0	1.000
hostid	106	106	0	1.000
id	142	142	0	1.000
join	152	152	0	1.000
kill	112	112	0	1.000
link	106	106	0	1.000
ln	231	231	0	1.000
logname	106	106	0	1.000
ls	484	484	0	1.000
md5sum	132	132	0	1.000
mkdir	165	165	0	1.000
mkfifo	131	131	0	1.000
mknod	134	134	0	1.000
mktemp	120	120	0	1.000
mv	394	394	0	1.000
nice	110	110	0	1.000
nl	307	307	0	1.000
nohup	115	115	0	1.000
nproc	113	113	0	1.000

Table 2: Function recovery (compilation = standard)

		ians			
Gro	ind truth fund	functions found	Functions trissed	Functions recovery	
numfmt	159	159	0	1.000	
od	172	172	0	1.000	
paste	114	114	0	1.000	
pathchk	110	110	0	1.000	
pinky	124	124	0	1.000	
pr	208	208	0	1.000	
printenv	105	105	0	1.000	
printf	138	138	0	1.000	
ptx	347	347	0	1.000	
pwd	115	115	0	1.000	
readlink	168	168	0	1.000	
realpath	174	174	0	1.000	
rm	234	234	0	1.000	
rmdir	124	124	0	1.000	
runcon	122	122	0	1.000	
seq	129	129	0	1.000	
sha1sum	133	133	0	1.000	
sha224sum	140	140	0	1.000	
sha256sum	140	140	0	1.000	
sha384sum	140	140	0	1.000	
sha512sum	140	140	0	1.000	

Table 2: Function recovery (compilation = standard)

	i,ć	ns				
Ć	ound truth function	Functions found	Functions nissed	Functions tecom		
shred	181	181	0	1.000		
shuf	215	215	0	1.000		
sleep	118	118	0	1.000		
sort	349	349	0	1.000		
split	154	154	0	1.000		
stat	240	240	0	1.000		
stdbuf	135	135	0	1.000		
stty	149	149	0	1.000		
sum	142	142	0	1.000		
sync	108	108	0	1.000		
tac	310	310	0	1.000		
tail	234	234	0	1.000		
tee	124	124	0	1.000		
test	147	147	0	1.000		
timeout	130	130	0	1.000		
touch	198	198	0	1.000		
tr	149	149	0	1.000		
true	104	104	0	1.000		
truncate	114	114	0	1.000		
tsort	125	125	0	1.000		
tty	105	105	0	1.000		

Table 2: Function recovery (compilation = standard)

Crci	and truth functi	gors Functions found	Functions nissed	Fainclions recovery fra
uname	107	107	0	1.000
unexpand	121	121	0	1.000
uniq	132	132	0	1.000
unlink	106	106	0	1.000
uptime	142	142	0	1.000
users	112	112	0	1.000
vdir	484	484	0	1.000
wc	152	152	0	1.000
who	138	138	0	1.000
whoami	106	106	0	1.000
yes	109	109	0	1.000

Table 3: Function recovery (compilation = debug)

G	gound truth functi	gons Functions found	Finctions nissed	, Functions recovery fraction
[152	152	0	1.000
b2sum	148	148	0	1.000
base32	128	128	0	1.000
			Co	entinued on next page

Table 3: Function recovery (compilation = debug)

	and fruit function	gre found	. hissed	Functions recovery f
Crc	unditt	Functions found	Functions Inissed	Functions
base64	129	129	0	1.000
basename	111	111	0	1.000
basenc	171	171	0	1.000
cat	124	124	0	1.000
chcon	247	247	0	1.000
chgrp	216	216	0	1.000
chmod	214	214	0	1.000
chown	218	218	0	1.000
chroot	125	125	0	1.000
cksum	246	246	0	1.000
comm	126	126	0	1.000
ср	335	335	0	1.000
csplit	339	339	0	1.000
cut	126	126	0	1.000
date	208	208	0	1.000
dd	197	197	0	1.000
df	266	266	0	1.000
dir	484	484	0	1.000
dircolors	125	125	0	1.000
dirname	108	108	0	1.000
du	513	513	0	1.000

Table 3: Function recovery (compilation = debug)

		Jou ⁵	>	
Ć	ound truth functi	Functions found	Functions nissed	Functions recovery
echo	105	105	0	1.000
env	126	126	0	1.000
expand	121	121	0	1.000
expr	323	323	0	1.000
factor	174	170	4	0.977
false	104	104	0	1.000
fmt	131	131	0	1.000
fold	116	116	0	1.000
groups	112	112	0	1.000
head	135	135	0	1.000
hostid	106	106	0	1.000
id	142	142	0	1.000
join	152	152	0	1.000
kill	112	112	0	1.000
link	106	106	0	1.000
ln	231	231	0	1.000
logname	106	106	0	1.000
ls	484	484	0	1.000
md5sum	132	132	0	1.000
mkdir	165	165	0	1.000
mkfifo	131	131	0	1.000

Table 3: Function recovery (compilation = debug)

Ć	and truth finct	gons Functions found	Functions nissed	Functions recovery fro
mknod	134	134	0	1.000
mktemp	120	120	0	1.000
mv	394	394	0	1.000
nice	110	110	0	1.000
nl	307	307	0	1.000
nohup	115	115	0	1.000
nproc	113	113	0	1.000
numfmt	159	159	0	1.000
od	172	172	0	1.000
paste	114	114	0	1.000
pathchk	110	110	0	1.000
pinky	124	124	0	1.000
pr	208	208	0	1.000
printenv	105	105	0	1.000
printf	138	138	0	1.000
otx	347	347	0	1.000
pwd	115	115	0	1.000
readlink	168	168	0	1.000
realpath	174	174	0	1.000
rm	234	234	0	1.000
rmdir	124	124	0	1.000

Table 3: Function recovery (compilation = debug)

	odito	ns .	χ.	Á
Grai	nd truth function	Functions found	Functions missed	Functions recover
runcon	122	122	0	1.000
seq	129	129	0	1.000
sha1sum	133	133	0	1.000
sha224sum	140	140	0	1.000
sha256sum	140	140	0	1.000
sha384sum	140	140	0	1.000
sha512sum	140	140	0	1.000
shred	181	181	0	1.000
shuf	215	215	0	1.000
sleep	118	118	0	1.000
sort	349	349	0	1.000
split	154	154	0	1.000
stat	240	240	0	1.000
stdbuf	135	135	0	1.000
stty	149	149	0	1.000
sum	142	142	0	1.000
sync	108	108	0	1.000
tac	310	310	0	1.000
tail	234	234	0	1.000
tee	124	124	0	1.000
test	147	147	0	1.000

Table 3: Function recovery (compilation = debug)

	.cš	Jon ⁵		and fits
Çıç	und truth funct	Functions found	Functions nissed	Functions recovery fro
timeout	130	130	0	1.000
touch	198	198	0	1.000
tr	149	149	0	1.000
true	104	104	0	1.000
truncate	114	114	0	1.000
tsort	125	125	0	1.000
tty	105	105	0	1.000
uname	107	107	0	1.000
unexpand	121	121	0	1.000
uniq	132	132	0	1.000
unlink	106	106	0	1.000
uptime	142	142	0	1.000
users	112	112	0	1.000
vdir	484	484	0	1.000
wc	152	152	0	1.000
who	138	138	0	1.000
whoami	106	106	0	1.000
yes	109	109	0	1.000

Table 4: Varnode recovery (compilation = stripped)

			ned@level.W	MAICH	ERLAR CU	teld @ level SUBSET Land ALIGNED level MAN led @ level MAN led			ste lo, il
	41 ⁹	ifnode ⁵	ned@levell	ned@levell	ied@level?	ed@level Fr	ed@levelly	comparison	I Partially is
Giç	und truth vo	Vatnodes mate	Varnodes mate	Vatnodes mate	Vatnode's trade	athodes hate	athode averate	CH Compaison sector	inodes frac
[266	5	20	10	125	106	0.789	0.981	0.398
b2sum	237	8	9	9	115	96	0.797	0.966	0.405
base32	160	7	7	4	79	63	0.787	0.956	0.394
base64	160	7	7	4	79	63	0.787	0.956	0.394
basename	129	5	7	4	74	39	0.762	0.961	0.302
basenc	219	14	9	4	103	89	0.779	0.936	0.406
cat	164	5	8	5	92	54	0.777	0.970	0.329
chcon	363	8	16	7	229	103	0.778	0.978	0.284
chgrp	339	8	15	9	200	107	0.782	0.976	0.316
chmod	347	9	16	11	206	105	0.775	0.974	0.303
chown	359	8	16	9	206	120	0.788	0.978	0.334
chroot	198	5	9	4	84	96	0.824	0.975	0.485
cksum	678	31	26	20	392	209	0.766	0.954	0.308
comm	171	5	13	5	99	49	0.754	0.971	0.287
ср	703	17	32	30	351	273	0.796	0.976	0.388
csplit	982	15	43	17	533	374	0.808	0.985	0.381
cut	192	7	8	4	112	61	0.776	0.964	0.318
date	747	29	40	37	383	258	0.768	0.961	0.345
dd	493	18	20	12	243	200	0.798	0.963	0.406

Table 4: Varnode recovery (compilation = stripped)

		Xe ⁵	ned@level. W	MAICH Revelor	Jed @ level SUBSET Jed @ level SUBSET Janodes matched @ level Manades @ leve			And City Scott on Partially Supercomparison Scott on Partially Supercomparison Scott on Partially Supercomparison Supercompari		
	ound truth val	not hatch	hed a hatch	vernode's match	vernodes match	attodes match	ed e average	ror fraction	indes frac	
df	640	9	25	15	283	308	0.834	0.986	0.481	
dir	1031	30	56	28	544	373	0.785	0.971	0.362	
dircolors	190	6	8	6	111	59	0.775	0.968	0.311	
dirname	125	6	7	4	70	38	0.754	0.952	0.304	
du	1499	30	56	34	824	555	0.803	0.980	0.370	
echo	118	4	7	4	68	35	0.761	0.966	0.297	
env	201	9	12	5	97	78	0.777	0.955	0.388	
expand	152	6	8	5	87	46	0.762	0.961	0.303	
expr	911	15	38	27	489	342	0.803	0.984	0.375	
factor	511	31	27	24	187	242	0.785	0.939	0.474	
false	109	4	7	4	63	31	0.752	0.963	0.284	
fmt	186	6	8	4	107	61	0.781	0.968	0.328	
fold	143	6	8	4	75	50	0.771	0.958	0.350	
groups	142	6	7	4	77	48	0.771	0.958	0.338	
head	215	5	15	6	113	76	0.779	0.977	0.353	
hostid	118	5	7	6	69	31	0.742	0.958	0.263	
id	196	8	8	4	99	77	0.792	0.959	0.393	
join	260	9	12	5	145	89	0.782	0.965	0.342	
kill	148	7	9	4	76	52	0.765	0.953	0.351	

Table 4: Varnode recovery (compilation = stripped)

			ned@level.40	MATCH	FRIAR LEVEL SUIT	SET .	Active And Andrope of the Androde are trage of the Androde are trage of the Androde of the Andro	CH Comparison sci	re[0,1]
		Xe ⁵	@level 140	of newelow	a level 51	e Revel A	a level MA	Maison st	artiallyre
	akh vat	nou	ned e match	ned & match	ned watch	jed e match	jed e verage	coir	J. Par
Cit	ound truth was	atnodes i.	Varnode's I	Vatnodes 1	Varnodes i	athodes i	vatnode at	ithodes i	inodest
link	117	5	7	6	68	31	0.741	0.957	0.265
ln	433	8	17	16	230	162	0.801	0.982	0.374
logname	118	5	7	6	69	31	0.742	0.958	0.263
ls	1031	30	56	28	544	373	0.785	0.971	0.362
md5sum	217	7	13	4	117	76	0.779	0.968	0.350
mkdir	306	7	15	10	146	128	0.805	0.977	0.418
mkfifo	148	6	9	5	83	45	0.757	0.959	0.304
mknod	165	6	9	5	86	59	0.777	0.964	0.358
mktemp	164	6	8	5	91	54	0.773	0.963	0.329
mv	773	15	37	26	427	268	0.790	0.981	0.347
nice	130	5	7	4	70	44	0.771	0.962	0.338
nl	896	23	39	17	468	349	0.802	0.974	0.390
nohup	162	5	8	6	102	41	0.756	0.969	0.253
nproc	139	5	7	4	74	49	0.779	0.964	0.353
numfmt	291	9	13	9	139	121	0.801	0.969	0.416
od	459	11	27	12	205	204	0.807	0.976	0.444
paste	142	5	7	4	82	44	0.769	0.965	0.310
pathchk	141	6	8	4	84	39	0.752	0.957	0.277
pinky	182	8	12	5	106	51	0.747	0.956	0.280

Table 4: Varnode recovery (compilation = stripped)

	a vatr	gale ⁵	attrades tratch	MATCH AATCH Led@levelout	ed@level Stle	ger and and a state	THED AND AND AND AND AND AND AND AND AND AN	J.H. Songaison soci	re 10.11 patially rect
Chan	nd truth vari	thode's this	athodes tha	atrodes tria	athodes his	utnodes ma	strode aver	nodes fra	
pr									0.330
printenv	119	5	7	4	65	38	0.761	0.958	0.319
printf	283	6	18	8	133	118	0.799	0.979	0.417
ptx	1126	19	56	32	575	444	0.804	0.983	0.394
pwd	143	5	8	9	84	37	0.745	0.965	0.259
readlink	243	6	10	7	134	86	0.792	0.975	0.354
realpath	248	6	10	7	135	90	0.795	0.976	0.363
rm	362	9	15	9	218	111	0.781	0.975	0.307
rmdir	234	6	10	7	112	99	0.808	0.974	0.423
runcon	121	5	7	4	72	33	0.750	0.959	0.273
seq	279	8	21	8	121	121	0.792	0.971	0.434
sha1sum	215	7	10	5	113	80	0.790	0.967	0.372
sha224sum	225	8	13	5	116	83	0.781	0.964	0.369
sha256sum	225	8	13	5	116	83	0.781	0.964	0.369
sha384sum	381	8	8	5	275	85	0.776	0.979	0.223
sha512sum	381	8	8	5	275	85	0.776	0.979	0.223
shred	370	9	21	8	200	132	0.787	0.976	0.357
shuf	374	6	9	6	215	138	0.814	0.984	0.369
sleep	143	5	9	6	77	46	0.762	0.965	0.322

Table 4: Varnode recovery (compilation = stripped)

			d@level NO	MATCH	PLAY Ad@ level SUB Add level SUB	ser se	MED MAIC	Andes Faction	1,0,1
		des	. @levelthe	@level 07	. @level50°	@level AL	@level Mr	inpatison s	artially rec
	truth vath	inatche	d	d stratche	d matched	inatched	s average of	fraction.	r Fracti
Cit	Jund truth ward	inodes 4	athodes 48	inodes 4	atnodes va	inodes va	inode Vari	iodes vari	nodes
sort	847	22	38	18	460	309	0.794	0.974	0.365
split	297	9	14	5	153	116	0.797	0.970	0.391
stat	608	20	22	20	313	233	0.795	0.967	0.383
stdbuf	267	7	10	9	125	116	0.812	0.974	0.434
stty	301	8	16	10	132	135	0.807	0.973	0.449
sum	278	8	13	7	136	114	0.801	0.971	0.410
sync	133	5	8	4	78	38	0.756	0.962	0.286
tac	920	17	39	18	500	346	0.804	0.982	0.376
tail	423	7	25	11	215	165	0.799	0.983	0.390
tee	154	6	9	5	90	44	0.755	0.961	0.286
test	260	4	19	9	125	103	0.792	0.985	0.396
timeout	175	6	10	4	86	69	0.789	0.966	0.394
touch	602	25	37	36	298	206	0.759	0.958	0.342
tr	241	9	9	6	114	103	0.804	0.963	0.427
true	109	4	7	4	63	31	0.752	0.963	0.284
truncate	145	5	8	5	80	47	0.769	0.966	0.324
tsort	162	5	10	6	93	48	0.761	0.969	0.296
tty	114	5	7	4	66	32	0.748	0.956	0.281
uname	120	6	7	5	68	34	0.744	0.950	0.283

Table 4: Varnode recovery (compilation = stripped)

Grov	nd truth with	ides matche	d@level.HO	MAICH d@levelOvi	Ala Brain State of St	SET ALIC	MED MATC	And Water	e 10.11 patrially reco
unexpand	158	5	7	5	89	52	0.778	0.968	0.329
uniq	202	7	10	6	112	67	0.775	0.965	0.332
unlink	117	5	7	6	68	31	0.741	0.957	0.265
uptime	353	11	12	12	210	108	0.778	0.969	0.306
users	133	5	7	6	78	37	0.754	0.962	0.278
vdir	1031	30	56	28	544	373	0.785	0.971	0.362
wc	268	8	8	8	148	96	0.795	0.970	0.358
who	282	10	10	8	138	116	0.801	0.965	0.411
whoami	120	5	7	6	71	31	0.742	0.958	0.258
yes	132	5	7	6	77	37	0.754	0.962	0.280

Table 5: Varnode recovery (metatype = INT) (compilation = stripped)

					<u> </u>				
Č.	Kound kuth va	indes econdier	trodes tratche	d@level. 10.	MATCH AND THE RESERVENCE OF THE PROPERTY OF TH	LAR (elevel 5 UR)	Eli Allande average	ED Revel MATCH	A [O.1] I Partially for the state of the sta
[157	0	0	0	83	74	0.868	1.000	0.471
b2sum	147	0	0	0	80	67	0.864	1.000	0.456
base32	96	0	0	0	51	45	0.867	1.000	0.469
base64	96	0	0	0	51	45	0.867	1.000	0.469
basename	· 71	0	0	0	47	24	0.835	1.000	0.338
basenc	133	0	1	0	70	62	0.863	1.000	0.466
cat	101	0	0	0	64	37	0.842	1.000	0.366
chcon	185	0	0	0	124	61	0.832	1.000	0.330
chgrp	166	0	0	0	103	63	0.845	1.000	0.380
chmod	176	0	0	0	110	66	0.844	1.000	0.375
chown	176	0	0	0	105	71	0.851	1.000	0.403
chroot	110	0	1	0	53	56	0.873	1.000	0.509
cksum	488	2	0	0	329	157	0.827	0.996	0.322
comm	104	0	0	0	74	30	0.822	1.000	0.288
cp	382	2	1	0	206	173	0.858	0.995	0.453
csplit	619	0	1	0	325	293	0.868	1.000	0.473
cut	124	1	0	0	80	43	0.831	0.992	0.347

Table 5: Varnode recovery (metatype = INT) (compilation = stripped)

					JCH.	N.	S 5	(P)	
			modes matched	O.	Majerial Over independent of the Decompiler with the Decompiler wi	र्भ द्यष्टि	ET ALICATION OF THE PROPERTY O	· MATCI	Ÿ
				@Jevel,	@ level C	@ Jevel 3	@level Alt.	plevel MA core control of the contro	(1,0
			atched	de atiche	de atched	atched	, was a sched	e score	113120
		nodes	odestria	odestria	odestria	odestria	odestria	compate	Partial
	and hull va	ir :\ei\ ³⁸	itite ilet voi	:1et 18	itile ilet vat	ie iet vat	ne average	Fraction	, Stacti
ĊŠ	ound it	ecompli	Gecompi.	zecompi.	Gecompi.	ecompi	athole c	inodes 18	inodes
				<u> </u>	<u> </u>		7, 4		
date	516	4	10	0	317	185	0.824	0.992	0.359
dd	332	1	0	0	186	145	0.857	0.997	0.437
df	326	0	0	0	158	168	0.879	1.000	0.515
dir	615	4	3	0	364	244	0.842	0.993	0.397
dircolors	90	0	0	0	58	32	0.839	1.000	0.356
dirname	73	1	0	0	46	26	0.829	0.986	0.356
du	931	4	3	0	518	406	0.854	0.996	0.436
echo	69	0	0	0	45	24	0.837	1.000	0.348
env	112	0	0	0	61	51	0.864	1.000	0.455
expand	94	0	0	0	59	35	0.843	1.000	0.372
expr	560	0	1	0	286	273	0.871	1.000	0.487
factor	343	21	2	0	128	192	0.841	0.939	0.560
false	62	0	0	0	40	22	0.839	1.000	0.355
fmt	112	0	0	0	72	40	0.839	1.000	0.357
fold	88	0	0	0	51	37	0.855	1.000	0.420
groups	81	0	0	0	51	30	0.843	1.000	0.370
head	138	0	0	0	82	56	0.851	1.000	0.406
hostid	67	0	0	0	45	22	0.832	1.000	0.328

Table 5: Varnode recovery (metatype = INT) (compilation = stripped)

				d@level HO.	Matchi de level Over	N.	ET ALICATION OF THE PROPERTY O	(D)	
				30.	MA WER	Jr GJB	ET ALICATION OF THE PROPERTY O	NAICH	3
				levelt	(Jewell)	Jevels	Jewel Ir	level A	(1,0
			che.	d she	d thed	@ Hed	. aned	score	\\$\\ \\$\\
		Je ⁵	1es mail	1es maio	aes maio	res mate	1es mate	annate	atially
	20 × 100	ithor . A	dthode , 4'	dinode . 48	ithoda var	ioge Agi	ugg giage	cu action	ي ني _م ري
	ad trutt	ampiler	ampilet	ampilet	anpiler	ampilet	ode ave	odestru	odesfru
Cit	and hull va	berg,	Deco	Deco	Deco. 2	peco ~	@ level All.	plevel MAR core of the compare score of the compare score of the compare score of the core	I Partially re
id	112	0	0	0	69	43	0.846	1.000	0.384
join	162	0	0	0	104	58	0.840	1.000	0.358
kill	88	0	0	0	52	36	0.852	1.000	0.409
link	66	0	0	0	44	22	0.833	1.000	0.333
ln	219	0	0	0	125	94	0.857	1.000	0.429
logname	66	0	0	0	44	22	0.833	1.000	0.333
ls	615	4	3	0	364	244	0.842	0.993	0.397
md5sum	139	0	0	0	81	58	0.854	1.000	0.417
mkdir	196	0	0	0	102	94	0.870	1.000	0.480
mkfifo	88	0	0	0	53	35	0.849	1.000	0.398
mknod	100	0	0	0	54	46	0.865	1.000	0.460
mktemp	96	0	0	0	60	36	0.844	1.000	0.375
mv	428	2	0	0	238	188	0.856	0.995	0.439
nice	77	0	0	0	47	30	0.847	1.000	0.390
nl	558	0	1	0	288	269	0.870	1.000	0.482
nohup	99	0	0	0	71	28	0.821	1.000	0.283
nproc	86	0	0	0	51	35	0.852	1.000	0.407
numfmt	184	0	0	0	98	86	0.867	1.000	0.467

Table 5: Varnode recovery (metatype = INT) (compilation = stripped)

	De De	iode ^s	Trades matched	@level NO?	Marchi Me level Owliked On the level Owlik	AR Bevel SUBSE	o level Allowing of Control of Co	Evol MATICAL John Pare Score	patially recoving partially recoving the partially recoving the partial partia
	Ind tr	ecolită!		Decoulds.	Decoundr. De				
od	294	0	1	0	146	147	0.873	1.000	0.500
paste	85	0	0	0	55	30	0.838	1.000	0.353
pathchk	85	0	0	0	57	28	0.832	1.000	0.329
pinky	96	0	0	0	65	31	0.831	1.000	0.323
pr	399	4	1	0	258	136	0.826	0.990	0.341
printenv	68	0	0	0	42	26	0.846	1.000	0.382
printf	168	0	2	0	85	81	0.865	1.000	0.482
ptx	673	0	1	0	347	325	0.870	1.000	0.483
pwd	75	0	0	0	50	25	0.833	1.000	0.333
readlink	111	0	0	0	69	42	0.845	1.000	0.378
realpath	111	0	0	0	65	46	0.854	1.000	0.414
rm	185	0	0	0	115	70	0.845	1.000	0.378
rmdir	139	0	0	0	73	66	0.869	1.000	0.475
runcon	65	0	0	0	42	23	0.838	1.000	0.354
seq	156	0	0	0	78	78	0.875	1.000	0.500
sha1sum	138	0	0	0	78	60	0.859	1.000	0.435
sha224sum	145	0	0	0	80	65	0.862	1.000	0.448
sha256sum	145	0	0	0	80	65	0.862	1.000	0.448

Table 5: Varnode recovery (metatype = INT) (compilation = stripped)

					<u></u>				
Gravi	d truth varnoi	des Indilet	varnodes matched @	level HO . Les maches	Majeth Me level of the Land Rodes matched @	R Revel SUBSE	Jewel Allicalist (%) Jewel All	Devel Marich Inhate score In	antially recove
sha384sum	301	0	0	0	236	65	0.804	1.000	0.216
sha512sum	301	0	0	0	236	65	0.804	1.000	0.216
shred	238	0	0	0	140	98	0.853	1.000	0.412
shuf	210	0	0	0	129	81	0.846	1.000	0.386
sleep	76	0	0	0	49	27	0.839	1.000	0.355
sort	440	0	0	0	260	180	0.852	1.000	0.409
split	195	0	0	0	109	86	0.860	1.000	0.441
stat	392	4	1	0	233	154	0.839	0.990	0.393
stdbuf	156	0	0	0	80	76	0.872	1.000	0.487
stty	189	0	1	0	89	99	0.878	1.000	0.524
sum	183	0	0	0	99	84	0.865	1.000	0.459
sync	83	0	0	0	54	29	0.837	1.000	0.349
tac	584	0	1	0	310	273	0.866	1.000	0.467
tail	239	0	0	0	141	98	0.853	1.000	0.410
tee	95	0	0	0	62	33	0.837	1.000	0.347
test	155	0	0	0	83	72	0.866	1.000	0.465
timeout	95	0	0	0	55	40	0.855	1.000	0.421
touch	396	4	9	0	240	143	0.821	0.990	0.361

Table 5: Varnode recovery (metatype = INT) (compilation = stripped)

					4				
Gro	Ter Des	des dandiet was	nodes mached for the property of the property	a level NO Marked	Recompler water	AR level SUBSE	Jewel All Chief Jewel	Devel MATCH Intrate score II	atially reco
tr	153	0	0	0	70	83	0.886	1.000	0.542
true	62	0	0	0	40	22	0.839	1.000	0.355
truncate	91	0	0	0	55	36	0.849	1.000	0.396
tsort	85	0	0	0	55	30	0.838	1.000	0.353
tty	65	0	0	0	43	22	0.835	1.000	0.338
uname	67	0	0	0	43	24	0.840	1.000	0.358
unexpand	101	0	0	0	61	40	0.849	1.000	0.396
uniq	125	0	0	0	79	46	0.842	1.000	0.368
unlink	66	0	0	0	44	22	0.833	1.000	0.333
uptime	261	4	1	0	170	86	0.819	0.985	0.330
users	73	0	0	0	47	26	0.839	1.000	0.356
vdir	615	4	3	0	364	244	0.842	0.993	0.397
wc	148	0	0	0	90	58	0.848	1.000	0.392
who	158	0	0	0	90	68	0.858	1.000	0.430
whoami	68	0	0	0	46	22	0.831	1.000	0.324
yes	76	0	0	0	50	26	0.836	1.000	0.342

Table 6: Varnode recovery (metatype = FLOAT) (compilation = stripped)

					The contribet warrodes tractical extending a varrode average contrates fraction partially to Decompilet warrodes warrode average contrates fraction partially to the contribution of the c							
		pecontrile i ve		a level 40	MA level Ovi	plir level 517	SEI ALICA	a level MAIC	(O,I)			
		Xe ⁵	as matche	d le stratche	d le stratche	d le stratche	d@level Al.	Devel Mr.	I Dadially re			
	ruth	athor iet va	inode ilei v	athode itervi	ithode ilet w	ithode itervi	atnode zvetage	cor	1. Pr			
Çí	ound truth	Decompli	Decompli	Decompli	Decompli	Decompli	Vatnode t	indes 49	arnodes			
[2	0	1	0	1	0	0.500	1.000	0.000			
b2sum	0	0	0	0	0	0	-	-	-			
base32	0	0	0	0	0	0	-	-	-			
base64	0	0	0	0	0	0	-	-	-			
basename	0	0	0	0	0	0	-	-	-			
basenc	0	0	0	0	0	0	-	-	-			
cat	0	0	0	0	0	0	-	-	-			
chcon	3	0	0	0	3	0	0.750	1.000	0.000			
chgrp	3	0	0	0	3	0	0.750	1.000	0.000			
chmod	3	0	0	0	3	0	0.750	1.000	0.000			
chown	3	0	0	0	3	0	0.750	1.000	0.000			
chroot	0	0	0	0	0	0	-	-	-			
cksum	3	0	2	0	1	0	0.417	1.000	0.000			
comm	0	0	0	0	0	0	-	-	-			
cp	3	0	0	0	3	0	0.750	1.000	0.000			
csplit	0	0	0	0	0	0	-	-	-			
cut	0	0	0	0	0	0	-	-	-			

Table 6: Varnode recovery (metatype = FLOAT) (compilation = stripped)

	Atruth	wathodes Decomplet wat	ndes matche	d@level. HO.	MAICH d@levelOvi	Plandes tradite	SET ALLICATION AND AND AND AND AND AND AND AND AND AN	ED MATCH	I D. II Dentially rectificates fractive
— Ctr	3111	Decon.	Decorr	Decon	Decon	Decon	Varnot Va	thor 18	<u>I</u> IIIOC
date	2	0	1	0	1	0	0.500	1.000	0.000
dd	7	0	3	0	4	0	0.536	1.000	0.000
df	13	0	3	0	5	5	0.731	1.000	0.385
dir	6	0	2	0	4	0	0.583	1.000	0.000
dircolors	0	0	0	0	0	0	-	-	-
dirname	0	0	0	0	0	0	-	-	-
du	6	0	2	0	4	0	0.583	1.000	0.000
echo	0	0	0	0	0	0	-	-	-
env	0	0	0	0	0	0	-	-	-
expand	0	0	0	0	0	0	-	-	-
expr	0	0	0	0	0	0	-	-	-
factor	0	0	0	0	0	0	-	-	-
false	0	0	0	0	0	0	-	-	-
fmt	0	0	0	0	0	0	-	-	-
fold	0	0	0	0	0	0	-	-	-
groups	0	0	0	0	0	0	-	-	-
head	0	0	0	0	0	0	-	-	-
hostid	0	0	0	0	0	0	-	-	_

Table 6: Varnode recovery (metatype = FLOAT) (compilation = stripped)

					c C Y	. 2		2	
		valuodes Decompiler va		d@level NO	MAI (F	RIAR A@levelsulf Allodes tratche	Seff Allowed Allow And Allowed And Androde Strategy Andro	Er SICI	X
				CASI TO	CAST ON	avelst,	avel Ali	avel Mr.	S
			o	9 ₆ /6	9 _{6/6}	0 PC 2	d@level Al., Althodes matched of Variodes average	a level Mrs. compare score	0.,
		۔د	match	match	match	matche	matche	Dates	riallyt
		atholes	inoles	indes	indes	inoles	inodes e	costite	1 Pate
	Tuth	oilet vi	silet v	di gilet vi	de Silet W	ir Silei vi	ir allerate	105 Fracti	, os trac
cs	Olind	Valuades Decomplet 48	Occoping.	Decomit	Decolink	Occount .	Varnode Va	strode v	I Partially for
		<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>			
id	0	0	0	0	0	0	-	-	-
join	0	0	0	0	0	0	-	-	-
kill	0	0	0	0	0	0	-	-	-
link	0	0	0	0	0	0	-	-	-
ln	3	0	0	0	3	0	0.750	1.000	0.000
logname	0	0	0	0	0	0	-	-	-
ls	6	0	2	0	4	0	0.583	1.000	0.000
md5sum	0	0	0	0	0	0	-	-	-
mkdir	2	0	1	0	1	0	0.500	1.000	0.000
mkfifo	0	0	0	0	0	0	-	-	-
mknod	0	0	0	0	0	0	-	-	-
mktemp	0	0	0	0	0	0	-	_	-
mv	3	0	0	0	3	0	0.750	1.000	0.000
nice	0	0	0	0	0	0	_	_	_
nl	0	0	0	0	0	0	_	_	_
nohup	0	0	0	0	0	0	_	_	_
nproc	0	0	0	0	0	0	_	_	_
-	7						0.202	1 000	0.000
numfmt	/	0	5	0	2	0	0.393	1.000	U.UU(

Table 6: Varnode recovery (metatype = FLOAT) (compilation = stripped)

Groi	ind truth ve	thodes peconpiler val	nodes mathed	@ level NO?	Majori © level ovici nodes mached	ALAR Becomplies was	SET ALICANA J. @ Level ALICANA J. attodes traterate C. Varnode average C. Varnode average C.	Devel MATCH	partially reco
od	11	0	3	0	8	0	0.614	1.000	0.000
paste	0	0	0	0	0	0	-	-	-
pathchk	0	0	0	0	0	0	-	-	-
pinky	0	0	0	0	0	0	-	-	-
pr	0	0	0	0	0	0	-	-	-
printenv	0	0	0	0	0	0	-	-	-
printf	7	0	5	0	2	0	0.393	1.000	0.000
ptx	0	0	0	0	0	0	-	-	-
pwd	0	0	0	0	0	0	-	-	-
readlink	3	0	0	0	3	0	0.750	1.000	0.000
realpath	3	0	0	0	3	0	0.750	1.000	0.000
rm	3	0	0	0	3	0	0.750	1.000	0.000
rmdir	2	0	1	0	1	0	0.500	1.000	0.000
runcon	0	0	0	0	0	0	-	-	-
seq	10	0	9	0	1	0	0.300	1.000	0.000
sha1sum	0	0	0	0	0	0	-	-	-
sha224sum	0	0	0	0	0	0	-	-	-
sha256sum	0	0	0	0	0	0	_	_	_

Table 6: Varnode recovery (metatype = FLOAT) (compilation = stripped)

					<u> </u>				
số	d tulh v	athodes Decompiler van	des hathed	@level NO N	MATCH ONER ON REPORT OF THE PROPERTY OF THE PR	Develouble of the state of the	ET ALICATE	D MATCH Spread MATCH Spread Spread Sp	patially res
Grat	4	Decc 0,	·s ^{cc}	Dece 2) ₆₀₀ 0	₂₀₀ ನ	arii Vari	. Vari	
sha384sum	0	0	0	0	0	0	-	-	-
sha512sum	0	0	0	0	0	0	-	-	-
shred	3	0	2	0	1	0	0.417	1.000	0.000
shuf	3	0	0	0	3	0	0.750	1.000	0.000
sleep	7	0	0	0	2	5	0.929	1.000	0.714
sort	18	0	4	0	12	2	0.667	1.000	0.11
split	0	0	0	0	0	0	-	-	-
stat	2	0	1	0	1	0	0.500	1.000	0.000
stdbuf	2	0	1	0	1	0	0.500	1.000	0.00
stty	2	0	1	0	1	0	0.500	1.000	0.000
sum	3	0	2	0	1	0	0.417	1.000	0.00
sync	0	0	0	0	0	0	-	-	-
tac	0	0	0	0	0	0	-	-	-
tail	11	0	0	0	6	5	0.864	1.000	0.45
tee	0	0	0	0	0	0	-	-	-
test	2	0	1	0	1	0	0.500	1.000	0.00
timeout	8	0	0	0	4	4	0.875	1.000	0.500
touch	2	0	1	0	1	0	0.500	1.000	0.00

Table 6: Varnode recovery (metatype = FLOAT) (compilation = stripped)

		A c									
			nodes matched	@ level NO M	AICH @ level OVER	LAR level stilles	ei level Allandi @ level Allandi andes natched @ l	Devel MATCH	الأن		
					gades r. Secondiler var		@ level All. @ level All. andes matched @ level andes matched average of	none staction for the stack of	J.I.I. patially franchistophic franc		
tr	0	0	0	0	0	0	-	-	-		
true	0	0	0	0	0	0	-	-	-		
truncate	0	0	0	0	0	0	-	-	-		
tsort	0	0	0	0	0	0	-	-	-		
tty	0	0	0	0	0	0	-	-	-		
uname	0	0	0	0	0	0	-	-	-		
unexpan	d 0	0	0	0	0	0	-	-	-		
uniq	0	0	0	0	0	0	-	-	-		
unlink	0	0	0	0	0	0	-	-	-		
uptime	2	0	0	0	1	1	0.875	1.000	0.50		
users	0	0	0	0	0	0	-	-	-		
vdir	6	0	2	0	4	0	0.583	1.000	0.00		
wc	4	0	0	0	4	0	0.750	1.000	0.00		
who	2	0	1	0	1	0	0.500	1.000	0.00		
whoami	0	0	0	0	0	0	-	-	-		
yes	0	0	0	0	0	0	-	-	-		

Table 7: Varnode recovery (metatype = POINTER) (compilation = stripped)

		vanodes Decompiler va	nodes matche	d @ level NO	MATCH AND ONE PORT OF THE PROPERTY OF THE PROP	JAR Gevel SUB	SEI ALICANIA. ORIO DE SEI ALICANIA DE SEI ALICANICA DE	ED MATCH	Datially re
Cr ^c	jund truth	Valuodes Decompiler va	Decompiler	Decompiler v	Decompiler va	Decompiler vo	Vatrode average	modes fract.	inodes frac
]	68	0	0	0	38	30	0.860	1.000	0.441
b2sum	56	0	0	0	32	24	0.857	1.000	0.429
base32	41	0	0	0	24	17	0.854	1.000	0.415
base64	41	0	0	0	24	17	0.854	1.000	0.415
basename	38	0	0	0	24	14	0.842	1.000	0.368
basenc	55	0	0	0	30	25	0.864	1.000	0.455
cat	41	0	0	0	25	16	0.848	1.000	0.390
chcon	134	1	0	0	93	40	0.819	0.993	0.299
chgrp	133	1	0	0	90	42	0.823	0.992	0.316
chmod	127	1	0	0	89	37	0.817	0.992	0.291
chown	142	1	0	0	94	47	0.827	0.993	0.331
chroot	67	0	0	0	28	39	0.896	1.000	0.582
cksum	99	0	0	0	56	43	0.859	1.000	0.434
comm	35	0	0	0	22	13	0.843	1.000	0.371
ср	231	0	0	0	133	98	0.856	1.000	0.424
csplit	272	6	0	0	202	64	0.792	0.978	0.235
cut	46	0	0	0	29	17	0.842	1.000	0.370

Table 7: Varnode recovery (metatype = POINTER) (compilation = stripped)

					Match de level Over incides matched	N2	er andes nached and and and and and and and and and an	ED .	
				d@level.HO.	Mr. OVER	Jir SUBS	E' ALIGN	MAICY	,,
				@ level,	@level	@level,	@level Alti nodes matched @	plevel MA core control of the control of the core of t	0,1)
			atche	desatche	d atched	atched	atched	se score	114 res
		noles	nodes title	aodes nie	nodes me	rodes title	odes till	COMPAR	. Partial
	KTUITH VP	ilet w	ilei v	ilet vo	ilei vai	i ilet vati	ir average	s fractio	Stracti
Cic	Jund Huth vo	recomp.	Second,	Decomp.	Oecolub,	ecomp.	athode 18	inodes 18	inodes
date	125	1	0	0	60	64	0.872	0.992	0.512
dd	98	0	0	0	50	48	0.872	1.000	0.490
df	239	0	0	0	110	129	0.885	1.000	0.540
dir	293	1	0	0	171	121	0.851	0.997	0.413
dircolors	76	0	0	0	50	26	0.836	1.000	0.342
dirname	32	0	0	0	21	11	0.836	1.000	0.344
du	438	8	0	0	295	135	0.813	0.982	0.308
echo	30	0	0	0	20	10	0.833	1.000	0.333
env	54	0	0	0	32	22	0.852	1.000	0.407
expand	35	0	0	0	25	10	0.821	1.000	0.286
expr	259	6	0	0	197	56	0.787	0.977	0.216
factor	98	1	0	0	57	40	0.844	0.990	0.408
false	28	0	0	0	20	8	0.821	1.000	0.286
fmt	52	0	0	0	32	20	0.846	1.000	0.385
fold	33	0	0	0	21	12	0.841	1.000	0.364
groups	40	0	0	0	23	17	0.856	1.000	0.425
head	47	0	0	0	28	19	0.851	1.000	0.404
hostid	29	0	0	0	21	8	0.819	1.000	0.276

Table 7: Varnode recovery (metatype = POINTER) (compilation = stripped)

					CH	0			
				<u> </u>	MAIL	JAY BE	jer jer	fil MO	>
				i gyel AO	, englow,	. इस्टोड्री	is well Ali	enel Mr.	S
				2 [®] 20	65 65 65 66	. ° '5	.@ ¹⁶	gill agre	.6c
		, e5	Tratche	Thatche	matche	Matche	(Inatche	aparesc	rtially it
	4 9	ithode	stholes	inoles o	indes at	uges a	nodes	contr	, Par
	A truth .	apiler	apiler	apiler	apiler	apilerau	ae aideirae	aes fract	3es fract
Ć	round truth w	Decours	Decompiler 19	Decours.	Majerial Over	Decours	eit Alteria	plevel MA core confidence of the confidence of t	inou
id	60	0	0	0	27	33	0.887	1.000	0.550
join	66	0	0	0	38	28	0.856	1.000	0.424
kill	36	0	0	0	21	15	0.854	1.000	0.417
link	29	0	0	0	21	8	0.819	1.000	0.276
ln	161	0	0	0	95	66	0.852	1.000	0.410
logname	30	0	0	0	22	8	0.817	1.000	0.267
ls	293	1	0	0	171	121	0.851	0.997	0.413
md5sum	50	0	0	0	33	17	0.835	1.000	0.340
mkdir	71	0	0	0	39	32	0.863	1.000	0.451
mkfifo	36	0	0	0	27	9	0.812	1.000	0.250
mknod	41	0	0	0	29	12	0.823	1.000	0.293
mktemp	44	0	0	0	28	16	0.841	1.000	0.364
mv	254	1	0	0	176	77	0.823	0.996	0.303
nice	33	0	0	0	20	13	0.848	1.000	0.394
nl	247	6	0	0	174	67	0.800	0.976	0.271
nohup	40	0	0	0	28	12	0.825	1.000	0.300
nproc	32	0	0	0	20	12	0.844	1.000	0.375
-									0.486
numfmt	70	0	0	0	36	34	0.871	1.000	0.4

Table 7: Varnode recovery (metatype = POINTER) (compilation = stripped)

Gro	und truth wat	nodes	Trades tratched	@ level 40)	ARICH OWER	LAR level SUBSE	A level Alicaliant of the state	and strated was	Patially recove
od	93	0	0	0	40	53	0.892	1.000	0.570
paste	37	0	0	0	24	13	0.838	1.000	0.351
pathchk	33	0	0	0	23	10	0.826	1.000	0.303
pinky	57	0	0	0	38	19	0.833	1.000	0.333
pr	102	1	0	0	62	39	0.838	0.990	0.382
printenv	31	0	0	0	20	11	0.839	1.000	0.355
printf	76	0	2	0	40	34	0.849	1.000	0.447
ptx	331	6	0	0	219	106	0.816	0.982	0.320
pwd	41	0	0	0	30	11	0.817	1.000	0.268
readlink	100	0	0	0	57	43	0.858	1.000	0.430
realpath	105	0	0	0	62	43	0.852	1.000	0.410
rm	136	1	0	0	96	39	0.816	0.993	0.287
rmdir	66	0	0	0	35	31	0.867	1.000	0.470
runcon	36	0	0	0	27	9	0.812	1.000	0.250
seq	81	0	1	0	39	41	0.870	1.000	0.506
sha1sum	49	0	0	0	32	17	0.837	1.000	0.347
sha224sum	50	0	0	0	33	17	0.835	1.000	0.340
sha256sum	50	0	0	0	33	17	0.835	1.000	0.340

Table 7: Varnode recovery (metatype = POINTER) (compilation = stripped)

Gran	d truth variod	es Tripiler without	Stratched Of	snauhed & le	THE TRANSPORT OF THE PROPERTY	Swel SLIBSET	swel Aller Aller Stratege Constant	ovel MAICH Indexescore lo	il geometral states fraction exacts
sha384sum	50	0	0	0	33	17	0.835	1.000	0.340
sha512sum	50	0	0	0	33	17	0.835	1.000	0.340
shred	87	0	0	0	56	31	0.839	1.000	0.356
shuf	134	0	0	0	79	55	0.853	1.000	0.410
sleep	35	0	0	0	23	12	0.836	1.000	0.343
sort	299	0	0	0	182	117	0.848	1.000	0.391
split	69	0	0	0	41	28	0.851	1.000	0.406
stat	150	1	0	0	73	76	0.872	0.993	0.507
stdbuf	79	0	0	0	41	38	0.870	1.000	0.481
stty	73	0	0	0	39	34	0.866	1.000	0.466
sum	60	0	0	0	33	27	0.863	1.000	0.450
sync	29	0	0	0	21	8	0.819	1.000	0.276
tac	250	6	0	0	184	60	0.792	0.976	0.240
tail	124	0	1	0	65	58	0.863	1.000	0.468
tee	35	0	0	0	25	10	0.821	1.000	0.286
test	67	0	0	0	38	29	0.858	1.000	0.433
timeout	41	0	0	0	23	18	0.860	1.000	0.439
touch	110	1	0	0	53	56	0.870	0.991	0.509

Table 7: Varnode recovery (metatype = POINTER) (compilation = stripped)

					•					
			The compiler was noted to be compiler to be compiler was noted to be compiler was noted to be compiler was noted to be compiler to be co							
	a wat	gode ^s	nodes fratched	indes hatched	nodes matched warm	des matched warm	des matched rage of	mpate score	atially reco	
	Ground truth war	compiler.	Jecompiler .	Jecompiler .	Decompiler De	compiler voi	inde aver Vari	odes frac	odes fra	
tr	58	0	0	0	39	19	0.832	1.000	0.328	
true	28	0	0	0	20	8	0.821	1.000	0.286	
truncate	32	0	0	0	22	10	0.828	1.000	0.312	
tsort	52	0	0	0	35	17	0.832	1.000	0.327	
tty	29	0	0	0	20	9	0.828	1.000	0.310	
uname	30	0	0	0	22	8	0.817	1.000	0.267	
unexpar	nd 36	0	0	0	25	11	0.826	1.000	0.306	
uniq	50	0	0	0	30	20	0.850	1.000	0.400	
unlink	29	0	0	0	21	8	0.819	1.000	0.276	
uptime	57	1	0	0	36	20	0.825	0.982	0.351	
users	38	0	0	0	28	10	0.816	1.000	0.263	
vdir	293	1	0	0	171	121	0.851	0.997	0.413	
wc	84	0	0	0	52	32	0.845	1.000	0.381	
who	83	0	0	0	44	39	0.867	1.000	0.470	
whoami	i 30	0	0	0	22	8	0.817	1.000	0.267	
yes	34	0	0	0	24	10	0.824	1.000	0.294	

Table 8: Varnode recovery (metatype = ARRAY) (compilation = stripped)

_					A				
	Jund Light V	atrodes Decomplies val	nodes nached	Decomplies was	Marchia (Charles Andreas Andre	ERLAR SUBSERIES OF	SET ALICATION AND AND AND AND AND AND AND AND AND AN	iD MAICE Score	A Datially to
Cit	sund t	Decolling,	Decount,	Decount.	Decount,	Decolub.	Vatrode Va	inodes 48	imodes
[15	4	5	4	0	2	0.350	0.733	0.133
b2sum	24	7	4	8	0	5	0.417	0.708	0.208
base32	12	6	2	3	0	1	0.250	0.500	0.083
base64	12	6	2	3	0	1	0.250	0.500	0.083
basename	10	4	2	3	0	1	0.300	0.600	0.100
basenc	20	13	2	3	0	2	0.200	0.350	0.100
cat	11	4	3	3	0	1	0.295	0.636	0.091
chcon	18	4	10	3	0	1	0.278	0.778	0.056
chgrp	15	4	7	3	0	1	0.283	0.733	0.067
chmod	19	5	8	5	0	1	0.289	0.737	0.053
chown	16	4	8	3	0	1	0.281	0.750	0.062
chroot	11	4	3	3	0	1	0.295	0.636	0.091
cksum	66	28	10	19	0	9	0.318	0.576	0.136
comm	22	4	8	4	0	6	0.455	0.818	0.273
cp	40	12	13	11	3	1	0.300	0.700	0.025
csplit	35	8	13	6	0	8	0.407	0.771	0.229
cut	12	5	3	3	0	1	0.271	0.583	0.083

Table 8: Varnode recovery (metatype = ARRAY) (compilation = stripped)

					<u></u>					
c sc	Jund truth	atrodes Decomplies val	nodes matched	Decomplies was	Matchia (Chevel Only Recomplier)	Teconpiler va	SET ALLONG AND	ED Ravel MATCH	d (O.1) Indially re	
date	63	23	14	20	0	6	0.310	0.635	0.095	
dd	34	16	7	8	0	3	0.257	0.529	0.088	
df	25	7	9	6	1	2	0.320	0.720	0.080	
dir	71	21	27	19	1	3	0.282	0.704	0.042	
dircolors	13	5	2	5	0	1	0.308	0.615	0.077	
dirname	10	4	2	3	0	1	0.300	0.600	0.100	
du	51	15	16	12	0	8	0.353	0.706	0.157	
echo	9	3	2	3	0	1	0.333	0.667	0.111	
env	18	6	7	3	1	1	0.278	0.667	0.056	
expand	13	5	3	4	0	1	0.288	0.615	0.077	
expr	33	8	9	8	0	8	0.432	0.758	0.242	
factor	37	8	10	10	0	9	0.446	0.784	0.243	
false	9	3	2	3	0	1	0.333	0.667	0.111	
fmt	12	5	3	3	0	1	0.271	0.583	0.083	
fold	12	5	3	3	0	1	0.271	0.583	0.083	
groups	11	5	2	3	0	1	0.273	0.545	0.091	
head	18	4	9	4	0	1	0.292	0.778	0.056	
hostid	12	4	2	5	0	1	0.333	0.667	0.083	

Table 8: Varnode recovery (metatype = ARRAY) (compilation = stripped)

join 18 7 5 3 0 3 0.319 0.611 0.16 kill 14 6 4 3 0 1 0.250 0.571 0.07 link 12 4 2 5 0 1 0.333 0.667 0.06 ln 22 6 7 5 3 1 0.341 0.727 0.06 logname 12 4 2 5 0 1 0.333 0.667 0.06 ls 71 21 27 19 1 3 0.282 0.704 0.06 md5sum 16 6 6 3 0 1 0.250 0.625 0.06 mkdir 19 6 7 4 0 2 0.303 0.684 0.16 mkfifo 12 5 3 3 0 1 0.271 0.583 0.06 mknod 12 5 3 3 0 1 0.271 0.583 0.06 mktemp 12 5 2 4 0 1 0.292 0.583 0.06 mv 34 9 14 7 3 1 0.301 0.735 0.06 nlce 10 4 2 3 0 1 0.300 0.600 0.16 nl 36 13 9 6 0 8 0.368 0.639 0.22						(CH	R	•	S	
id 14 7 3 3 0 1 0.232 0.500 0.00 join 18 7 5 3 0 3 0.319 0.611 0.16 kill 14 6 4 3 0 1 0.250 0.571 0.00 link 12 4 2 5 0 1 0.333 0.667 0.00 ln 22 6 7 5 3 1 0.341 0.727 0.00 logname 12 4 2 5 0 1 0.333 0.667 0.00 ls 71 21 27 19 1 3 0.282 0.704 0.00 md5sum 16 6 6 3 0 1 0.250 0.625 0.00 mkdir 19 6 7 4 0 2 0.303 0.684 0.10 mknod 12 5 3 3 0 1 0.271 0.583 0.00					, O	MAX	RIA B	sei igi	ir , XICY	>
id 14 7 3 3 0 1 0.232 0.500 0.00 join 18 7 5 3 0 3 0.319 0.611 0.16 kill 14 6 4 3 0 1 0.250 0.571 0.00 link 12 4 2 5 0 1 0.333 0.667 0.00 ln 22 6 7 5 3 1 0.341 0.727 0.00 logname 12 4 2 5 0 1 0.333 0.667 0.00 ls 71 21 27 19 1 3 0.282 0.704 0.00 md5sum 16 6 6 3 0 1 0.250 0.625 0.00 mkdir 19 6 7 4 0 2 0.303 0.684 0.10 mknod 12 5 3 3 0 1 0.271 0.583 0.00					is well the	ishelog	i gwel 50	is well Al	· SASI MI	S
id 14 7 3 3 0 1 0.232 0.500 0.00 join 18 7 5 3 0 3 0.319 0.611 0.16 kill 14 6 4 3 0 1 0.250 0.571 0.00 link 12 4 2 5 0 1 0.333 0.667 0.00 ln 22 6 7 5 3 1 0.341 0.727 0.00 logname 12 4 2 5 0 1 0.333 0.667 0.00 ls 71 21 27 19 1 3 0.282 0.704 0.00 md5sum 16 6 6 3 0 1 0.250 0.625 0.00 mkdir 19 6 7 4 0 2 0.303 0.684 0.10 mknod 12 5 3 3 0 1 0.271 0.583 0.00					6 S		9 _© 5	oge ege) le core	6.,
id 14 7 3 3 0 1 0.232 0.500 0.00 join 18 7 5 3 0 3 0.319 0.611 0.16 kill 14 6 4 3 0 1 0.250 0.571 0.0 link 12 4 2 5 0 1 0.333 0.667 0.0 ln 22 6 7 5 3 1 0.341 0.727 0.0 logname 12 4 2 5 0 1 0.333 0.667 0.0 ls 71 21 27 19 1 3 0.282 0.704 0.0 md5sum 16 6 6 3 0 1 0.250 0.625 0.0 mkdir 19 6 7 4 0 2 0.303 0.684 0.16 mknod 12 5 3 3 0 1 0.271 0.583 0.0 <th></th> <th></th> <th>جي.</th> <th>natchi</th> <th>natche</th> <th>Match</th> <th>natche</th> <th>matche</th> <th>addiesc</th> <th>rially!</th>			جي.	natchi	natche	Match	natche	matche	addiesc	rially!
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id 14 7 3 3 0 1 0.232 0.500 0.00 join 18 7 5 3 0 3 0.319 0.611 0.16 kill 14 6 4 3 0 1 0.250 0.571 0.0 link 12 4 2 5 0 1 0.333 0.667 0.0 ln 22 6 7 5 3 1 0.341 0.727 0.0 logname 12 4 2 5 0 1 0.333 0.667 0.0 ls 71 21 27 19 1 3 0.282 0.704 0.0 md5sum 16 6 6 3 0 1 0.250 0.625 0.0 mkdir 19 6 7 4 0 2 0.303 0.684 0.16 mknod 12 5 3 3 0 1 0.271 0.583 0.0 <th></th> <th>CHOUNG</th> <th>Seconing</th> <th>Decomit</th> <th>Decountry .</th> <th>Oecolitik</th> <th>Decornie 4</th> <th>Vatnode Va</th> <th>inode 18</th> <th>Inode</th>		CHOUNG	Seconing	Decomit	Decountry .	Oecolitik	Decornie 4	Vatnode Va	inode 18	Inode
join 18 7 5 3 0 3 0.319 0.611 0.10 kill 14 6 4 3 0 1 0.250 0.571 0.00 link 12 4 2 5 0 1 0.333 0.667 0.00 logname 12 4 2 5 0 1 0.333 0.667 0.00 ls 71 21 27 19 1 3 0.282 0.704 0.00 md5sum 16 6 6 3 0 1 0.250 0.625 0.00 mkdir 19 6 7 4 0 2 0.303 0.684 0.10 mkfifo 12 5 3 3 0 1 0.271 0.583 0.00 mknod 12 5 3 3 0 1 0.271 0.583 0.00 mktemp 12 5 2 4 0 1 0.292 0.583 0.00 mktemp 12 5 2 4 0 1 0.292 0.583 0.00 mktemp 12 5 2 4 0 1 0.300 0.600 0.10 nl 0.36 13 9 6 0 8 0.368 0.639 0.22										
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link 12 4 2 5 0 1 0.333 0.667 0.00 ln 22 6 7 5 3 1 0.341 0.727 0.00 logname 12 4 2 5 0 1 0.333 0.667 0.00 ls 71 21 27 19 1 3 0.282 0.704 0.00 md5sum 16 6 6 3 0 1 0.250 0.625 0.00 mkdir 19 6 7 4 0 2 0.303 0.684 0.10 mkfifo 12 5 3 3 0 1 0.271 0.583 0.00 mktemp 12 5 3 3 0 1 0.271 0.583 0.00 mv 34 9 14 7 3 1 0.301 0.735 0.00 nice 10 4 2 3 0 1 0.300 0.600 0.10 </td <td>join</td> <td>18</td> <td>7</td> <td>5</td> <td>3</td> <td>0</td> <td>3</td> <td>0.319</td> <td>0.611</td> <td>0.167</td>	join	18	7	5	3	0	3	0.319	0.611	0.167
In 22 6 7 5 3 1 0.341 0.727 0.04 logname 12 4 2 5 0 1 0.333 0.667 0.00 ls 71 21 27 19 1 3 0.282 0.704 0.00 md5sum 16 6 6 3 0 1 0.250 0.625 0.00 mkdir 19 6 7 4 0 2 0.303 0.684 0.10 mkfifo 12 5 3 3 0 1 0.271 0.583 0.00 mknod 12 5 3 3 0 1 0.271 0.583 0.00 mktemp 12 5 2 4 0 1 0.292 0.583 0.00 mv 34 9 14 7 3 1 0.301 0.735 0.00 nl 36 13 9 6 0 8 0.368 0.639 0.25 </td <td>kill</td> <td>14</td> <td>6</td> <td>4</td> <td>3</td> <td>0</td> <td>1</td> <td>0.250</td> <td>0.571</td> <td>0.071</td>	kill	14	6	4	3	0	1	0.250	0.571	0.071
logname 12 4 2 5 0 1 0.333 0.667 0.00 ls 71 21 27 19 1 3 0.282 0.704 0.00 md5sum 16 6 6 3 0 1 0.250 0.625 0.00 mkdir 19 6 7 4 0 2 0.303 0.684 0.10 mkfifo 12 5 3 3 0 1 0.271 0.583 0.00 mknod 12 5 3 3 0 1 0.271 0.583 0.00 mktemp 12 5 2 4 0 1 0.292 0.583 0.00 mktemp 12 5 2 4 0 1 0.292 0.583 0.00 mktemp 12 5 2 4 0 1 0.301 0.735 0.00 mice 10 4 2 3 0 1 0.300 0.600 0.10 nl 36 13 9 6 0 8 0.368 0.639 0.25	link	12	4	2	5	0	1	0.333	0.667	0.083
Is 71 21 27 19 1 3 0.282 0.704 0.04 md5sum 16 6 6 3 0 1 0.250 0.625 0.06 mkdir 19 6 7 4 0 2 0.303 0.684 0.10 mkfifo 12 5 3 3 0 1 0.271 0.583 0.00 mknod 12 5 3 3 0 1 0.271 0.583 0.00 mktemp 12 5 2 4 0 1 0.292 0.583 0.00 mv 34 9 14 7 3 1 0.301 0.735 0.00 nice 10 4 2 3 0 1 0.300 0.600 0.10 nl 36 13 9 6 0 8 0.368 0.639 0.25	ln	22	6	7	5	3	1	0.341	0.727	0.045
md5sum 16 6 6 3 0 1 0.250 0.625 0.00 mkdir 19 6 7 4 0 2 0.303 0.684 0.10 mkfifo 12 5 3 3 0 1 0.271 0.583 0.00 mknod 12 5 3 3 0 1 0.271 0.583 0.00 mktemp 12 5 2 4 0 1 0.292 0.583 0.00 mv 34 9 14 7 3 1 0.301 0.735 0.00 nice 10 4 2 3 0 1 0.300 0.600 0.10 nl 36 13 9 6 0 8 0.368 0.639 0.25	lognam	e 12	4	2	5	0	1	0.333	0.667	0.083
mkdir 19 6 7 4 0 2 0.303 0.684 0.10 mkfifo 12 5 3 3 0 1 0.271 0.583 0.00 mknod 12 5 3 3 0 1 0.271 0.583 0.00 mktemp 12 5 2 4 0 1 0.292 0.583 0.00 mv 34 9 14 7 3 1 0.301 0.735 0.00 nice 10 4 2 3 0 1 0.300 0.600 0.10 nl 36 13 9 6 0 8 0.368 0.639 0.22	ls	71	21	27	19	1	3	0.282	0.704	0.042
mkfifo 12 5 3 3 0 1 0.271 0.583 0.08 mknod 12 5 3 3 0 1 0.271 0.583 0.08 mktemp 12 5 2 4 0 1 0.292 0.583 0.08 mv 34 9 14 7 3 1 0.301 0.735 0.09 nice 10 4 2 3 0 1 0.300 0.600 0.16 nl 36 13 9 6 0 8 0.368 0.639 0.22	md5sur	n 16	6	6	3	0	1	0.250	0.625	0.062
mknod 12 5 3 3 0 1 0.271 0.583 0.000 mktemp 12 5 2 4 0 1 0.292 0.583 0.000 mv 34 9 14 7 3 1 0.301 0.735 0.000 nice 10 4 2 3 0 1 0.300 0.600 0.100 nl 36 13 9 6 0 8 0.368 0.639 0.22	mkdir	19	6	7	4	0	2	0.303	0.684	0.105
mktemp 12 5 2 4 0 1 0.292 0.583 0.09 mv 34 9 14 7 3 1 0.301 0.735 0.09 nice 10 4 2 3 0 1 0.300 0.600 0.10 nl 36 13 9 6 0 8 0.368 0.639 0.22	mkfifo	12	5	3	3	0	1	0.271	0.583	0.083
mv 34 9 14 7 3 1 0.301 0.735 0.000 nice 10 4 2 3 0 1 0.300 0.600 0.100 nl 36 13 9 6 0 8 0.368 0.639 0.200	mknod	12	5	3	3	0	1	0.271	0.583	0.083
nice 10 4 2 3 0 1 0.300 0.600 0.10 nl 36 13 9 6 0 8 0.368 0.639 0.22	mktemp	p 12	5	2	4	0	1	0.292	0.583	0.083
nl 36 13 9 6 0 8 0.368 0.639 0.22	mv	34	9	14	7	3	1	0.301	0.735	0.029
nl 36 13 9 6 0 8 0.368 0.639 0.22	nice	10	4	2	3	0	1	0.300	0.600	0.100
										0.222
	nohup	13	4	3	5	0	1	0.327	0.692	0.077
·	_									0.100
	-									0.050

Table 8: Varnode recovery (metatype = ARRAY) (compilation = stripped)

Cres	and hith va	modes var	nodes mached	@ level NO.	MATCH OVE	ALAR LEVEL SUBS	ET ALICAN © Level ALICAN Modes Inatched ©	Jewel MATCH	Datially rec
od	40	10	18	8	0	4	0.312	0.750	0.100
paste	10	4	2	3	0	1	0.300	0.600	0.100
pathchk	10	4	2	3	0	1	0.300	0.600	0.100
pinky	17	6	7	3	0	1	0.250	0.647	0.059
pr	20	6	6	6	0	2	0.325	0.700	0.100
printenv	10	4	2	3	0	1	0.300	0.600	0.100
printf	17	5	4	5	0	3	0.382	0.706	0.176
ptx	39	12	9	7	3	8	0.410	0.692	0.205
pwd	10	4	2	3	0	1	0.300	0.600	0.100
readlink	12	4	3	3	1	1	0.333	0.667	0.083
realpath	11	4	2	3	1	1	0.341	0.636	0.091
rm	15	5	5	4	0	1	0.283	0.667	0.067
rmdir	14	5	3	4	0	2	0.339	0.643	0.143
runcon	10	4	2	3	0	1	0.300	0.600	0.100
seq	15	7	2	4	0	2	0.300	0.533	0.133
sha1sum	16	6	3	4	0	3	0.359	0.625	0.188
sha224sum	n 17	7	5	4	0	1	0.250	0.588	0.059
sha256sum	n 17	7	5	4	0	1	0.250	0.588	0.059

Table 8: Varnode recovery (metatype = ARRAY) (compilation = stripped)

				ges matched @ level NO MATCH Level Outled Land Substituted @ level Outled Land Substituted @ level Attention Matched Becompiler variodes matched becompiler variodes matched average compare score The compiler variode average compare station The compiler variode average compiler variode average compare station The compiler variode average compiler variode average compare station The compiler variode average compiler variode average average compare station The compiler variode average compiler variode average average compare station The compiler variode average average compiler variode average average compare station The compiler variode average average aver							
Grand	id truth v	atrodes Decompilet vario	ses matched	nodes mached	odes matched	nodes matched	@ level All. ades matched @ lands addrage con	revel Min repair score In repair scion f	patially reactions		
sha384sum	17	7	3	4	0	3	0.338	0.588	0.17		
sha512sum	17	7	3	4	0	3	0.338	0.588	0.17		
shred	27	8	11	5	0	3	0.306	0.704	0.11		
shuf	12	4	3	3	0	2	0.354	0.667	0.16		
sleep	12	4	2	5	0	1	0.333	0.667	0.08		
sort	46	19	17	8	0	2	0.223	0.587	0.04		
split	18	6	7	4	0	1	0.264	0.667	0.05		
stat	32	14	7	9	0	2	0.258	0.562	0.06		
stdbuf	16	6	3	5	0	2	0.328	0.625	0.12		
stty	19	5	5	7	0	2	0.355	0.737	0.10		
sum	22	7	6	6	0	3	0.341	0.682	0.13		
sync	11	4	3	3	0	1	0.295	0.636	0.09		
tac	33	9	9	7	0	8	0.417	0.727	0.24		
tail	20	5	9	5	0	1	0.287	0.750	0.05		
tee	14	5	4	4	0	1	0.286	0.643	0.07		
test	12	3	4	3	0	2	0.375	0.750	0.16		
timeout	13	5	4	3	0	1	0.269	0.615	0.07		
touch	56	19	14	17	0	6	0.321	0.661	0.10		

Table 8: Varnode recovery (metatype = ARRAY) (compilation = stripped)

		L kruth V	atrodes Decompilet	vatiodes that?	ped@level. Warnades mately	, MAICH , Marked exel of	AERIAR I LEVEL CO	JBSET BURELALIGH	ED ARICH Plevel MARICH Compare score	Patialy reco
	Croun	ÇÜ .	Deconin	Deconiti	Decomin	Deconni	Deconin	Varnod	ithoda Va	inode
tr		17	8	3	5	0	1	0.250	0.529	0.059
true		9	3	2	3	0	1	0.333	0.667	0.111
trunca	te	10	4	2	3	0	1	0.300	0.600	0.100
tsort		13	4	3	5	0	1	0.327	0.692	0.077
tty		10	4	2	3	0	1	0.300	0.600	0.100
uname	.	12	5	2	4	0	1	0.292	0.583	0.083
unexp	and	11	4	2	4	0	1	0.318	0.636	0.091
uniq		15	6	3	5	0	1	0.283	0.600	0.067
unlink	-	12	4	2	5	0	1	0.333	0.667	0.083
uptime	e	18	5	4	8	0	1	0.333	0.722	0.056
users		12	4	2	5	0	1	0.333	0.667	0.083
vdir		71	21	27	19	1	3	0.282	0.704	0.042
wc		16	7	3	5	0	1	0.266	0.562	0.062
who		25	8	4	4	0	9	0.480	0.680	0.360
whoan	ni	12	4	2	5	0	1	0.333	0.667	0.083
yes		12	4	2	5	0	1	0.333	0.667	0.083

Table 9: Varnode recovery (metatype = STRUCT) (compilation = stripped)

		TON BR (SD)								
ć	and truth "	unodes	nodes natched	@ level 100.	Mala evel Out	Decomplet va	SET ALICAN AND AND AND AND AND AND AND AND AND A	il MATCI	A [O,1] I Partially is	
[24	1	14	6	3	0	0.365	0.958	0.000	
b2sum	10	1	5	1	3	0	0.400	0.900	0.000	
base32	11	1	5	1	4	0	0.432	0.909	0.000	
base64	11	1	5	1	4	0	0.432	0.909	0.000	
basename	10	1	5	1	3	0	0.400	0.900	0.000	
basenc	11	1	6	1	3	0	0.386	0.909	0.000	
cat	11	1	5	2	3	0	0.409	0.909	0.000	
chcon	23	3	6	4	9	1	0.489	0.870	0.043	
chgrp	22	3	8	6	4	1	0.409	0.864	0.045	
chmod	22	3	8	6	4	1	0.409	0.864	0.045	
chown	22	3	8	6	4	1	0.409	0.864	0.045	
chroot	10	1	5	1	3	0	0.400	0.900	0.000	
cksum	22	1	14	1	6	0	0.386	0.955	0.000	
comm	10	1	5	1	3	0	0.400	0.900	0.000	
cp	46	3	18	19	5	1	0.408	0.935	0.022	
csplit	56	1	29	11	6	9	0.469	0.982	0.161	
cut	10	1	5	1	3	0	0.400	0.900	0.000	

Table 9: Varnode recovery (metatype = STRUCT) (compilation = stripped)

				nached @ level MO MARCH. Inached @ level Address that ched @ level substituted @ level Address that ched @ level MARCH. Inached @ level Address that ched @ level substituted @ level Address that ched @ level MARCH. Inached @ level Address that ched @ level substituted @ level Address that ched @ level MARCH. Inached @ level Address that ched @ level substituted @ level Address that ched @ level MARCH. Inached @ level Address that ched @ level substituted @ level Address that ched @ level MARCH. Inached @ level Address that ched @ level substituted @ level Address that ched @ level MARCH. Inached @ level Address that ched @ level substituted @ level Address that ched @ level MARCH. Inached @ level Address that ched @ level substituted @ level Address that ched @ level MARCH. Inached @ level Address that ched @ level substituted @ level Address that ched @ level MARCH. Inached @ level Address that ched @ level substituted @ level Address that ched @ level MARCH. Inached @ level Address that ched @ level substituted @ level Address that ched @ level substituted @ level Address that ched @ level substituted @ level substi							
				₂ 0?	Mr. ONE	pli sub	SE' ALIGH	MAICY	,,		
				@Jevel,	@ level e	@ level?	L@ level All. Linodes matched Aarrode average	plevel MA core control of the contro	(1,0		
			atched	s tched	de atche	de atchei	de skihed e	e scoie	114 th		
	jund fruit	ades	ales ma	ales ma	ades ma	adestria	ades mia	Compate	I Partially is		
	nin'	ati.	inc seivat	ne 18148	ine servi	atric service	ine average	fraction	Et.gc.		
ي .	Jund ti	acompile	acompile	acompile	acomplite	acomplie	athode a	inoles,	indes,		
		<u> </u>	<u> </u>		<u> </u>	<u> </u>	7.0 7.0	7.0	·		
date	39	1	15	15	5	3	0.462	0.974	0.077		
dd	22	1	10	4	3	4	0.489	0.955	0.182		
df	37	2	13	9	9	4	0.500	0.946	0.108		
dir	46	4	24	9	4	5	0.402	0.913	0.109		
dircolors	11	1	6	1	3	0	0.386	0.909	0.000		
dirname	10	1	5	1	3	0	0.400	0.900	0.000		
du	73	3	35	22	7	6	0.425	0.959	0.082		
echo	10	1	5	1	3	0	0.400	0.900	0.000		
env	17	3	5	2	3	4	0.500	0.824	0.235		
expand	10	1	5	1	3	0	0.400	0.900	0.000		
expr	59	1	28	19	6	5	0.441	0.983	0.085		
factor	32	1	14	14	2	1	0.406	0.969	0.031		
false	10	1	5	1	3	0	0.400	0.900	0.000		
fmt	10	1	5	1	3	0	0.400	0.900	0.000		
fold	10	1	5	1	3	0	0.400	0.900	0.000		
groups	10	1	5	1	3	0	0.400	0.900	0.000		
head	12	1	6	2	3	0	0.396	0.917	0.000		
hostid	10	1	5	1	3	0	0.400	0.900	0.000		

Table 9: Varnode recovery (metatype = STRUCT) (compilation = stripped)

		Atruth variodes Tocompiler variodes matched Decompiler variodes matched Decompiler variodes average consideration of the property of the period of the property of the period of the per										
				140)	Mr JOYS	er isub	St Aligh	evel ALICI Stratched @ Level MATO Stratched @ Level MATO				
				@lever	@lever	, @lever	@lever	lever .e.	611			
			matcher	matches	d matche	id natcher	d matched	ane scole	ally re			
		athodes	nodesir	nodesir	nolesti	molesti	nodes ir	ionil ⁱ	Parti			
	Atuth	atilet va	s oiler va	s offer vo	. atilet v	di atilet vo	r realetials	1es fracti	res fract			
Cit	Juliu	vernodes Decompiler var	Decount (Decount .	Decount	Decount .	Vatnode Va	ithode 18	rnode			
id	10	1	5	1	3	0	0.400	0.900	0.000			
join	14	2	7	2	3	0	0.357	0.857	0.000			
kill	10	1	5	1	3	0	0.400	0.900	0.000			
link	10	1	5	1	3	0	0.400	0.900	0.000			
ln	28	2	10	11	4	1	0.429	0.929	0.036			
logname	10	1	5	1	3	0	0.400	0.900	0.000			
ls	46	4	24	9	4	5	0.402	0.913	0.109			
md5sum	12	1	7	1	3	0	0.375	0.917	0.000			
mkdir	18	1	7	6	4	0	0.431	0.944	0.000			
mkfifo	12	1	6	2	3	0	0.396	0.917	0.000			
mknod	12	1	6	2	3	0	0.396	0.917	0.000			
mktemp	12	1	6	1	3	1	0.438	0.917	0.083			
mv	53	3	23	19	6	2	0.410	0.943	0.038			
nice	10	1	5	1	3	0	0.400	0.900	0.000			
nl	55	4	29	11	6	5	0.405	0.927	0.091			
nohup	10	1	5	1	3	0	0.400	0.900	0.000			
nproc	11	1	5	1	3	1	0.455	0.909	0.091			
numfmt	10	1	5	1	3	0	0.400	0.900	0.000			

Table 9: Varnode recovery (metatype = STRUCT) (compilation = stripped)

					AICH	LAP.	es del di				
ñ	ind truth "	atrodes Decompiler var	nodes matched	@level 10 19	na evel over	ALAR LEVEL SUBS	ET ALICANIA ALICANIA O ANTONIO DE CARROLE ANTONIO DE ANTONIO DE CARROLE ANTONIO DE CARROLE DE CARRO	level MATCH	Pare score 10.11 Pare score 10.11 Pare score 10.11 Pare score		
od	13	1	5 5	4	3	0	0.423	0.923	0.000		
paste	10 13	1 2	6	1	3 4	0	0.400 0.385	0.900 0.846	0.000		
pathchk	12	2	5	2	3	0	0.375	0.840	0.000		
pinky	22	1	11	4	4	2	0.373	0.855	0.000		
pr printenv	10	1	5	1	3	0	0.443	0.933	0.001		
printf	15	1	5	3	6	0	0.483	0.933	0.000		
ptx	82	1	45	25	6	5	0.405	0.933	0.061		
pwd	17	1	6	6	4	0	0.441	0.941	0.001		
readlink	17	2	7	4	4	0	0.397	0.882	0.000		
realpath	18	2	8	4	4	0	0.389	0.889	0.000		
rm	23	3	10	5	4	1	0.391	0.870	0.043		
rmdir	13	1	6	3	3	0	0.404	0.923	0.000		
runcon	10	1	5	1	3	0	0.400	0.900	0.000		
seq	17	1	9	4	3	0	0.382	0.941	0.000		
sha1sum	12	1	7	1	3	0	0.375	0.917	0.000		
sha224sum		1	8	1	3	0	0.365	0.923	0.000		
sha256sum		1	8	1	3	0	0.365	0.923	0.000		

Table 9: Varnode recovery (metatype = STRUCT) (compilation = stripped)

-					<u> </u>				
. તાર્ય	nd full v	amodes	ades tratched a control of the contr	@ level NO M	AICH OVER	LAR General States of the Land	elevel Allandia @ level Allandia	Devel Marich Intrate scare of	atially rec
sha384sum	13	1	5	1	6	0	0.481	0.923	0.000
sha512sum	13	1	5	1	6	0	0.481	0.923	0.000
shred	15	1	8	3	3	0	0.383	0.933	0.000
shuf	15	2	6	3	4	0	0.400	0.867	0.000
sleep	13	1	7	1	3	1	0.423	0.923	0.07
sort	44	3	17	10	6	8	0.494	0.932	0.182
split	15	3	7	1	3	1	0.367	0.800	0.06
stat	32	1	13	11	6	1	0.445	0.969	0.03
stdbuf	14	1	6	4	3	0	0.411	0.929	0.00
stty	18	3	9	3	3	0	0.333	0.833	0.000
sum	10	1	5	1	3	0	0.400	0.900	0.000
sync	10	1	5	1	3	0	0.400	0.900	0.000
tac	53	2	29	11	6	5	0.420	0.962	0.094
tail	29	2	15	6	3	3	0.414	0.931	0.103
tee	10	1	5	1	3	0	0.400	0.900	0.000
test	24	1	14	6	3	0	0.365	0.958	0.00
timeout	18	1	6	1	4	6	0.611	0.944	0.333
touch	36	1	13	17	4	1	0.438	0.972	0.028

Table 9: Varnode recovery (metatype = STRUCT) (compilation = stripped)

					À				
			kodes matched van		AMIC (ER	JAR Glevel SUBSE	el level Allowelled @ landes mached @ landes mached @ lande average con	Sich	
				well to	wel On r	avelsul	Wel Alix	wel MA	<u> </u>
) الح	g\e 6 ₂	. ° ° ° ° °	@ ¹⁶	® _{}e}	e die l	,5°° ,5°°
		1 000	anatche	Smatche	s matche	anatche	Finatche	Maie st	rtially it
	Vatr	jode	ides	odes	nodes	nodes	odes age co	ation s	jar ,xi
	adtruth	milet	miler	miler	mpiler	miler	deaverter	. Nes frau	Jes frac
Ö	cound truth vari	cor	become	econ.	Decoir S	become	@ level All.r	ngale score lo	andes fracti
tr	13	1	6	1	5	0	0.442	0.923	0.000
true	10	1	5	1	3	0	0.400	0.900	0.000
truncate	12	1	6	2	3	0	0.396	0.917	0.000
tsort	12	1	7	1	3	0	0.375	0.917	0.000
tty	10	1	5	1	3	0	0.400	0.900	0.000
uname	11	1	5	1	3	1	0.455	0.909	0.091
unexpand	10	1	5	1	3	0	0.400	0.900	0.000
uniq	12	1	7	1	3	0	0.375	0.917	0.000
unlink	10	1	5	1	3	0	0.400	0.900	0.000
uptime	15	1	7	4	3	0	0.400	0.933	0.000
users	10	1	5	1	3	0	0.400	0.900	0.000
vdir	46	4	24	9	4	5	0.402	0.913	0.109
wc	16	1	5	3	2	5	0.578	0.938	0.312
who	14	2	5	4	3	0	0.393	0.857	0.000
whoami	10	1	5	1	3	0	0.400	0.900	0.000
yes	10	1	5	1	3	0	0.400	0.900	0.000

Table 10: Varnode recovery (metatype = UNION) (compilation = stripped)

					C. T.	2			
		varnode ⁵ Decompiler va		d@level MO	MATE	RLAR BLAR SUR	SET ALLICE AND	ED SC	*
				i evel the	, englow,	ं व्यावद्यार	d@level Alir Inodes matched	Devel Mr. Compare score	. 🕥
			206	9 _{©,6}	d@16 256	d@16 "	sele sele	g le	`0.,
		Xe ⁵	. 25 Match	, as match	Sinatch	, 25 Match	Shatch	Mare se	artially
	~	Varnot Va	ithode.	inole.	stnode.	athode.	ithode, 1.965	cor	A patially a
	ind truth	ampiler	angiler	anpiler	angiler	ampiler	ode aver	odestra	odes fro
CS	ound truth	Deco	Deco	Decr	Deco	Deco.	Varine Va	Attice 4	diffe
[0	0	0	0	0	0	-	-	-
b2sum	0	0	0	0	0	0	-	-	-
base32	0	0	0	0	0	0	-	-	-
base64	0	0	0	0	0	0	-	-	-
basename	0	0	0	0	0	0	-	-	-
basenc	0	0	0	0	0	0	-	-	-
cat	0	0	0	0	0	0	-	-	-
chcon	0	0	0	0	0	0	-	-	-
chgrp	0	0	0	0	0	0	-	-	-
chmod	0	0	0	0	0	0	-	-	-
chown	0	0	0	0	0	0	-	-	-
chroot	0	0	0	0	0	0	-	-	-
cksum	0	0	0	0	0	0	-	-	-
comm	0	0	0	0	0	0	-	-	-
ср	1	0	0	0	1	0	0.750	1.000	0.000
csplit	0	0	0	0	0	0	-	-	-
cut	0	0	0	0	0	0	-	-	-

Table 10: Varnode recovery (metatype = UNION) (compilation = stripped)

				Decompiler variodes fractived @ Decompiler variodes average compare score 10.1.1								
Gst	and truth	Valuades Decompiler va	Decompiler 1.	Decomplet 15	Decompiler of	Decompiler 15	undes hatched	e level Mr. Compare score	n Partially for			
date	2	0	0	2	0	0	0.500	1.000	0.000			
dd	0	0	0	0	0	0	-	-	-			
df	0	0	0	0	0	0	-	-	-			
dir	0	0	0	0	0	0	-	-	-			
dircolors	0	0	0	0	0	0	-	-	-			
dirname	0	0	0	0	0	0	-	-	-			
du	0	0	0	0	0	0	-	-	-			
echo	0	0	0	0	0	0	-	-	-			
env	0	0	0	0	0	0	-	-	-			
expand	0	0	0	0	0	0	-	-	-			
expr	0	0	0	0	0	0	-	-	-			
factor	1	0	1	0	0	0	0.250	1.000	0.000			
false	0	0	0	0	0	0	-	-	-			
fmt	0	0	0	0	0	0	-	-	-			
fold	0	0	0	0	0	0	-	_	_			
groups	0	0	0	0	0	0	-	_	-			
head	0	0	0	0	0	0	-	_	_			
hostid	0	0	0	0	0	0	-	_	_			

Table 10: Varnode recovery (metatype = UNION) (compilation = stripped)

		The contribution of the property of the proper									
				.e/10	MAICE	RIAR	SET ALICANA A LICANA A MORE AND A	ED MATC	>		
			, che	d@lear	d@leat to	d@lexe rate	d@level Alic Inodes matched	plevel Mrs. Compare score	0,1		
	ound truth	amodes	rnodes mat	rhodes mat	rnodes mat	rnodes mai	rnodes mai	compare .or	I Patially indes fro		
	nd truth.	annilei ve	u angiler v	u angiler vi	u angilei v	di. Tipjler vo	n ale average	desfraction	destra		
	OUL	Deco.	Deco.	Deco.	Decor	Decor	Varing Va	itie 4	MINE		
id	0	0	0	0	0	0	-	-	-		
join	0	0	0	0	0	0	-	-	-		
kill	0	0	0	0	0	0	-	-	-		
link	0	0	0	0	0	0	-	-	-		
ln	0	0	0	0	0	0	-	-	-		
logname	0	0	0	0	0	0	-	-	-		
ls	0	0	0	0	0	0	-	-	-		
md5sum	0	0	0	0	0	0	-	-	-		
mkdir	0	0	0	0	0	0	-	-	-		
mkfifo	0	0	0	0	0	0	-	-	-		
mknod	0	0	0	0	0	0	-	-	-		
mktemp	0	0	0	0	0	0	-	-	-		
mv	1	0	0	0	1	0	0.750	1.000	0.000		
nice	0	0	0	0	0	0	-	-	-		
nl	0	0	0	0	0	0	-	-	-		
nohup	0	0	0	0	0	0	-	-	-		
nproc	0	0	0	0	0	0	-	-	-		
numfmt	0	0	0	0	0	0	-	-	-		

Table 10: Varnode recovery (metatype = UNION) (compilation = stripped)

			.2	@level 140?	ARIC WEI	A Changle 2018	SET ALICATION	eld MAICH		
	ad tuth	patrodes Decomplies was	nodes matche	Decomplies was	nodes hatche	ALAR Decomplies was	SET ALICANA ALICANA COMPANIES OF A STANDARD AND A STANDARD A STANDARD AND A STANDARD AND A STANDARD AND A STANDARD A STAND	Jewel With a January Landes Fraction	partially rev	
- Grai	<u> </u>	Deco,	Dero,	Derg, <	Dero,	Derg, 4	Vature Va	Title Val		
od	8	0	0	0	8	0	0.750	1.000	0.000	
paste	0	0	0	0	0	0	-	-	-	
pathchk	0	0	0	0	0	0	-	-	-	
pinky	0	0	0	0	0	0	-	-	-	
pr	0	0	0	0	0	0	-	-	-	
printenv	0	0	0	0	0	0	-	-	-	
printf	0	0	0	0	0	0	-	-	-	
ptx	1	0	1	0	0	0	0.250	1.000	0.000	
pwd	0	0	0	0	0	0	-	-	-	
readlink	0	0	0	0	0	0	-	-	-	
realpath	0	0	0	0	0	0	-	-	-	
rm	0	0	0	0	0	0	-	-	-	
rmdir	0	0	0	0	0	0	-	-	-	
runcon	0	0	0	0	0	0	-	-	-	
seq	0	0	0	0	0	0	-	-	-	
sha1sum	0	0	0	0	0	0	-	-	-	
sha224sum	0	0	0	0	0	0	-	-	-	
sha256sum	0	0	0	0	0	0	_	-	_	

Table 10: Varnode recovery (metatype = UNION) (compilation = stripped)

					<u> </u>				
Gravi	ad truth	vanodes Decompler vitu	odes mathed	@level NO M	ACULTANCE ONER	LAR (Bevelouble) @ levelouble tradition of the state of	ei level Allichi © level Alliched (© level Alliched (o level	ED MATCH	Dalially res
sha384sum	0	0	0	0	0	0		-	_
sha512sum	0	0	0	0	0	0	-	-	-
shred	0	0	0	0	0	0	-	-	-
shuf	0	0	0	0	0	0	-	-	-
sleep	0	0	0	0	0	0	-	-	-
sort	0	0	0	0	0	0	-	-	-
split	0	0	0	0	0	0	-	-	-
stat	0	0	0	0	0	0	-	-	-
stdbuf	0	0	0	0	0	0	-	-	-
stty	0	0	0	0	0	0	-	-	-
sum	0	0	0	0	0	0	-	-	-
sync	0	0	0	0	0	0	-	-	-
tac	0	0	0	0	0	0	-	-	-
tail	0	0	0	0	0	0	-	-	-
tee	0	0	0	0	0	0	-	-	-
test	0	0	0	0	0	0	-	-	-
timeout	0	0	0	0	0	0	-	-	-
touch	2	0	0	2	0	0	0.500	1.000	0.000

Table 10: Varnode recovery (metatype = UNION) (compilation = stripped)

		No.	Shadked	@level NO M	a level over	LAR Develocited One of the land of the lan	ET ALICO	WED WED THAT!	JA ElO,ll
							nodes average	@ level Mir.	on Par Varnodes fr
tr	0	0	0	0	0	0	-	-	-
true	0	0	0	0	0	0	-	-	-
truncate	0	0	0	0	0	0	-	-	-
tsort	0	0	0	0	0	0	-	-	-
tty	0	0	0	0	0	0	-	-	-
uname	0	0	0	0	0	0	-	-	-
unexpand	0	0	0	0	0	0	-	-	-
uniq	0	0	0	0	0	0	-	-	-
unlink	0	0	0	0	0	0	-	-	-
uptime	0	0	0	0	0	0	-	-	-
users	0	0	0	0	0	0	-	-	-
vdir	0	0	0	0	0	0	-	-	-
wc	0	0	0	0	0	0	-	-	-
who	0	0	0	0	0	0	-	-	-
whoami	0	0	0	0	0	0	-	-	-
yes	0	0	0	0	0	0	-	-	-

Table 11: Varnode recovery (compilation = standard)

			ned@level.	MATCH	Agandes mach	TH Songscore (0,1) Comparison score (0,1) Comparison score (0,1)			
		رجي ر	Jevel HC) (Jewello)	ir levelsti	s level Al	level MA	apatison so	rtiallyre
	Jund ruth 4"	athode asti	ned @	ned @	ned @	ed (W	zd [©]	contr	, Pai
ي د	Jund trut	athodes file	athodes file	andes ni	ornodes fir	rinodes file	athode and	inodesfile	inolesfit
——————————————————————————————————————			7.92	<u> </u>	7.92 7	· (65 ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	(or 7/0	70	
[266	1	18	5	128	114	0.816	0.996	0.429
b2sum	237	1		7	118				0.435
base32	160	2	6	2	82	68	0.825	0.988	0.425
base64	160	1	6	2	82	69	0.831	0.994	0.431
basename	129	1	6	2	77	43	0.800	0.992	0.333
basenc	219	5	8	2	106	98	0.824	0.977	0.447
cat	164	1	6	2	98	57	0.811	0.994	0.348
chcon	363	2	14	4	234	109	0.799	0.994	0.300
chgrp	339	2	11	5	204	117	0.812	0.994	0.345
chmod	347	3	12	7	211	114	0.803	0.991	0.329
chown	359	2	12	5	209	131	0.817	0.994	0.365
chroot	198	1	8	2	87	100	0.850	0.995	0.505
cksum	678	13	24	13	396	232	0.799	0.981	0.342
comm	171	1	11	3	103	53	0.787	0.994	0.310
ср	703	3	28	12	357	303	0.830	0.996	0.431
csplit	982	8	41	15	537	381	0.816	0.992	0.388
cut	192	1	7	2	117	65	0.810	0.995	0.339
date	747	4	38	26	387	292	0.810	0.995	0.391
dd 	493	4	18	9	250	212	0.829	0.992	0.430

Table 11: Varnode recovery (compilation = standard)

			ned@level.W	MCH	Field Revel SU	Ś	red@level.MASi red@level.MASi naturate average 0.854	Agricult Lege comparison score 10,11 Lege comparison partially for the c		
			140	Jyn, Joh	ibri Isti	BSE A	ICITY I MAI	Cr,	Sie i	
	Jund truth was	odes	1@1ever	1@Jeyer	2@Jexer	a@lever	2 @ JENE1	Onpais	Dartially	
	ruth var	ile mati	ned match	ned match	net match	geld	eu averiage	Fraction	Stack	
cá ^c	ound it.	atholes	lathodes ,	lathodes ,	latnodes (athodes ,	athode a	indes 1	inoles	
			20		207	221	0.054	0.000		
df	640								0.502	
dir	1031	3	52	13	560	403	0.817	0.997	0.391	
dircolors	190	2	6	2	115	65	0.809	0.989	0.342	
dirname	125	1	6	2	74	42	0.800	0.992	0.336	
du	1499	10	54	28	835	572	0.818	0.993	0.382	
echo	118	1	6	2	71	38	0.794	0.992	0.322	
env	201	2	11	3	102	83	0.815	0.990	0.413	
expand	152	1	7	2	90	52	0.804	0.993	0.342	
expr	911	8	37	25	492	349	0.812	0.991	0.383	
factor	511	23	24	22	191	251	0.805	0.955	0.491	
false	109	1	6	2	66	34	0.789	0.991	0.312	
fmt	186	1	6	2	110	67	0.817	0.995	0.360	
fold	143	1	7	2	78	55	0.813	0.993	0.385	
groups	142	1	6	2	80	53	0.813	0.993	0.373	
head	215	1	13	2	116	83	0.810	0.995	0.386	
hostid	118	1	6	4	72	35	0.784	0.992	0.297	
id	196	1	7	2	102	84	0.833	0.995	0.429	
join	260	1	8	3	151	97	0.822	0.996	0.373	
kill	148	3	8	2	79	56	0.799	0.980	0.378	

Table 11: Varnode recovery (compilation = standard)

			hed level No.	MATCH	OLAR	TED .	Devel MATCH (a) Level MATCH (a) Level MATCH (b) Level MATCH (c) Level MATCH (d) Level MATCH Les fraction partially (d) Level MATCH Les fraction partially (e) L		
			a el AC) ja mel On	ith avelous	33 weldi	ic. avel MAI	atison scr	is Alls.
	Jund truth vist	noles	ned ex	jed@je	reg s	ed@16	20 E	compide idos	1 Partiu
	nd truth	alesman	ades mail	ades mate	ales mate	ades mate	ade averare	adestract	ades frac
Cit	Jili V	atric	Vatric S	Varino 4	Varino 4	atric 4	atric 48	stric 48	inic
link	117	1	6	4	71	35	0.784	0.991	0.299
ln	433	2	12	7	233	179	0.832	0.995	0.413
logname	118	1	6	4	72	35	0.784	0.992	0.297
ls	1031	3	52	13	560	403	0.817	0.997	0.391
md5sum	217	2	12	2	120	81	0.806	0.991	0.373
mkdir	306	2	12	6	149	137	0.833	0.993	0.448
mkfifo	148	2	7	2	86	51	0.799	0.986	0.345
mknod	165	2	7	2	89	65	0.815	0.988	0.394
mktemp	164	2	6	2	94	60	0.811	0.988	0.366
mv	773	4	30	12	433	294	0.818	0.995	0.380
nice	130	1	6	2	73	48	0.810	0.992	0.369
nl	896	11	36	15	476	358	0.816	0.988	0.400
nohup	162	1	7	4	105	45	0.787	0.994	0.278
nproc	139	1	6	2	77	53	0.815	0.993	0.381
numfmt	291	1	12	3	142	133	0.838	0.997	0.457
od	459	2	20	7	209	221	0.842	0.996	0.481
paste	142	1	6	2	85	48	0.805	0.993	0.338
pathchk	141	1	6	2	88	44	0.798	0.993	0.312
pinky	182	1	11	2	110	58	0.793	0.995	0.319

Table 11: Varnode recovery (compilation = standard)

			ned@level. No.	SCH	ipel. AR level SUR	Á	THED HATT	<u> </u>	(1,0)
			. 40	My ON	ipli sup	SE, AI	AMIC MAIN	TH Section of the sec	نۍ نۍ
	nd truth vari	ales	@lexel,	. @ level	@level.	@level,	@level	MRaitsU	cartially r
	n var	io. Valig	ned natch	id natch	ed natche	d matche	d etage	craction	eracij ⁽
gi	ind tru	nodesti	modesti	rnodestr	modesti	modestr	mode an	nodestr	nodestr
- Cite	73		7.91 1		$\frac{1}{\sqrt{2}}$		7.9	7.9	
pr	543	2	16	8	332	185	0.814	0.996	0.341
printenv	119	1	6	2	68	42	0.803	0.992	0.353
printf	283	1	17	7	136	122	0.819	0.996	0.431
ptx	1126	8	44	28	590	456	0.820	0.993	0.405
pwd	143	1	6	3	87	46	0.799	0.993	0.322
readlink	243	1	9	5	137	91	0.817	0.996	0.374
realpath	248	1	8	5	138	96	0.823	0.996	0.387
rm	362	2	10	5	222	123	0.814	0.994	0.340
rmdir	234	1	8	5	115	105	0.837	0.996	0.449
runcon	121	1	6	2	75	37	0.791	0.992	0.306
seq	279	1	20	6	128	124	0.817	0.996	0.444
sha1sum	215	2	9	3	116	85	0.817	0.991	0.395
sha224sum	225	2	12	3	119	89	0.812	0.991	0.396
sha256sum	225	2	12	3	119	89	0.812	0.991	0.396
sha384sum	381	3	7	3	278	90	0.792	0.992	0.236
sha512sum	381	3	7	3	278	90	0.792	0.992	0.236
shred	370	2	18	2	203	145	0.818	0.995	0.392
shuf	374	1	7	3	218	145	0.834	0.997	0.388
sleep	143	1	8	4	80	50	0.797	0.993	0.350

Table 11: Varnode recovery (compilation = standard)

			,el 70.	MAICH iel OVE	RIAR iels US	SET 181 ALIE	JAED MAIC	ji jedne scar	119 rec
ÇÇ	Jud Hull Vari	nodes match	ed@level. NO.	de le de la	PLAR SUBSIDE S	@les mathed	Mill MAIC	Andes fraction f	patian
sort	847	7	34	12	467	327	0.817	0.992	0.386
split	297	2	12	2	159	122	0.826	0.993	0.411
stat	608	5	21	14	321	247	0.822	0.992	0.406
stdbuf	267	1	8	6	128	124	0.843	0.996	0.464
stty	301	1	13	5	138	144	0.841	0.997	0.478
sum	278	2	12	2	140	122	0.831	0.993	0.439
sync	133	1	7	2	81	42	0.793	0.992	0.316
tac	920	8	37	15	505	355	0.816	0.991	0.386
tail	423	1	18	5	220	179	0.830	0.998	0.423
tee	154	1	8	2	93	50	0.797	0.994	0.325
test	260	0	17	4	128	111	0.820	1.000	0.427
timeout	175	2	9	2	89	73	0.817	0.989	0.417
touch	602	3	33	25	305	236	0.806	0.995	0.392
tr	241	1	8	3	117	112	0.843	0.996	0.465
true	109	1	6	2	66	34	0.789	0.991	0.312
truncate	145	1	6	2	83	53	0.812	0.993	0.366
tsort	162	1	9	4	96	52	0.792	0.994	0.321
tty	114	1	6	2	69	36	0.792	0.991	0.316
uname	120	2	6	2	71	39	0.790	0.983	0.325

Table 11: Varnode recovery (compilation = standard)

	ind truth variety	odes mach	THED MAIC	Andrew Fraction F	ell'il patially rect				
unexpand	158	1	6	2	92	57	0.813	0.994	0.361
uniq unlink	202117	1	9 6	2	115 71	75 35	0.814 0.784	0.995 0.991	0.371 0.299
uptime users	353 133	1	11 6	10 4	218 81	113 41	0.805 0.791	0.997 0.992	0.320
vdir wc	1031 268	3	52 7	13 5	560153	403 102	0.817 0.825	0.997 0.996	0.391 0.381
who whoami	282 120	1	9 6	5 4	144 74	123 35	0.836 0.783	0.996 0.992	0.436
yes	132	1	6	4	80	41	0.792	0.992	0.311

Table 12: Varnode recovery (metatype = INT) (compilation = standard)

		andes prodes translate wandes trached pecontainer wandes trached pecontainer wandes trached are are face contrainer wandes. The contrainer wandes trached pecontainer wandes trached are are face contrainer wandes.								
	round truth vo	peophitier v	Decompiler ve	Decompiler va	Decompiler with	nodes peconopiler val	nodes	rodes fraction	I Partially is	
[157	0	0	0	83	74	0.868	1.000	0.471	
b2sum	147	0	0	0	80	67	0.864	1.000	0.456	
base32	96	0	0	0	51	45	0.867	1.000	0.469	
base64	96	0	0	0	51	45	0.867	1.000	0.469	
basenam	e 71	0	0	0	47	24	0.835	1.000	0.338	
basenc	133	0	1	0	70	62	0.863	1.000	0.466	
cat	101	0	0	0	64	37	0.842	1.000	0.366	
chcon	185	0	0	0	124	61	0.832	1.000	0.330	
chgrp	166	0	0	0	102	64	0.846	1.000	0.386	
chmod	176	0	0	0	110	66	0.844	1.000	0.375	
chown	176	0	0	0	103	73	0.854	1.000	0.415	
chroot	110	0	1	0	53	56	0.873	1.000	0.509	
cksum	488	2	0	0	329	157	0.827	0.996	0.322	
comm	104	0	0	0	74	30	0.822	1.000	0.288	
ср	382	0	1	0	208	173	0.862	1.000	0.453	
csplit	619	0	1	0	325	293	0.868	1.000	0.473	
cut	124	0	0	0	81	43	0.837	1.000	0.347	

Table 12: Varnode recovery (metatype = INT) (compilation = standard)

					A.				
	∆?i	rrade ⁵	modes matched	@ level HO	MATCH AMARCHA OVER	LAR @levelsUBS	ET ALICANO DE LA COMPANIO DE LA COMPANIO DE STATEMENTO DE	ED MATCH	A O.11 Partially rec
Cu ^c	Jund Huth vo	Jecompiler v	Decompiler ve	Decompiler	Decompiler vic	pecolingiles via	vatuode averace	inodes fract	indes tract
date	516	0	10	0	321	185	0.830	1.000	0.359
dd	332	0	0	0	187	145	0.859	1.000	0.437
df	326	0	0	0	158	168	0.879	1.000	0.515
dir	615	0	3	0	368	244	0.847	1.000	0.397
dircolors	90	0	0	0	58	32	0.839	1.000	0.356
dirname	73	0	0	0	47	26	0.839	1.000	0.356
du	931	0	3	0	522	406	0.857	1.000	0.436
echo	69	0	0	0	45	24	0.837	1.000	0.348
env	112	0	0	0	61	51	0.864	1.000	0.455
expand	94	0	0	0	59	35	0.843	1.000	0.372
expr	560	0	1	0	286	273	0.871	1.000	0.487
factor	343	21	2	0	128	192	0.841	0.939	0.560
false	62	0	0	0	40	22	0.839	1.000	0.355
fmt	112	0	0	0	72	40	0.839	1.000	0.357
fold	88	0	0	0	51	37	0.855	1.000	0.420
groups	81	0	0	0	51	30	0.843	1.000	0.370
head	138	0	0	0	82	56	0.851	1.000	0.406
hostid	67	0	0	0	45	22	0.832	1.000	0.328

Table 12: Varnode recovery (metatype = INT) (compilation = standard)

					JCH.	N2	<u> </u>	iD 1	
				d@level.HO?	Majerial Over	Jr sylk	eit Alteria	MATCY	<i>Ş</i> *
				@ Jevel,	@ level C	@ Jevel s	a level,	pleasily.	(1,0)
			atche	de atche	de atched	atched	atched	e scare	11470
		nodes	odes mic	odes mic	odes mic	odes mic	odes nic	compai	Patiar
	ruth vo	i. ilei ^{vi}	dili Jet v	ili 18148	iti ilet vat	i. ∶ોદાં √ર્યો	it average	s fractio	frack
ĊŚ	and hull va	ecompi	Seconipi.	Seconity.	Gecompl.	recountry.	@level Alt.	plevel MA core control of the contro	inodes
id	112	0	0	0	69	43	0.846	1.000	0.384
join	162	0	0	0	104	58	0.840	1.000	0.358
kill	88	0	0	0	52	36	0.852	1.000	0.409
link	66	0	0	0	44	22	0.833	1.000	0.333
ln	219	0	0	0	125	94	0.857	1.000	0.429
logname	66	0	0	0	44	22	0.833	1.000	0.333
ls	615	0	3	0	368	244	0.847	1.000	0.397
md5sum	139	0	0	0	81	58	0.854	1.000	0.417
mkdir	196	0	0	0	102	94	0.870	1.000	0.480
mkfifo	88	0	0	0	53	35	0.849	1.000	0.398
mknod	100	0	0	0	54	46	0.865	1.000	0.460
mktemp	96	0	0	0	60	36	0.844	1.000	0.375
mv	428	0	0	0	241	187	0.859	1.000	0.437
nice	77	0	0	0	47	30	0.847	1.000	0.390
nl	558	0	1	0	288	269	0.870	1.000	0.482
nohup	99	0	0	0	71	28	0.821	1.000	0.283
nproc	86	0	0	0	51	35	0.852	1.000	0.407
numfmt	184	0	0	0	98	86	0.867	1.000	0.467

Table 12: Varnode recovery (metatype = INT) (compilation = standard)

	Je De	gales via	modes matched	@ level NO.	Marchi Me level Owliked Occompiler ward Decompiler ward	AR Perel SUBSE	o level Allowing of the state o	D Devel MARCH	patially recoving pation
<u>- </u>	Jan De	con.		Decour.	Decour. De				
od	294 85	0	1	0	146 55	147 30	0.873 0.838	1.000 1.000	0.500 0.353
paste	85	0	0	0	55 57	28	0.838	1.000	0.333
pathchk			0	0					
pinky	96	0			65	31	0.831	1.000	0.323
pr · .	399	0	1	0	262	136	0.834	1.000	0.341
printenv	68	0	0	0	42	26	0.846	1.000	0.382
printf	168	0	2	0	85	81	0.865	1.000	0.482
ptx	673	0	1	0	347	325	0.870	1.000	0.483
pwd	75	0	0	0	50	25	0.833	1.000	0.333
readlink	111	0	0	0	69	42	0.845	1.000	0.378
realpath	111	0	0	0	65	46	0.854	1.000	0.414
rm	185	0	0	0	115	70	0.845	1.000	0.378
rmdir	139	0	0	0	73	66	0.869	1.000	0.475
runcon	65	0	0	0	42	23	0.838	1.000	0.354
seq	156	0	0	0	81	75	0.870	1.000	0.481
sha1sum	138	0	0	0	78	60	0.859	1.000	0.435
sha224sum	145	0	0	0	80	65	0.862	1.000	0.448
sha256sum	145	0	0	0	80	65	0.862	1.000	0.448

Table 12: Varnode recovery (metatype = INT) (compilation = standard)

				Δ.						
Gran	d truth vathe	des Indiler	vanodes matched @	Jewel WO State Read Read Read Read Read Read Read Rea	Marchi. Reveal Over Red. R. Recomplier wathout Decomplier wathout Decomplier was not been as a second of the secon	Revel SUBSE	Jewel Alltradie	Devel Marich Surpare score In Surpare score In	and spatially recovery	
sha384sum	301	0	0	0	236	65	0.804	1.000	0.216	
sha512sum	301	0	0	0	236	65	0.804	1.000	0.216	
shred	238	0	0	0	140	98	0.853	1.000	0.412	
shuf	210	0	0	0	129	81	0.846	1.000	0.386	
sleep	76	0	0	0	49	27	0.839	1.000	0.355	
sort	440	0	0	0	260	180	0.852	1.000	0.409	
split	195	0	0	0	109	86	0.860	1.000	0.441	
stat	392	0	1	0	237	154	0.847	1.000	0.393	
stdbuf	156	0	0	0	80	76	0.872	1.000	0.487	
stty	189	0	1	0	89	99	0.878	1.000	0.524	
sum	183	0	0	0	99	84	0.865	1.000	0.459	
sync	83	0	0	0	54	29	0.837	1.000	0.349	
tac	584	0	1	0	310	273	0.866	1.000	0.467	
tail	239	0	0	0	141	98	0.853	1.000	0.410	
tee	95	0	0	0	62	33	0.837	1.000	0.347	
test	155	0	0	0	83	72	0.866	1.000	0.465	
timeout	95	0	0	0	55	40	0.855	1.000	0.421	
touch	396	0	9	0	244	143	0.829	1.000	0.361	

Table 12: Varnode recovery (metatype = INT) (compilation = standard)

				<u> </u>							
			₩	es partiet variodes materied a level partiet variodes materied a level partiet variodes materied average compare score (0,1). Decompiler variodes materied a percentile variodes materied average compare score (0,1). Decompiler variodes materied average compiler variodes materied average compare score (0,1). Decompiler variodes materied average compiler variodes materied average compare stration materials.							
_	Groun	d truth varie	ongileri	Decomplet with	compiler var	Decompiler without	ongilet varus	inode average co	des fraction f	and specification of the second of the secon	
tr		153	0	0	0	70	83	0.886	1.000	0.542	
true		62	0	0	0	40	22	0.839	1.000	0.355	
trunca	ite	91	0	0	0	55	36	0.849	1.000	0.396	
tsort		85	0	0	0	55	30	0.838	1.000	0.353	
tty		65	0	0	0	43	22	0.835	1.000	0.338	
uname	e	67	0	0	0	43	24	0.840	1.000	0.358	
unexp	and	101	0	0	0	61	40	0.849	1.000	0.396	
uniq		125	0	0	0	79	46	0.842	1.000	0.368	
unlink		66	0	0	0	44	22	0.833	1.000	0.333	
uptim	e	261	0	1	0	174	86	0.830	1.000	0.330	
users		73	0	0	0	47	26	0.839	1.000	0.356	
vdir		615	0	3	0	368	244	0.847	1.000	0.397	
wc		148	0	0	0	90	58	0.848	1.000	0.392	
who		158	0	0	0	90	68	0.858	1.000	0.430	
whoai	ni	68	0	0	0	46	22	0.831	1.000	0.324	
yes		76	0	0	0	50	26	0.836	1.000	0.342	

Table 13: Varnode recovery (metatype = FLOAT) (compilation = standard)

	Tround truth war nodes transled to be read t										
 	ound truth	Decompiler	Decompiler "	Decompiler	Decompiler	Decompiler	Varnode avert	indes frac	undes frac		
[2	0	1	0	1	0	0.500	1.000	0.000		
b2sum	0	0	0	0	0	0	-	-	-		
base32	0	0	0	0	0	0	-	-	-		
base64	0	0	0	0	0	0	-	-	-		
basename	0	0	0	0	0	0	-	-	-		
basenc	0	0	0	0	0	0	-	-	-		
cat	0	0	0	0	0	0	-	-	-		
chcon	3	0	0	0	3	0	0.750	1.000	0.000		
chgrp	3	0	0	0	3	0	0.750	1.000	0.000		
chmod	3	0	0	0	3	0	0.750	1.000	0.000		
chown	3	0	0	0	3	0	0.750	1.000	0.000		
chroot	0	0	0	0	0	0	-	-	-		
cksum	3	0	2	0	1	0	0.417	1.000	0.000		
comm	0	0	0	0	0	0	-	-	-		
cp	3	0	0	0	3	0	0.750	1.000	0.000		
csplit	0	0	0	0	0	0	-	-	-		
cut	0	0	0	0	0	0	-	-	-		

Table 13: Varnode recovery (metatype = FLOAT) (compilation = standard)

				0	MATCH	PIN B	zer rez	ÉD STO	>
	sand tradi	Jecompiler va	nodes match	ed @ level AO atrodes tratche	MATCH Ad @ level Over Inddes matche	d@level 30li	Seft Allicasion of the Allicas	Devel MA.	O.I. Patially ref
date	2	0	1	0	1	0	0.500	1.000	0.000
dd	7	0	3	0	4	0	0.536	1.000	0.000
df	13	0	3	0	5	5	0.731	1.000	0.385
dir	6	0	2	0	4	0	0.583	1.000	0.000
dircolors	0	0	0	0	0	0	-	-	-
dirname	0	0	0	0	0	0	-	-	-
du	6	0	2	0	4	0	0.583	1.000	0.000
echo	0	0	0	0	0	0	-	-	-
env	0	0	0	0	0	0	-	-	-
expand	0	0	0	0	0	0	-	-	-
expr	0	0	0	0	0	0	-	-	-
factor	0	0	0	0	0	0	-	-	-
false	0	0	0	0	0	0	-	-	-
fmt	0	0	0	0	0	0	-	-	-
fold	0	0	0	0	0	0	-	-	-
groups	0	0	0	0	0	0	-	-	-
head	0	0	0	0	0	0	-	-	-
hostid	0	0	0	0	0	0	-	-	-

Table 13: Varnode recovery (metatype = FLOAT) (compilation = standard)

	Α.										
ÇĞ	ound truth	Vallode's Decompiler v	hindes hatche	d@level. HO.	MATCH d@levelOVE Inddes matche	RLAY Decompletes Decompletes	SET ALICE AND	ED level MATC	A (O.1) A Partially for the strategy of the st		
id	0	0	0	0	0	0	-	-	_		
join	0	0	0	0	0	0	-	-	-		
kill	0	0	0	0	0	0	-	-	-		
link	0	0	0	0	0	0	-	-	-		
ln	3	0	0	0	3	0	0.750	1.000	0.000		
logname	0	0	0	0	0	0	-	-	-		
ls	6	0	2	0	4	0	0.583	1.000	0.000		
md5sum	0	0	0	0	0	0	-	-	-		
mkdir	2	0	1	0	1	0	0.500	1.000	0.000		
mkfifo	0	0	0	0	0	0	-	-	-		
mknod	0	0	0	0	0	0	-	-	-		
mktemp	0	0	0	0	0	0	-	-	-		
mv	3	0	0	0	3	0	0.750	1.000	0.000		
nice	0	0	0	0	0	0	-	-	-		
nl	0	0	0	0	0	0	-	-	-		
nohup	0	0	0	0	0	0	-	-	-		
nproc	0	0	0	0	0	0	-	-	-		
numfmt	7	0	5	0	2	0	0.393	1.000	0.000		

Table 13: Varnode recovery (metatype = FLOAT) (compilation = standard)

Groi	ind truth v	arnodes	nodes matched	@ level NO?	Marchi. @ level Owlift modes matched	ALAR Decomplies was	SET ALICANA J. @ Level ALICANA J. amodes matched @ Varnode average C. Varnode average C.	Parel March	Patialy reco
od	11	0	3	0	8	0	0.614	1.000	0.000
paste	0	0	0	0	0	0	-	-	-
pathchk	0	0	0	0	0	0	-	-	-
pinky	0	0	0	0	0	0	-	-	-
pr	0	0	0	0	0	0	-	-	-
printenv	0	0	0	0	0	0	-	-	-
printf	7	0	5	0	2	0	0.393	1.000	0.000
ptx	0	0	0	0	0	0	-	-	-
pwd	0	0	0	0	0	0	-	-	-
readlink	3	0	0	0	3	0	0.750	1.000	0.000
realpath	3	0	0	0	3	0	0.750	1.000	0.000
rm	3	0	0	0	3	0	0.750	1.000	0.000
rmdir	2	0	1	0	1	0	0.500	1.000	0.000
runcon	0	0	0	0	0	0	-	-	-
seq	10	0	9	0	1	0	0.300	1.000	0.000
sha1sum	0	0	0	0	0	0	-	-	-
sha224sum	0	0	0	0	0	0	-	-	-
sha256sum	0	0	0	0	0	0	_	_	_

Table 13: Varnode recovery (metatype = FLOAT) (compilation = standard)

Gran	d truth varied	ges Ingilet varnod	es matched @ \ Indited wathout	evel NO Mark	TH THE THE THE THE THE THE THE THE THE T	Republication of the state of t	evel Aller Election of the State of the Stat	Pare MARCH Inpare score 10	Attally reco
sha384sum	0	0	0	0	0	0	-	-	-
sha512sum	0	0	0	0	0	0	-	-	-
shred	3	0	2	0	1	0	0.417	1.000	0.000
shuf	3	0	0	0	3	0	0.750	1.000	0.000
sleep	7	0	0	0	2	5	0.929	1.000	0.714
sort	18	0	4	0	12	2	0.667	1.000	0.111
split	0	0	0	0	0	0	-	-	-
stat	2	0	1	0	1	0	0.500	1.000	0.000
stdbuf	2	0	1	0	1	0	0.500	1.000	0.000
stty	2	0	1	0	1	0	0.500	1.000	0.000
sum	3	0	2	0	1	0	0.417	1.000	0.000
sync	0	0	0	0	0	0	-	-	-
tac	0	0	0	0	0	0	-	-	-
tail	11	0	0	0	6	5	0.864	1.000	0.455
tee	0	0	0	0	0	0	-	-	-
test	2	0	1	0	1	0	0.500	1.000	0.000
timeout	8	0	0	0	4	4	0.875	1.000	0.500
touch	2	0	1	0	1	0	0.500	1.000	0.000

Table 13: Varnode recovery (metatype = FLOAT) (compilation = standard)

			naiched	@ level NO M	AND MARICHA DECOMPRIENT TO COMPRIENT WARRINGS TRACTED & VARRINGS TRACTED WARRINGS TO THE WARR						
					gades r. Secondiler var		attode average co	ndes fraction f	J.I.I. patially franchistically franchisticall		
tr	0	0	0	0	0	0	-	-	-		
true	0	0	0	0	0	0	-	-	-		
truncate	0	0	0	0	0	0	-	-	-		
tsort	0	0	0	0	0	0	-	-	-		
tty	0	0	0	0	0	0	-	-	-		
uname	0	0	0	0	0	0	-	-	-		
unexpan	d 0	0	0	0	0	0	-	-	-		
uniq	0	0	0	0	0	0	-	-	-		
unlink	0	0	0	0	0	0	-	-	-		
uptime	2	0	0	0	1	1	0.875	1.000	0.50		
users	0	0	0	0	0	0	-	-	-		
vdir	6	0	2	0	4	0	0.583	1.000	0.00		
wc	4	0	0	0	4	0	0.750	1.000	0.00		
who	2	0	1	0	1	0	0.500	1.000	0.00		
whoami	0	0	0	0	0	0	-	-	-		
yes	0	0	0	0	0	0	-	-	-		

Table 14: Varnode recovery (metatype = POINTER) (compilation = standard)

					7CH	R	^		
				40.	MAIL	JA 18	sei Ja r	is said	>
				Decompiler vo	MATCH AMATCH ON EN	revelse	SEI ALICANIA. ORIO DE SEI DE SEI ALICANIA DE S	Plevel MAR.	(Lo
			36	zd () ne	d [®] ' nei	. wei	o ned	e core	<i>`</i> ⊘"
		Xe S	125 Mater	125 Malcr	125 Males	125 Mater	125 mater	Mares	artially
	×.	Vatriot , Va	thode . 4	athode . 48	ithode wat	node va	Hode Hage	io, actios	Datially i
	and trutt	ampiler	anpiler	annilei	anpilet	ampilet	ode aver	odestru	odestru
Cic	and fruit	Degr 4	Decr	Deco	Deco <	Deco 4	Varine Va	48	itile
[68	0	0	0	38	30	0.860	1.000	0.44
b2sum	56	0	0	0	32	24	0.857	1.000	0.429
base32	41	0	0	0	24	17	0.854	1.000	0.415
base64	41	0	0	0	24	17	0.854	1.000	0.415
basename	38	0	0	0	24	14	0.842	1.000	0.368
basenc	55	0	0	0	30	25	0.864	1.000	0.455
cat	41	0	0	0	28	13	0.829	1.000	0.317
chcon	134	1	0	0	93	40	0.819	0.993	0.299
chgrp	133	1	0	0	90	42	0.823	0.992	0.316
chmod	127	1	0	0	89	37	0.817	0.992	0.291
chown	142	1	0	0	94	47	0.827	0.993	0.331
chroot	67	0	0	0	28	39	0.896	1.000	0.582
cksum	99	0	0	0	56	43	0.859	1.000	0.434
comm	35	0	0	0	22	13	0.843	1.000	0.371
cp	231	0	0	0	132	99	0.857	1.000	0.429
csplit	272	6	0	0	202	64	0.792	0.978	0.235
cut	46	0	0	0	29	17	0.842	1.000	0.370

Table 14: Varnode recovery (metatype = POINTER) (compilation = standard)

				•	MAICH D	JAR es	ir a	ED CY	<u> </u>
ÇŞ	Jund truth	athodes	inodes hatche	d@level.HO?	Matchi de level Over	@level 51185 @level 51185	e level Allication of the land	Jevel MATC	O.11 Partially res
date	125	0	0	0	57	68	0.886	1.000	0.544
dd	98	0	0	0	50	48	0.872	1.000	0.490
df	239	0	0	0	110	129	0.885	1.000	0.540
dir	293	0	0	0	173	120	0.852	1.000	0.410
dircolors	76	0	0	0	50	26	0.836	1.000	0.342
dirname	32	0	0	0	21	11	0.836	1.000	0.344
du	438	7	0	0	296	135	0.815	0.984	0.308
echo	30	0	0	0	20	10	0.833	1.000	0.333
env	54	0	0	0	32	22	0.852	1.000	0.407
expand	35	0	0	0	25	10	0.821	1.000	0.286
expr	259	6	0	0	197	56	0.787	0.977	0.216
factor	98	1	0	0	57	40	0.844	0.990	0.408
false	28	0	0	0	20	8	0.821	1.000	0.286
fmt	52	0	0	0	32	20	0.846	1.000	0.385
fold	33	0	0	0	21	12	0.841	1.000	0.364
groups	40	0	0	0	23	17	0.856	1.000	0.425
head	47	0	0	0	28	19	0.851	1.000	0.404
hostid	29	0	0	0	21	8	0.819	1.000	0.276

Table 14: Varnode recovery (metatype = POINTER) (compilation = standard)

					C.	0		2	
				d@level.HO.	MATCH OVER	JAI BE	eft Alteria	il sici	>
				avel AO	, well on ,	algus,	Wel Ali	avel Mr.	S
				1 [®] / ₆	6° 50	. ° 's	@ ₁₆	gill sore	0,1
		جي.	natchi	matche	matche	natche	matche	anate sco	rtially to
	~ 19	athode	indes	indes	inoles	nodes ar	nodes	conn	i Palit
	A truth "	adiler	apiler	apiler	apilerva	apilervu	ae aderious	aes fract	3es Fraci
CS	and hull v	Decours	Deconity	Decour	Deconiii <	Decours	@level Alti nodes matched	plevel MA core confidence of the confidence of t	inou
id	60	0	0	0	27	33	0.887	1.000	0.550
	66	0	0	0	38	28	0.856		0.330
join								1.000	
kill	36	0	0	0	21	15	0.854	1.000	0.417
link	29	0	0	0	21	8	0.819	1.000	0.276
ln	161	0	0	0	95	66	0.852	1.000	0.410
logname	30	0	0	0	22	8	0.817	1.000	0.267
ls	293	0	0	0	173	120	0.852	1.000	0.410
md5sum	50	0	0	0	33	17	0.835	1.000	0.340
mkdir	71	0	0	0	39	32	0.863	1.000	0.451
mkfifo	36	0	0	0	27	9	0.812	1.000	0.250
mknod	41	0	0	0	29	12	0.823	1.000	0.293
mktemp	44	0	0	0	28	16	0.841	1.000	0.364
mv	254	1	0	0	174	79	0.825	0.996	0.311
nice	33	0	0	0	20	13	0.848	1.000	0.394
nl	247	6	0	0	174	67	0.800	0.976	0.271
nohup	40	0	0	0	28	12	0.825	1.000	0.300
nproc	32	0	0	0	20	12	0.844	1.000	0.375
numfmt	70	0	0	0	36	34	0.871	1.000	0.486
	70	<u> </u>	U	<u> </u>	<i></i>	J 4	0.0/1	1.000	U.46U

Table 14: Varnode recovery (metatype = POINTER) (compilation = standard)

			ntihed	@ level MO?	Marcha Ovieti	LAR level stilless	e level Aliched @	D MAICH).]]].]]
Groi	ind truth ve	inodes Jeconpilet val	nodes für	nodes file.	nodes nu vand	ades für vari	@ level Ali	level Mix one for the foliation of the f	patita. padės fractici
od	93	0	0	0	40	53	0.892	1.000	0.570
paste	37	0	0	0	24	13	0.838	1.000	0.351
pathchk	33	0	0	0	23	10	0.826	1.000	0.303
pinky	57	0	0	0	38	19	0.833	1.000	0.333
pr	102	0	0	0	63	39	0.846	1.000	0.382
printenv	31	0	0	0	20	11	0.839	1.000	0.355
printf	76	0	2	0	40	34	0.849	1.000	0.447
ptx	331	6	0	0	219	106	0.816	0.982	0.320
pwd	41	0	0	0	30	11	0.817	1.000	0.268
readlink	100	0	0	0	57	43	0.858	1.000	0.430
realpath	105	0	0	0	62	43	0.852	1.000	0.410
rm	136	1	0	0	95	40	0.818	0.993	0.294
rmdir	66	0	0	0	35	31	0.867	1.000	0.470
runcon	36	0	0	0	27	9	0.812	1.000	0.250
seq	81	0	1	0	39	41	0.870	1.000	0.506
sha1sum	49	0	0	0	32	17	0.837	1.000	0.347
sha224sum	50	0	0	0	33	17	0.835	1.000	0.340
sha256sum	50	0	0	0	33	17	0.835	1.000	0.340

Table 14: Varnode recovery (metatype = POINTER) (compilation = standard)

					<u> </u>					
Grad	d truth wather	des Intipiler	patrodes traticised @	level NO.	MATCH WELL AND CONTROL OF THE PROPERTY OF THE	AR Level SUBSE	A level All Graff	D Revel MATCH Interest score of the Station of the	atially recov	
sha384sum	50	0	0	0	33	17	0.835	1.000	0.340	
sha512sum	50	0	0	0	33	17	0.835	1.000	0.340	
shred	87	0	0	0	55	32	0.842	1.000	0.368	
shuf	134	0	0	0	78	56	0.854	1.000	0.418	
sleep	35	0	0	0	23	12	0.836	1.000	0.343	
sort	299	0	0	0	181	118	0.849	1.000	0.395	
split	69	0	0	0	41	28	0.851	1.000	0.406	
stat	150	0	0	0	74	76	0.877	1.000	0.507	
stdbuf	79	0	0	0	40	39	0.873	1.000	0.494	
stty	73	0	0	0	39	34	0.866	1.000	0.466	
sum	60	0	0	0	33	27	0.863	1.000	0.450	
sync	29	0	0	0	21	8	0.819	1.000	0.276	
tac	250	6	0	0	184	60	0.792	0.976	0.240	
tail	124	0	1	0	65	58	0.863	1.000	0.468	
tee	35	0	0	0	25	10	0.821	1.000	0.286	
test	67	0	0	0	38	29	0.858	1.000	0.433	
timeout	41	0	0	0	23	18	0.860	1.000	0.439	
touch	110	0	0	0	53	57	0.880	1.000	0.518	

Table 14: Varnode recovery (metatype = POINTER) (compilation = standard)

truncate 32 0 0 0 0 22 10 0.828 1.000 0.3 tsort 52 0 0 0 0 35 17 0.832 1.000 0.3 tty 29 0 0 0 0 20 9 0.828 1.000 0.3 uname 30 0 0 0 22 8 0.817 1.000 0.3 uniq 50 0 0 0 21 8 0.819 1.000 0.4 unlink 29 0 0 0 0 21 8 0.819 1.000 0.3 users 38 0 0 0 0 28 10 0.838 1.000 0.3 users 38 0 0 0 0 28 10 0.816 1.000 0.3 vdir 293 0 0 0 0 173 120 0.852 1.000 0.4 wc 84 0 0 0 0 52 32 0.845 1.000 0.3 who 83 0 0 0 0 44 39 0.867 1.000 0.4 whoami 30 0 0 0 0 22 8 0.817 1.000 0.4 whoami 30 0 0 0 0 0 22 8 0.817 1.000 0.4 whoami 30 0 0 0 0 0 0 0 0 0 0.2 0.817 1.000 0.4 whoami 30 0 0 0 0 0 0 0 0 0.2 0.817 1.000 0.4 0.4 0.816 1.000 0.3 0.3 0.817 1.000 0.4 0.4 0.816 1.000 0.3 0.3 0.817 1.000 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3										
true 58 0 0 0 0 39 19 0.832 1.000 0.3 true 28 0 0 0 0 20 8 0.821 1.000 0.2 truncate 32 0 0 0 0 22 10 0.828 1.000 0.3 tsort 52 0 0 0 0 35 17 0.832 1.000 0.3 tty 29 0 0 0 0 20 9 0.828 1.000 0.3 uname 30 0 0 0 22 8 0.817 1.000 0.3 uniq 50 0 0 0 25 11 0.826 1.000 0.3 unliq 50 0 0 0 21 8 0.819 1.000 0.4 unlink 29 0 0 0 0 21 8 0.819 1.000 0.2 uptime 57 0 0 0 0 37 20 0.838 1.000 0.3 users 38 0 0 0 0 28 10 0.816 1.000 0.3 users 38 0 0 0 0 173 120 0.852 1.000 0.4 wc 84 0 0 0 0 52 32 0.845 1.000 0.4 who 83 0 0 0 44 39 0.867 1.000 0.4 who 83 0 0 0 44 39 0.867 1.000 0.4 who 83 0 0 0 0 44 39 0.867 1.000 0.4 who 83 0 0 0 0 22 8 0.817 1.000 0.4 who 83 0 0 0 0 22 8 0.817 1.000 0.4		and fruit vari	gales var	ndes matched	e level to M	ATCH RAICHEAN BEAR OF THE REAL PROPERTY OF THE	AR Level SUBSE	Jewel All Chief	Devel March	antially reco
true 28 0 0 0 20 8 0.821 1.000 0.2 truncate 32 0 0 0 0 22 10 0.828 1.000 0.3 tsort 52 0 0 0 0 35 17 0.832 1.000 0.3 tty 29 0 0 0 0 20 9 0.828 1.000 0.3 uname 30 0 0 0 22 8 0.817 1.000 0.3 uniq 50 0 0 0 25 11 0.826 1.000 0.4 unlink 29 0 0 0 0 21 8 0.819 1.000 0.2 uptime 57 0 0 0 0 37 20 0.838 1.000 0.3 users 38 0 0 0 0 28 10 0.816 1.000 0.3 vdir 293 0 0 0 173 120 0.852 1.000 0.4 wc 84 0 0 0 0 52 32 0.845 1.000 0.3 who 83 0 0 0 0 44 39 0.867 1.000 0.4 whoami 30 0 0 0 0 22 8 0.817 1.000 0.4 whoami 30 0 0 0 0 22 8 0.817 1.000 0.4 whoami 30 0 0 0 0 22 8 0.817 1.000 0.4 whoami 30 0 0 0 0 22 8 0.817 1.000 0.4 whoami 30 0 0 0 0 0 22 8 0.817 1.000 0.4 whoami 30 0 0 0 0 0 0 0 0 0 0 0 0.8 0.8 0.8 0.8										
truncate 32 0 0 0 0 22 10 0.828 1.000 0.3 tsort 52 0 0 0 0 35 17 0.832 1.000 0.3 tty 29 0 0 0 0 20 9 0.828 1.000 0.3 uname 30 0 0 0 22 8 0.817 1.000 0.3 uniq 50 0 0 0 21 8 0.819 1.000 0.4 unlink 29 0 0 0 0 21 8 0.819 1.000 0.3 users 38 0 0 0 0 28 10 0.838 1.000 0.3 users 38 0 0 0 0 28 10 0.816 1.000 0.3 vdir 293 0 0 0 0 173 120 0.852 1.000 0.4 wc 84 0 0 0 0 52 32 0.845 1.000 0.3 who 83 0 0 0 0 44 39 0.867 1.000 0.4 whoami 30 0 0 0 0 22 8 0.817 1.000 0.4 whoami 30 0 0 0 0 0 22 8 0.817 1.000 0.4 whoami 30 0 0 0 0 0 0 0 0 0 0.2 0.817 1.000 0.4 whoami 30 0 0 0 0 0 0 0 0 0.2 0.817 1.000 0.4 0.4 0.816 1.000 0.3 0.3 0.817 1.000 0.4 0.4 0.816 1.000 0.3 0.3 0.817 1.000 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3										
tsort 52 0 0 0 0 35 17 0.832 1.000 0.35 tty 29 0 0 0 0 20 9 0.828 1.000 0.3 uname 30 0 0 0 22 8 0.817 1.000 0.2 unexpand 36 0 0 0 0 25 11 0.826 1.000 0.3 uniq 50 0 0 0 30 20 0.850 1.000 0.4 unlink 29 0 0 0 0 21 8 0.819 1.000 0.2 uptime 57 0 0 0 0 37 20 0.838 1.000 0.3 users 38 0 0 0 0 28 10 0.816 1.000 0.2 vdir 293 0 0 0 0 173 120 0.852 1.000 0.4 wc 84 0 0 0 52 32 0.845 1.000 0.3 who 83 0 0 0 0 44 39 0.867 1.000 0.4 who 83 0 0 0 0 22 8 0.817 1.000 0.4 who 83 0 0 0 0 22 8 0.817 1.000 0.4 who 83 0 0 0 0 22 8 0.817 1.000 0.4 who 83 0 0 0 0 22 8 0.817 1.000 0.4 who 83 0 0 0 0 0 22 8 0.817 1.000 0.4 who 83 0 0 0 0 0 22 8 0.817 1.000 0.4 who 83 0 0 0 0 0 22 8 0.817 1.000 0.4 who 83 0 0 0 0 0 0 22 8 0.817 1.000 0.4 who 83 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0										0.286
tty 29 0 0 0 0 20 9 0.828 1.000 0.3 uname 30 0 0 0 0 22 8 0.817 1.000 0.2 unexpand 36 0 0 0 0 25 11 0.826 1.000 0.3 uniq 50 0 0 0 30 20 0.850 1.000 0.4 unlink 29 0 0 0 21 8 0.819 1.000 0.2 uptime 57 0 0 0 0 37 20 0.838 1.000 0.3 users 38 0 0 0 28 10 0.816 1.000 0.2 vdir 293 0 0 0 173 120 0.852 1.000 0.4 wc 84 0 0 0 52 32 0.845 1.000 0.3 who 83 0 0 0 0 44 39 0.867 1.000 0.4 whoami 30 0 0 0 22 8 0.817 1.000 0.4	truncate									0.312
uname 30 0 0 0 0 22 8 0.817 1.000 0.20 unexpand 36 0 0 0 25 11 0.826 1.000 0.30 uniq 50 0 0 0 30 20 0.850 1.000 0.40 unlink 29 0 0 0 21 8 0.819 1.000 0.20 uptime 57 0 0 0 37 20 0.838 1.000 0.30 users 38 0 0 0 28 10 0.816 1.000 0.20 vdir 293 0 0 0 173 120 0.852 1.000 0.4 wc 84 0 0 0 52 32 0.845 1.000 0.3 who ami 30 0 0 0 22 8 0.817 1.000 0.2	tsort	52	0	0	0	35	17	0.832	1.000	0.327
unexpand 36 0 0 0 25 11 0.826 1.000 0.30 uniq 50 0 0 0 30 20 0.850 1.000 0.40 unlink 29 0 0 0 21 8 0.819 1.000 0.2 uptime 57 0 0 0 37 20 0.838 1.000 0.3 users 38 0 0 0 28 10 0.816 1.000 0.2 vdir 293 0 0 0 173 120 0.852 1.000 0.4 wc 84 0 0 0 52 32 0.845 1.000 0.3 who 83 0 0 0 44 39 0.867 1.000 0.4 whoami 30 0 0 0 22 8 0.817 1.000 0.2	tty	29	0	0	0	20	9	0.828	1.000	0.310
uniq 50 0 0 0 30 20 0.850 1.000 0.40 unlink 29 0 0 0 21 8 0.819 1.000 0.20 uptime 57 0 0 0 37 20 0.838 1.000 0.33 users 38 0 0 0 28 10 0.816 1.000 0.20 vdir 293 0 0 0 173 120 0.852 1.000 0.4 wc 84 0 0 0 52 32 0.845 1.000 0.33 who 83 0 0 0 44 39 0.867 1.000 0.4 whoami 30 0 0 0 22 8 0.817 1.000 0.2	uname	30	0	0	0	22	8	0.817	1.000	0.267
unlink 29 0 0 0 0 21 8 0.819 1.000 0.2 uptime 57 0 0 0 37 20 0.838 1.000 0.3 users 38 0 0 0 28 10 0.816 1.000 0.2 vdir 293 0 0 0 173 120 0.852 1.000 0.4 wc 84 0 0 0 52 32 0.845 1.000 0.3 who 83 0 0 0 44 39 0.867 1.000 0.4 whoami 30 0 0 0 22 8 0.817 1.000 0.2	unexpand	36	0	0	0	25	11	0.826	1.000	0.306
uptime 57 0 0 0 37 20 0.838 1.000 0.33 users 38 0 0 0 28 10 0.816 1.000 0.20 vdir 293 0 0 0 173 120 0.852 1.000 0.4 wc 84 0 0 0 52 32 0.845 1.000 0.33 who 83 0 0 0 44 39 0.867 1.000 0.44 whoami 30 0 0 0 22 8 0.817 1.000 0.24	uniq	50	0	0	0	30	20	0.850	1.000	0.400
uptime 57 0 0 0 37 20 0.838 1.000 0.33 users 38 0 0 0 28 10 0.816 1.000 0.20 vdir 293 0 0 0 173 120 0.852 1.000 0.4 wc 84 0 0 0 52 32 0.845 1.000 0.33 who 83 0 0 0 44 39 0.867 1.000 0.44 whoami 30 0 0 0 22 8 0.817 1.000 0.24	unlink	29	0	0	0	21	8	0.819	1.000	0.276
users 38 0 0 0 28 10 0.816 1.000 0.20 vdir 293 0 0 0 173 120 0.852 1.000 0.4 wc 84 0 0 0 52 32 0.845 1.000 0.33 who 83 0 0 0 44 39 0.867 1.000 0.44 whoami 30 0 0 0 22 8 0.817 1.000 0.24			0	0	0		20			0.351
vdir 293 0 0 0 173 120 0.852 1.000 0.4 wc 84 0 0 0 52 32 0.845 1.000 0.33 who 83 0 0 0 44 39 0.867 1.000 0.4 whoami 30 0 0 0 22 8 0.817 1.000 0.20	_									0.263
wc 84 0 0 0 52 32 0.845 1.000 0.34 who 83 0 0 0 44 39 0.867 1.000 0.44 whoami 30 0 0 0 22 8 0.817 1.000 0.24										0.410
who 83 0 0 0 44 39 0.867 1.000 0.49 whoami 30 0 0 0 22 8 0.817 1.000 0.20										
whoami 30 0 0 0 22 8 0.817 1.000 0.20										0.381
	who	83	0	0	0	44	39	0.867	1.000	0.470
yes 34 0 0 0 24 10 0.824 1.000 0.29	whoami	30	0	0	0	22	8	0.817	1.000	0.267
	yes	34	0	0	0	24	10	0.824	1.000	0.294

Table 15: Varnode recovery (metatype = ARRAY) (compilation = standard)

					A.				
			Decompiles va	Jevel 40?	MATU	Decomplet wat	Seit Aller Aller Andread	ievel MAICI	d Oll
		æ ^s) es matched	. © , shatched	d@ * Stratche	d. es matched	@ level All the mode's matched a verses with the level and	plevel MA Core score score score score score	I. Patially f
	round truth v	athor vilet vi	inode vilet voi	inode vilet vi	inode vilet v	athode silet vat	mode average	ior restraction	iP ⁱ
	round	Decount .	Decount	Decount	Decount	Decoluly 4	Vathode 48	inode 48	arnode
[15	1	5	3	0	6	0.583	0.933	0.400
b2sum	24	1	4	7	0	12	0.688	0.958	0.500
base32	12	2	2	2	0	6	0.625	0.833	0.500
base64	12	1	2	2	0	7	0.708	0.917	0.583
basename	10	1	2	2	0	5	0.650	0.900	0.500
basenc	20	5	2	2	0	11	0.625	0.750	0.550
cat	11	1	2	2	0	6	0.682	0.909	0.545
chcon	18	1	10	2	0	5	0.472	0.944	0.278
chgrp	15	1	7	2	0	5	0.517	0.933	0.333
chmod	19	2	8	4	0	5	0.474	0.895	0.263
chown	16	1	8	2	0	5	0.500	0.938	0.312
chroot	11	1	3	2	0	5	0.614	0.909	0.455
cksum	66	11	9	13	1	32	0.629	0.833	0.485
comm	22	1	7	3	1	10	0.636	0.955	0.455
cp	40	3	13	4	3	17	0.613	0.925	0.425
csplit	35	2	13	5	0	15	0.593	0.943	0.429
cut	12	1	3	2	1	5	0.625	0.917	0.417

Table 15: Varnode recovery (metatype = ARRAY) (compilation = standard)

					TOH	B	<i>S</i> .	æ .	
		atrodes Decompiler va	mades matched	,O?	MA. WE	Ada level silbe	stif Alleria (Carolica Alleria) (Carolica Indes Inational Alleria)	Mich	>
				level 7	Jewel C	level Se	level Ar	Jenel Mr	(1,0
			nei	o mei) () () () () () () () () () (d [®] med	,@' ned @	g ' goie	
		æs	125 MalCr	125 MalCs	105 Mail	1es maicr	1es maic.	annaie!	atially
	35 ³	athor vo	inode , vo	inode vo	ithode . 48	ithode , vat	Mode Mage	co, action	S. S. S. S.
	and trutt	ampilet	andilei	andiei	ampilet	ampiles	ode and	odestru	odestru
Cit	lund fruith.	Deco d	Deco 4	Deco 4	Deco	Deco 2	@ level All. Indes matched	Devel MAR COMPART SCORE	I Partially is
date	63	4	14	10	0	35	0.690	0.937	0.556
dd	34	4	7	6	2	15	0.625	0.882	0.441
df	25	1	9	3	2	10	0.610	0.960	0.400
dir	71	3	27	6	3	32	0.620	0.958	0.451
dircolors	13	2	2	2	0	7	0.654	0.846	0.538
dirname	10	1	2	2	0	5	0.650	0.900	0.500
du	51	3	16	8	1	23	0.623	0.941	0.451
echo	9	1	2	2	0	4	0.611	0.889	0.444
env	18	2	7	2	1	6	0.528	0.889	0.333
expand	13	1	3	2	0	7	0.673	0.923	0.538
expr	33	2	9	7	0	15	0.629	0.939	0.455
factor	37	1	9	9	0	18	0.669	0.973	0.486
false	9	1	2	2	0	4	0.611	0.889	0.444
fmt	12	1	2	2	0	7	0.708	0.917	0.583
fold	12	1	3	2	0	6	0.646	0.917	0.500
groups	11	1	2	2	0	6	0.682	0.909	0.545
head	18	1	9	2	0	6	0.514	0.944	0.333
hostid	12	1	2	4	0	5	0.625	0.917	0.417

Table 15: Varnode recovery (metatype = ARRAY) (compilation = standard)

					AMCH	olar	er sa	ji)	<u> </u>
	round truth	athode's	undes hatched	le level ho	And evel out	RLAR Ade level stips and the land and the la	SEI ALICAS Rodes matched Authode average Varnode average	Jevel MATC	O.I.I. Datially is
Č	ground true	Decompile	Decompile.	Decompile.	Decompiles	Decompile.	Vatuode au	inodes it	inodesti
id	14	1	3	2	0	8	0.696	0.929	0.571
join	18	1	3	2	1	11	0.750	0.944	0.611
kill	14	3	4	2	0	5	0.500	0.786	0.357
link	12	1	2	4	0	5	0.625	0.917	0.417
ln	22	2	6	2	3	9	0.625	0.909	0.409
logname	12	1	2	4	0	5	0.625	0.917	0.417
ls	71	3	27	6	3	32	0.620	0.958	0.451
md5sum	16	2	6	2	0	6	0.531	0.875	0.375
mkdir	19	2	7	3	0	7	0.539	0.895	0.368
mkfifo	12	2	3	2	0	5	0.562	0.833	0.417
mknod	12	2	3	2	0	5	0.562	0.833	0.417
mktemp	12	2	2	2	0	6	0.625	0.833	0.500
mv	34	3	13	4	3	11	0.544	0.912	0.324
nice	10	1	2	2	0	5	0.650	0.900	0.500
nl	36	5	8	5	1	17	0.618	0.861	0.472
nohup	13	1	3	4	0	5	0.596	0.923	0.385
nproc	10	1	2	2	0	5	0.650	0.900	0.500
numfmt	20	1	3	3	0	13	0.762	0.950	0.650

Table 15: Varnode recovery (metatype = ARRAY) (compilation = standard)

Grovi	ind truth ve	inodes Jeconniler va	nodes matched	Decomplies was	MATCH. MATCH. J. W. Level Owler J. W. Level Owle	ALAR SUBSIDIO OF THE PROPERTY	eil aller alle alle alle alle alle alle al	Level MATCH Compare score i	D.I.I. Patially reco
od	40	2	12	5	1	20	0.656	0.950	0.500
paste	10	1	2	2	0	5	0.650	0.900	0.500
pathchk	10	1	2	2	0	5	0.650	0.900	0.500
pinky	17	1	7	2	0	7	0.574	0.941	0.412
pr	20	2	6	5	0	7	0.550	0.900	0.350
printenv	10	1	2	2	0	5	0.650	0.900	0.500
printf	17	1	4	5	0	7	0.618	0.941	0.412
ptx	39	2	9	5	4	19	0.686	0.949	0.487
pwd	10	1	2	2	0	5	0.650	0.900	0.500
readlink	12	1	3	2	1	5	0.625	0.917	0.417
realpath	11	1	2	2	1	5	0.659	0.909	0.455
rm	15	1	5	2	0	7	0.617	0.933	0.467
rmdir	14	1	3	3	0	7	0.661	0.929	0.500
runcon	10	1	2	2	0	5	0.650	0.900	0.500
seq	15	1	2	3	1	8	0.717	0.933	0.533
sha1sum	16	2	3	3	0	8	0.641	0.875	0.500
sha224sum	17	2	5	3	0	7	0.574	0.882	0.412
sha256sum	17	2	5	3	0	7	0.574	0.882	0.412

Table 15: Varnode recovery (metatype = ARRAY) (compilation = standard)

					(CH	R	, ,)	
				107	JAX VER	JA BSE) Jak	Mich	
				Jevel The	Jenst O.	revel St	revel Ar	evelyn	S
			ned	© 1.	® r	@ red	Dr rege	coje)
		Xe ⁵	. 25 Trater	es mater	es mater	as match	as mater	inpaie 3	atially,
	~	varnot varn	yari	jode var	node var	node varn	agge co	ocion s	ža.
S	id tritili	mpiler	mpiler	mpiler	apiler	appiler	deaver	odes fra	destra
Citair	•	varnodes Decompler varn	io,	sco,	and the land of th	LAP CLEVEL STIPSET VALLED OF THE PROPERTY OF T	Jevel Aller E	revel Mir Score In Stragge Score In Stragge Stragge Stragge Vari	adially fi
sha384sum	17	3	3	3	0	8	0.603	0.824	0.47
sha512sum	17	3	3	3	0	8	0.603	0.824	0.47
shred	27	2	10	2	1	12	0.602	0.926	0.44
shuf	12	1	3	2	0	6	0.646	0.917	0.50
sleep	12	1	2	4	0	5	0.625	0.917	0.41
sort	46	6	17	5	1	17	0.533	0.870	0.37
split	18	2	7	2	0	7	0.542	0.889	0.38
stat	32	5	7	6	0	14	0.586	0.844	0.43
stdbuf	16	1	3	4	0	8	0.672	0.938	0.50
stty	19	1	4	3	0	11	0.711	0.947	0.57
sum	22	2	6	2	1	11	0.648	0.909	0.50
sync	11	1	3	2	0	5	0.614	0.909	0.45
tac	33	2	9	5	0	17	0.659	0.939	0.51
tail	20	1	9	3	1	6	0.525	0.950	0.30
tee	14	1	4	2	0	7	0.643	0.929	0.50
test	12	0	4	2	0	6	0.667	1.000	0.50
timeout	13	2	4	2	0	5	0.538	0.846	0.38
touch	56	3	13	7	0	33	0.710	0.946	0.58

Table 15: Varnode recovery (metatype = ARRAY) (compilation = standard)

	Ground truth val	nodes	nodes traiched	@ level 120 3.	MAICH @ level OVER mode's matched	LAP ALAPSE AND	Develational Control of the Strate of the St	Devel March Repare score In	patially reco
	Char De	you s	Dece 2	ecc <	Dece 2	Dec. 74	iti Vati	\dil	>
tr	17	1	3	3	0	10	0.721	0.941	0.588
true	9	1	2	2	0	4	0.611	0.889	0.444
truncate	e 10	1	2	2	0	5	0.650	0.900	0.500
tsort	13	1	3	4	0	5	0.596	0.923	0.385
tty	10	1	2	2	0	5	0.650	0.900	0.500
uname	12	2	2	2	0	6	0.625	0.833	0.500
unexpa	nd 11	1	2	2	0	6	0.682	0.909	0.545
uniq	15	1	3	2	0	9	0.717	0.933	0.600
unlink	12	1	2	4	0	5	0.625	0.917	0.417
uptime	18	1	4	7	0	6	0.583	0.944	0.333
users	12	1	2	4	0	5	0.625	0.917	0.417
vdir	71	3	27	6	3	32	0.620	0.958	0.451
wc	16	1	3	4	2	6	0.641	0.938	0.375
who	25	1	4	3	2	15	0.760	0.960	0.600
whoam	i 12	1	2	4	0	5	0.625	0.917	0.417
yes	12	1	2	4	0	5	0.625	0.917	0.417

Table 16: Varnode recovery (metatype = STRUCT) (compilation = standard)

					A.	2		_	
			undes hatched		MATE	ALAR LEVEL SUBS	SET ALICANIA. O LOCAL AND	en sici	>
				is welt the	Jewel On	revelso?	Thodes hatched a verage of	Jewel MA.	<u></u>
			, es	,@ \c ,\ei	J® le nei	s [®] le sei	o reg	ote acore	0.
		స్ట్రా	Shatch	as match	Shatch	as match	Shatch	Mare se	artially
	20 A	athou w	ithode, Ast	inode.	inode	ithode, Ast	inode, rage,	.or action	1. Pic
	and truth	milet	miler	applet	miler	applet	ale aver	destra	destro
Ć	ound truth vi	Deco,	Deco,	Deco,	Dero,	Osco, v	Varing Va	The 48	Inatially f
[24	0	12	2	6	4	0.521	1.000	0.16
b2sum	10	0	4	0	6	0	0.550	1.000	0.000
base32	11	0	4	0	7	0	0.568	1.000	0.000
base64	11	0	4	0	7	0	0.568	1.000	0.000
basename	10	0	4	0	6	0	0.550	1.000	0.000
basenc	11	0	5	0	6	0	0.523	1.000	0.000
cat	11	0	4	0	6	1	0.591	1.000	0.091
chcon	23	0	4	2	14	3	0.674	1.000	0.130
chgrp	22	0	4	3	9	6	0.693	1.000	0.273
chmod	22	0	4	3	9	6	0.693	1.000	0.273
chown	22	0	4	3	9	6	0.693	1.000	0.273
chroot	10	0	4	0	6	0	0.550	1.000	0.000
cksum	22	0	13	0	9	0	0.455	1.000	0.000
comm	10	0	4	0	6	0	0.550	1.000	0.000
ср	46	0	14	8	10	14	0.630	1.000	0.304
csplit	56	0	27	10	10	9	0.504	1.000	0.161
cut	10	0	4	0	6	0	0.550	1.000	0.000

Table 16: Varnode recovery (metatype = STRUCT) (compilation = standard)

				. 207	MATCH OVE	ALAR SUB	SET ALIGHT	ED MATCH	>
	auth	vatrodes Decompiler vat	nodes matched	de level MO?	@ level	l@lever	Seri d@level.Allica Janodes natched@ Vanode average	Jewel MAR	O.11 Partially re
CXC	Jundite	Decomplite	peconnaine .	Decombite 4	Decompile	Decompile	Vatnode a	inodes ,	inodes,
date	39	0	13	14	8	4	0.519	1.000	0.103
dd	22	0	8	3	7	4	0.580	1.000	0.182
df	37	0	8	8	12	9	0.649	1.000	0.243
dir	46	0	20	7	12	7	0.533	1.000	0.152
dircolors	11	0	4	0	7	0	0.568	1.000	0.000
dirname	10	0	4	0	6	0	0.550	1.000	0.000
du	73	0	33	20	12	8	0.483	1.000	0.110
echo	10	0	4	0	6	0	0.550	1.000	0.000
env	17	0	4	1	8	4	0.676	1.000	0.235
expand	10	0	4	0	6	0	0.550	1.000	0.000
expr	59	0	27	18	9	5	0.466	1.000	0.085
factor	32	0	12	13	6	1	0.469	1.000	0.031
false	10	0	4	0	6	0	0.550	1.000	0.000
fmt	10	0	4	0	6	0	0.550	1.000	0.000
fold	10	0	4	0	6	0	0.550	1.000	0.000
groups	10	0	4	0	6	0	0.550	1.000	0.000
head	12	0	4	0	6	2	0.625	1.000	0.167
hostid	10	0	4	0	6	0	0.550	1.000	0.000

Table 16: Varnode recovery (metatype = STRUCT) (compilation = standard)

		Valuode ⁵ Decompler va	makhel	d. Level NO.	MATCH. @ level Ovicion of the control of the contr	ALAR Inache	SET ALICAS A BENET ALICAS A BROADE AVERAGE A	ED MATCH	o.ll
Csr	Jund truth	Varnode's Decompiler va	Decompilet vi	prodes /	nodes , Decompiler va	Decompiler va	Thodes hatched a Various and Astronomy	Jewel MA. Longage score	. Pate Inodes fract
id	10	0	4	0	6	0	0.550	1.000	0.000
join	14	0	5	1	8	0	0.554	1.000	0.000
kill	10	0	4	0	6	0	0.550	1.000	0.000
link	10	0	4	0	6	0	0.550	1.000	0.000
ln	28	0	6	5	7	10	0.688	1.000	0.357
logname	10	0	4	0	6	0	0.550	1.000	0.000
ls	46	0	20	7	12	7	0.533	1.000	0.152
md5sum	12	0	6	0	6	0	0.500	1.000	0.000
mkdir	18	0	4	3	7	4	0.653	1.000	0.222
mkfifo	12	0	4	0	6	2	0.625	1.000	0.167
mknod	12	0	4	0	6	2	0.625	1.000	0.167
mktemp	12	0	4	0	6	2	0.625	1.000	0.167
mv	53	0	17	8	11	17	0.632	1.000	0.321
nice	10	0	4	0	6	0	0.550	1.000	0.000
nl	55	0	27	10	13	5	0.482	1.000	0.091
nohup	10	0	4	0	6	0	0.550	1.000	0.000
nproc	11	0	4	0	6	1	0.591	1.000	0.091
numfmt	10	0	4	0	6	0	0.550	1.000	0.000

Table 16: Varnode recovery (metatype = STRUCT) (compilation = standard)

					4				
GKQ1	and truth	atrodes	nodes matched	@level NO No level nodes matched	Andes matched	JAR (evel style in odes matched was becompiler with the was becompiler with the was becompiler w	SET ALICANT	Donnare score I	Datially reco
od od	13	0	4	2	6	1	0.577	1.000	0.077
paste	10	0	4	0	6	0	0.550	1.000	0.000
pathchk	13	0	4	0	8	1	0.615	1.000	0.077
pinky	12	0	4	0	7	1	0.604	1.000	0.083
pr	22	0	9	3	7	3	0.545	1.000	0.136
printenv	10	0	4	0	6	0	0.550	1.000	0.000
printf	15	0	4	2	9	0	0.583	1.000	0.000
ptx	82	0	33	23	20	6	0.497	1.000	0.073
pwd	17	0	4	1	7	5	0.691	1.000	0.294
readlink	17	0	6	3	7	1	0.544	1.000	0.059
realpath	18	0	6	3	7	2	0.569	1.000	0.111
rm	23	0	5	3	9	6	0.674	1.000	0.261
rmdir	13	0	4	2	6	1	0.577	1.000	0.077
runcon	10	0	4	0	6	0	0.550	1.000	0.000
seq	17	0	8	3	6	0	0.471	1.000	0.000
sha1sum	12	0	6	0	6	0	0.500	1.000	0.000
sha224sum	13	0	7	0	6	0	0.481	1.000	0.000
sha256sum	13	0	7	0	6	0	0.481	1.000	0.000

Table 16: Varnode recovery (metatype = STRUCT) (compilation = standard)

Crow	Jec Jec	ses Inhilet varnode	Stratched Of	straiched e le	JH Spel Over Red A Speed On the Speed Over The Control of the Cont	evel stilbskil smatched @ 1	s matched of the same age of the same age.	wel MAICH Indate score lo	istially recovered
sha384sum	13	0	4	0	9	0	0.596	1.000	0.000
sha512sum	13	0	4	0	9	0	0.596	1.000	0.000
shred	15	0	6	0	6	3	0.600	1.000	0.200
shuf	15	0	4	1	8	2	0.633	1.000	0.133
sleep	13	0	6	0	6	1	0.538	1.000	0.077
sort	44	1	13	7	13	10	0.602	0.977	0.227
split	15	0	5	0	9	1	0.600	1.000	0.067
stat	32	0	12	8	9	3	0.523	1.000	0.094
stdbuf	14	0	4	2	7	1	0.589	1.000	0.071
stty	18	0	7	2	9	0	0.528	1.000	0.000
sum	10	0	4	0	6	0	0.550	1.000	0.000
sync	10	0	4	0	6	0	0.550	1.000	0.000
tac	53	0	27	10	11	5	0.472	1.000	0.094
tail	29	0	8	2	7	12	0.698	1.000	0.414
tee	10	0	4	0	6	0	0.550	1.000	0.000
test	24	0	12	2	6	4	0.521	1.000	0.167
timeout	18	0	5	0	7	6	0.694	1.000	0.333
touch	36	0	10	16	7	3	0.521	1.000	0.083

Table 16: Varnode recovery (metatype = STRUCT) (compilation = standard)

_	Grand	J. truth water	nodes	odes matched o	Jewel NO No. Jewel No. Jew	indes natched	LAR level SUBSI	ei level Aller Ei @ level Aller Ei arode average cof	evel MATCH Indate score 10	atially recor
tr		13	0	5	0	8	0	0.558	1.000	0.000
true		10	0	4	0	6	0	0.550	1.000	0.000
trunca	te	12	0	4	0	6	2	0.625	1.000	0.167
tsort		12	0	6	0	6	0	0.500	1.000	0.000
tty		10	0	4	0	6	0	0.550	1.000	0.000
uname	2	11	0	4	0	6	1	0.591	1.000	0.091
unexp	and	10	0	4	0	6	0	0.550	1.000	0.000
uniq		12	0	6	0	6	0	0.500	1.000	0.000
unlink		10	0	4	0	6	0	0.550	1.000	0.000
uptime	e	15	0	6	3	6	0	0.500	1.000	0.000
users		10	0	4	0	6	0	0.550	1.000	0.000
vdir		46	0	20	7	12	7	0.533	1.000	0.152
wc		16	0	4	1	5	6	0.703	1.000	0.375
who		14	0	4	2	7	1	0.589	1.000	0.071
whoar	ni	10	0	4	0	6	0	0.550	1.000	0.000
yes		10	0	4	0	6	0	0.550	1.000	0.000

Table 17: Varnode recovery (metatype = UNION) (compilation = standard)

					C.	Ω.			
					MATE	PLAY 125	FET 197	ith sta	>
				avel 70	weldy,	avel 501	wel Alix	welmix	<u> </u>
			Decomplet w	3 [®] %	2 [®] 2	RIAR AND BURGER OF THE STREET	SET ALLICATION AND AND AND AND AND AND AND AND AND AN	Devel Mrs. Compare score	6.
		, 0 ⁶ 5	Smatche	STRAICHT	- matche	Smatche	Thatche	Maie su	rtially
	4	athode	strode ³	inodes	indes	strodes 18	indes age	contr	i Patially
	adtuih	miler	apiler	miler	mpiler	apiler	deaveil	ades frac	-des fro
(Round truth	Decor	Decor	Decor	Decor	Decor	Astinge 48	ATTION V	arnor
[0	0	0	0	0	0	_	_	
b2sum	0	0	0	0	0	0	_	_	_
base32	0	0	0	0	0	0	-	_	_
base64	0	0	0	0	0	0	_	_	_
basenam	e 0	0	0	0	0	0	_	_	_
basenc	0	0	0	0	0	0	-	_	_
cat	0	0	0	0	0	0	-	_	-
chcon	0	0	0	0	0	0	-	_	-
chgrp	0	0	0	0	0	0	-	-	-
chmod	0	0	0	0	0	0	-	-	-
chown	0	0	0	0	0	0	-	-	-
chroot	0	0	0	0	0	0	-	-	-
cksum	0	0	0	0	0	0	-	-	-
comm	0	0	0	0	0	0	-	-	-
ср	1	0	0	0	1	0	0.750	1.000	0.000
csplit	0	0	0	0	0	0	-	-	-
cut	0	0	0	0	0	0	-	-	-

Table 17: Varnode recovery (metatype = UNION) (compilation = standard)

				Thed @ Level NO MARICH DE VEI ON FRED AND SELF STATE OF THE PROPERTY OF THE PR						
				±0.	MA	MATCH				
				@ level,	@ level C	@ level 3	d@level Ali. Alinodes inautred Warnode average	Devel Mr. Compare score	(1,0)	
			atche	de	d le atche	id le atché	de atched	ie scoie	I Partially I	
		Jeografier was	odesmi	odestrice	odestria	odestria	odesnia	compai	Partial	
	TUIS	i vali	:Jei v ⁱ	atite iver vi	itir	atile iet vi	atitu average	Fractio	Sta	
¢.s.	Jund (1	Geograph.	ecompl.	secompi.	3ecompi.	seconny.	13thole c	inodes 1	arnodes	
		V	<u> </u>	<u> </u>	V	<u> </u>	4, 4,			
date	2	0	0	2	0	0	0.500	1.000	0.000	
dd	0	0	0	0	0	0	-	-	-	
df	0	0	0	0	0	0	-	-	-	
dir	0	0	0	0	0	0	-	-	-	
dircolors	0	0	0	0	0	0	-	-	-	
dirname	0	0	0	0	0	0	-	-	-	
du	0	0	0	0	0	0	-	-	-	
echo	0	0	0	0	0	0	-	-	-	
env	0	0	0	0	0	0	-	-	-	
expand	0	0	0	0	0	0	-	-	-	
expr	0	0	0	0	0	0	-	-	-	
factor	1	0	1	0	0	0	0.250	1.000	0.000	
false	0	0	0	0	0	0	-	-	-	
fmt	0	0	0	0	0	0	-	-	-	
fold	0	0	0	0	0	0	-	-	-	
groups	0	0	0	0	0	0	-	-	-	
head	0	0	0	0	0	0	-	-	-	
hostid	0	0	0	0	0	0	-	-	-	

Table 17: Varnode recovery (metatype = UNION) (compilation = standard)

					MATCH MA					
		varnodes Decompiler va		.0	MAI	BIN WE	Fil JIGH	A NATO	\$	
				levelt	a level O	level 5	de level Ali. Allo level Ali. Al	plevel Mr. Compare score	(1,0)	
			, ch ^e	d che	d [®]	id in the	o sched	y ascore	,V ,AA	
		odes	adesmail	ades mail	ades mai	adesmale	desmal	Onpare	Dartiall's	
	ith	Vernodes Decompiler ve	ithor out a	dinos con vi	itha . et a	atrice of vo	ind weinge	Staction	I Patially	
ار	ound tru	acompile	acompile	acompile	acompile	acompile	rnode a	indest	modesi	
		→		De.	D 60	D 4	7.gr 7.s	7.		
id	0	0	0	0	0	0	-	-	-	
join	0	0	0	0	0	0	-	-	-	
kill	0	0	0	0	0	0	-	-	-	
link	0	0	0	0	0	0	-	-	-	
ln	0	0	0	0	0	0	-	-	-	
logname	0	0	0	0	0	0	-	-	-	
ls	0	0	0	0	0	0	-	-	-	
md5sum	0	0	0	0	0	0	-	-	-	
mkdir	0	0	0	0	0	0	-	-	-	
mkfifo	0	0	0	0	0	0	-	-	-	
mknod	0	0	0	0	0	0	-	-	-	
mktemp	0	0	0	0	0	0	-	-	-	
mv	1	0	0	0	1	0	0.750	1.000	0.000	
nice	0	0	0	0	0	0	-	-	-	
nl	0	0	0	0	0	0	-	-	-	
nohup	0	0	0	0	0	0	-	-	-	
nproc	0	0	0	0	0	0	-	-	-	
numfmt	0	0	0	0	0	0	-	-	-	

Table 17: Varnode recovery (metatype = UNION) (compilation = standard)

	Æ	varrodes Decompiler var	nodes matched	de level MO.	MATCH. Me level Over 1. Marketer 1. Marke	ALAR SUBSIDE	SEI ALICANA ALICANA VAI	ED MAICH	Partially recov
od Csto	8	Decompile of	peconnaile o	Decompile s	Decompile 4	Decountific .	Vatrode at Vat	nodes r	nodest 0.000
paste	0	0	0	0	0	0	-	-	-
pathchk	0	0	0	0	0	0	-	-	-
pinky	0	0	0	0	0	0	-	-	-
pr	0	0	0	0	0	0	-	-	-
printenv	0	0	0	0	0	0	-	-	-
printf	0	0	0	0	0	0	-	-	-
ptx	1	0	1	0	0	0	0.250	1.000	0.000
pwd	0	0	0	0	0	0	-	-	-
readlink	0	0	0	0	0	0	-	-	-
realpath	0	0	0	0	0	0	-	-	-
rm	0	0	0	0	0	0	-	-	-
rmdir	0	0	0	0	0	0	-	-	-
runcon	0	0	0	0	0	0	-	-	-
seq	0	0	0	0	0	0	-	-	-
sha1sum	0	0	0	0	0	0	-	-	-
sha224sum	0	0	0	0	0	0	-	-	-
sha256sum	0	0	0	0	0	0	-	-	-

Table 17: Varnode recovery (metatype = UNION) (compilation = standard)

		vanode ⁵ Decompler vano		@level NO M	ACH S	JAR S	eil aller Al	ED Revel MATCH	>
				Jenst 170 }	revel Ovier	Jevel SUB?	Jewel ALIC	Jevel MAI	<u>,</u>
			tched	. Ched	@ '	@ ' sched	@ ' whed	a level MAR compare score i	94 je
		noles	ides mat	odesmar	odestrate	odesmar	odes mat	compare	Partiall'
	Tuin	, vai silet vaiti	silet vat	ir Silet Vail	i Silet var	ir gilet vat	, average) of fraction	os frac
Grout	ig	vatuodes Decomplet vatue	count	Decount 2	ecounty 5	Decounts of	athode 4	athode 48	inode
sha384sum	0	0	0	0	0	0	-	-	
sha512sum	0	0	0	0	0	0	-	-	-
shred	0	0	0	0	0	0	-	-	-
shuf	0	0	0	0	0	0	-	-	-
sleep	0	0	0	0	0	0	-	-	-
sort	0	0	0	0	0	0	-	-	-
split	0	0	0	0	0	0	-	-	-
stat	0	0	0	0	0	0	-	-	-
stdbuf	0	0	0	0	0	0	-	-	-
stty	0	0	0	0	0	0	-	-	-
sum	0	0	0	0	0	0	-	-	-
sync	0	0	0	0	0	0	-	-	-
tac	0	0	0	0	0	0	-	-	-
tail	0	0	0	0	0	0	-	-	-
tee	0	0	0	0	0	0	-	-	-
test	0	0	0	0	0	0	-	-	-
timeout	0	0	0	0	0	0	-	-	-
touch	2	0	0	2	0	0	0.500	1.000	0.00

Table 17: Varnode recovery (metatype = UNION) (compilation = standard)

Ç	ound truth vari	golfoiler visi	hodes matched	@ level NO M	Archi Arei Over Area Control of the Area Contr	LAR Quevel SUBS	ET Devel ALLE	Welevel Mark	Hanodes f
tr	0	0	0	0	0	0	-	-	-
true	0	0	0	0	0	0	-	-	-
truncate	0	0	0	0	0	0	-	-	-
tsort	0	0	0	0	0	0	-	-	-
tty	0	0	0	0	0	0	-	-	-
uname	0	0	0	0	0	0	-	-	-
unexpand	0	0	0	0	0	0	-	-	-
uniq	0	0	0	0	0	0	-	-	-
unlink	0	0	0	0	0	0	-	-	-
uptime	0	0	0	0	0	0	-	-	-
users	0	0	0	0	0	0	-	-	-
vdir	0	0	0	0	0	0	-	-	-
wc	0	0	0	0	0	0	-	-	-
who	0	0	0	0	0	0	-	-	-
whoami	0	0	0	0	0	0	-	-	-
yes	0	0	0	0	0	0	-	-	-

Table 18: Varnode recovery (compilation = debug)

			hed@level ¹⁴	MCH	Aled levels	Á	ET RATECTIFED WATCH. (a) Level ALLCENTED Level WATCH. (b) Level ALLCENTED Level WATCH. (c) Level ALLCENTED Level WATCH. (c) Level ALLCENTED Level WATCH. (c) Level ALLCENTED Level WATCH. (d) Level ALLCENTED Level WATCH. (d) Level ALLCENTED Level WATCH. (e) Level WATCH.				
			7	D.Mr.	VERLY S	JBSE AL	STA, MAY	OK,	31 ⁰ 1		
	and truth w	odes	1@Jener	1@Jever	, @ lever	, @ lever	1 @ lever	omparise.	Dartially		
	all v	atrice mate	hed nati	thed inal	thed mal	thed match	u verage	Fraction	s stact		
ر نام	and the	istnodes!	1athodes !	lathodes.	1athodes 1	1strodes 1	athode's	tholes i	inodes r		
		70		70		70 7		7,			
[266	0	0	0	0	266	1.000	1.000	1.000		
b2sum	237	0	0	0	0	237	1.000	1.000	1.000		
base32	160	0	0	0	0	160	1.000	1.000	1.000		
base64	160	0	0	0	0	160	1.000	1.000	1.000		
basename	129	0	0	0	0	129	1.000	1.000	1.000		
basenc	219	0	0	0	0	219	1.000	1.000	1.000		
cat	164	0	0	0	0	164	1.000	1.000	1.000		
chcon	363	0	0	0	0	363	1.000	1.000	1.000		
chgrp	339	0	0	0	0	339	1.000	1.000	1.000		
chmod	347	0	0	0	0	347	1.000	1.000	1.000		
chown	359	0	0	0	0	359	1.000	1.000	1.000		
chroot	198	0	1	0	0	197	0.996	1.000	0.995		
cksum	678	0	0	0	0	678	1.000	1.000	1.000		
comm	171	0	0	0	0	171	1.000	1.000	1.000		
ср	703	0	2	0	2	699	0.997	1.000	0.994		
csplit	982	0	1	1	0	980	0.999	1.000	0.998		
cut	192	0	0	0	0	192	1.000	1.000	1.000		
date	747	0	8	2	0	737	0.991	1.000	0.987		
dd	493	0	0	0	0	493	1.000	1.000	1.000		

Table 18: Varnode recovery (compilation = debug)

				O MATCH thed@level.C	Will AR Warnades man	£	Esta ALICATED ANTICIT Esta ALICATED Score (0.1) Les tradiched © Level MATICIT Score (0.1) Les tradiched © Level MATICIT ANTICAL STRATEGISCON PARTICIPATION				
				MAX	VERLIN CI	JBSET JI	311/2 AAS	igy Sec	siele		
		∖ &	a level?	a level C	, lengly	@level fr	@level h	Maits Oil	artially		
	22/201	inode stê	ned le av	hed w	thed to	hed le atche	7.00°	iotica	, Q'ar		
	and truth	odestria	odesmid	odestria	odesmid	odestria	ode aver	odesfra	odestra		
Cit	Sund truth was	atite	Varia	Varite	Varia	Varing Va	As	48	III		
df	640	0	2	0	0	638	0.998	1.000	0.997		
dir	1031	0	4	3	0	1024	0.996	1.000	0.993		
dircolors	190	0	0	0	0	190	1.000	1.000	1.000		
dirname	125	0	0	0	0	125	1.000	1.000	1.000		
du	1499	0	2	2	0	1495	0.998	1.000	0.997		
echo	118	0	0	0	0	118	1.000	1.000	1.000		
env	201	0	0	0	0	201	1.000	1.000	1.000		
expand	152	0	0	0	0	152	1.000	1.000	1.000		
expr	911	0	1	1	0	909	0.999	1.000	0.998		
factor	511	23	1	0	0	487	0.954	0.955	0.953		
false	109	0	0	0	0	109	1.000	1.000	1.000		
fmt	186	0	0	0	0	186	1.000	1.000	1.000		
fold	143	0	0	0	0	143	1.000	1.000	1.000		
groups	142	0	0	0	0	142	1.000	1.000	1.000		
head	215	0	0	0	0	215	1.000	1.000	1.000		
hostid	118	0	0	0	0	118	1.000	1.000	1.000		
id	196	0	0	0	0	196	1.000	1.000	1.000		
join	260	0	0	0	0	260	1.000	1.000	1.000		
kill	148	0	0	0	0	148	1.000	1.000	1.000		

Table 18: Varnode recovery (compilation = debug)

			a el A	O MATCH	WERLAR SIES	JBSET MALI	3TED MAY	JI ajson sc	Je (0,1)
Çst	ound truth var	inodes mat	thed @ level h	hed@leshal	WERLAY Stred @ level St	JBSET LIVED RAIN LIVED REPORT TO THE WASTINGLES TRANSFER VIEW TO THE WASTINGLES VIEW TO THE	JHED AND	th comparison sec	. Partic
link	117	0	0	0	0	117	1.000	1.000	1.000
ln	433	0	0	0	0	433	1.000	1.000	1.000
logname	118	0	0	0	0	118	1.000	1.000	1.000
ls	1031	0	4	3	0	1024	0.996	1.000	0.993
md5sum	217	0	0	0	0	217	1.000	1.000	1.000
mkdir	306	0	1	0	0	305	0.998	1.000	0.997
mkfifo	148	0	0	0	0	148	1.000	1.000	1.000
mknod	165	0	0	0	0	165	1.000	1.000	1.000
mktemp	164	0	0	0	0	164	1.000	1.000	1.000
mv	773	0	1	0	2	770	0.998	1.000	0.996
nice	130	0	0	0	0	130	1.000	1.000	1.000
nl	896	0	1	1	0	894	0.999	1.000	0.998
nohup	162	0	0	0	0	162	1.000	1.000	1.000
nproc	139	0	0	0	0	139	1.000	1.000	1.000
numfmt	291	0	0	0	0	291	1.000	1.000	1.000
od	459	0	1	0	0	458	0.998	1.000	0.998
paste	142	0	0	0	0	142	1.000	1.000	1.000
pathchk	141	0	0	0	0	141	1.000	1.000	1.000
pinky	182	0	0	1	0	181	0.997	1.000	0.995

Table 18: Varnode recovery (compilation = debug)

				r CH	.2		<u> </u>		<u> </u>
			٠.	MAI	ERLA.	BSET JE	Mil A	y i sco	;eW,
		ے۔	level 14	1evel 0	Jewel St	level Ar	Jenel Mr.	Datison	tially rec
	Vari	jode ^e	ned (a)	ned (, c	ned (a)	ned (chei	S	onic	Qar.
	ad truth	ades mai	ades mai	adesmail	adesmail	ades mair	ale avertu	destrac	alestral
Citai	nd truth vali	inc .	ned@level.W	Vatric .	AERLAR REVOLUTION OF THE REVOL	Besteri ned@levelAlla Autodes natched	THED MAY	JII ompatison scot ompatison ompatis	in ^O
pr	543	0	0	1	0	542	0.999	1.000	0.998
printenv	119	0	0	0	0	119	1.000	1.000	1.000
printf	283	0	3	0	0	280	0.992	1.000	0.989
ptx	1126	0	2	1	0	1123	0.998	1.000	0.997
pwd	143	0	0	0	0	143	1.000	1.000	1.000
readlink	243	0	0	0	0	243	1.000	1.000	1.000
realpath	248	0	0	0	0	248	1.000	1.000	1.000
rm	362	0	0	0	0	362	1.000	1.000	1.000
rmdir	234	0	0	0	0	234	1.000	1.000	1.000
runcon	121	0	0	0	0	121	1.000	1.000	1.000
seq	279	0	0	0	0	279	1.000	1.000	1.000
sha1sum	215	0	0	0	0	215	1.000	1.000	1.000
sha224sum	225	0	0	0	0	225	1.000	1.000	1.000
sha256sum	225	0	0	0	0	225	1.000	1.000	1.000
sha384sum	381	0	0	0	0	381	1.000	1.000	1.000
sha512sum	381	0	0	0	0	381	1.000	1.000	1.000
shred	370	0	0	1	0	369	0.999	1.000	0.997
shuf	374	0	0	0	0	374	1.000	1.000	1.000
sleep	143	0	0	0	0	143	1.000	1.000	1.000

Table 18: Varnode recovery (compilation = debug)

				e level NO MARICH e level NO MARICH e level of level of the level of					
			. 40	Mir OV	irin, sur	SE, MIG	MAIC	Annaison score	د ^د رونا
	Jud Hull Vari	ales	. @level	. @ level	@level.	. @level.	@level	MARATISU	artially ,
	nih vath	is match	ed	ed match	ed natch	ed natched	, etage co	's craction'	eraciis
.0	nind true	nodestr	modesin	modestr	inodestr	modes it	node av	odesti	jodestr
— Gi	7.9					g. 79	- Agr	701	
sort	847	0	2	0	0	845	0.998	1.000	0.998
split	297	0	1	0	0	296	0.997	1.000	0.997
stat	608	0	0	1	0	607	0.999	1.000	0.998
stdbuf	267	0	0	0	0	267	1.000	1.000	1.000
stty	301	0	0	0	0	301	1.000	1.000	1.000
sum	278	0	0	0	0	278	1.000	1.000	1.000
sync	133	0	0	0	0	133	1.000	1.000	1.000
tac	920	0	1	1	0	918	0.999	1.000	0.998
tail	423	0	1	0	0	422	0.998	1.000	0.998
tee	154	0	0	0	0	154	1.000	1.000	1.000
test	260	0	0	0	0	260	1.000	1.000	1.000
timeout	175	0	0	0	0	175	1.000	1.000	1.000
touch	602	0	8	1	2	591	0.988	1.000	0.982
tr	241	0	0	0	0	241	1.000	1.000	1.000
true	109	0	0	0	0	109	1.000	1.000	1.000
truncate	145	0	0	0	0	145	1.000	1.000	1.000
tsort	162	0	0	0	0	162	1.000	1.000	1.000
tty	114	0	0	0	0	114	1.000	1.000	1.000
uname	120	0	0	0	0	120	1.000	1.000	1.000

Table 18: Varnode recovery (compilation = debug)

- Crain	nd truth vari	odes mati	ged@level. No.	MAICH d@levelOvi	ted @ level subsections	SET ALICI	(@ level MAIC's	A Stadion Scott	alolly reco
unexpand	158	0	0	0	0	158	1.000	1.000	1.000
uniq	202	0	0	0	0	202	1.000	1.000	1.000
unlink	117	0	0	0	0	117	1.000	1.000	1.000
uptime	353	0	0	1	1	351	0.998	1.000	0.994
users	133	0	0	0	0	133	1.000	1.000	1.000
vdir	1031	0	4	3	0	1024	0.996	1.000	0.993
wc	268	0	0	0	0	268	1.000	1.000	1.000
who	282	0	0	0	0	282	1.000	1.000	1.000
whoami	120	0	0	0	0	120	1.000	1.000	1.000
yes	132	0	0	0	0	132	1.000	1.000	1.000

Table 19: Varnode recovery (metatype = INT) (compilation = debug)

_	Coronal truth Transactes transactes transactes transactes transacted to Decompiles transacted to Decompiles transactes transacted to Decompiles transactes transacted to Decompiles transacted to De												
					Nevel HO	MAIC, OVE	RUAY SUBSE	a level Alica	ED MATCH	0.11			
			√ E ^S	as matched	d (e sinatche	d le granding	d (contractive d	e matched	Level ALICATED Level MATCH Level ALICATED Level MATCH Les matched @ Level MATCH Les matched @ Level MATCH Les matched @ Level MATCH Level ALICATED Level ALI				
		uin	wathor Jet va	ithode 18148	inode Jervi	ithode ist	uthode 187 vati	jode werage	or fraction	, Pr Etal			
	Crov	indition	variodes Decomplet va	Decomplie	Decompile	Decomplie	Decolutive 1	athode a	inodes,	inodes,			
[157	0	0	0	0	157	1.000	1.000	1.000			
b2sum	1	147	0	0	0	0	147	1.000	1.000	1.000			
base32	2	96	0	0	0	0	96	1.000	1.000	1.000			
base64	1	96	0	0	0	0	96	1.000	1.000	1.000			
basena	ame	71	0	0	0	0	71	1.000	1.000	1.000			
baseno		133	0	0	0	0	133	1.000	1.000	1.000			
cat		101	0	0	0	0	101	1.000	1.000	1.000			
chcon		185	0	0	0	0	185	1.000	1.000	1.000			
chgrp		166	0	0	0	0	166	1.000	1.000	1.000			
chmod	l	176	0	0	0	0	176	1.000	1.000	1.000			
chown	l	176	0	0	0	0	176	1.000	1.000	1.000			
chroot		110	0	1	0	0	109	0.993	1.000	0.991			
cksum	l	488	0	0	0	0	488	1.000	1.000	1.000			
comm		104	0	0	0	0	104	1.000	1.000	1.000			
cp		382	0	1	0	2	379	0.997	1.000	0.992			
csplit		619	0	1	0	0	618	0.999	1.000	0.998			
cut		124	0	0	0	0	124	1.000	1.000	1.000			

Table 19: Varnode recovery (metatype = INT) (compilation = debug)

					MCH	1 12	<u>.</u>	ED .	
	.99	inode ⁵	nodes matche	d@level.WO	MA level OVE	RLAR BLAR SUBSE	e level Allon	Leon Rate score	O.I.
Cr ^C	ound truth vo	Decompiler vi	Decompilery	Decompiler v	Decompiler v	Decompiler via	athode average	indes fracti	inodes fraci
date	516	0	5	0	0	511	0.993	1.000	0.990
dd	332	0	0	0	0	332	1.000	1.000	1.000
df	326	0	0	0	0	326	1.000	1.000	1.000
dir	615	0	1	0	0	614	0.999	1.000	0.998
dircolors	90	0	0	0	0	90	1.000	1.000	1.000
dirname	73	0	0	0	0	73	1.000	1.000	1.000
du	931	0	2	0	0	929	0.998	1.000	0.998
echo	69	0	0	0	0	69	1.000	1.000	1.000
env	112	0	0	0	0	112	1.000	1.000	1.000
expand	94	0	0	0	0	94	1.000	1.000	1.000
expr	560	0	1	0	0	559	0.999	1.000	0.998
factor	343	13	0	0	0	330	0.962	0.962	0.962
false	62	0	0	0	0	62	1.000	1.000	1.000
fmt	112	0	0	0	0	112	1.000	1.000	1.000
fold	88	0	0	0	0	88	1.000	1.000	1.000
groups	81	0	0	0	0	81	1.000	1.000	1.000
head	138	0	0	0	0	138	1.000	1.000	1.000
hostid	67	0	0	0	0	67	1.000	1.000	1.000

Table 19: Varnode recovery (metatype = INT) (compilation = debug)

			Tecompiler v		MAICH A Michaele A Maiche de	ALAR Level 5 UBS	S S	iD s	
				, 2 0	Mr. WE	क्रा विशिष्ट	s Aligh	MATC	•
				@level	. @lever	@level	@ 1ever	ever .	671
			natche	d natche	id satche	s saiched	atched	ne score	ally re
		inoles	nodesni	nodes ni	nodesti	nodes it.	iodes in	ionnaid.	. Partice
	, thith v	silet v	di.	di.	dir Silet ve	di Silei vai	, average	i as fractic	i es fract
Cit	Jund Fruth vo	Decount	Decorrie	Decomit	Decount	Decoluis 4	@ level Alir	e level MA core in the core in	rnode
id	112	0	0	0	0	112	1.000	1.000	1.000
join	162	0	0	0	0	162	1.000	1.000	1.000
kill	88	0	0	0	0	88	1.000	1.000	1.000
link	66	0	0	0	0	66	1.000	1.000	1.000
ln	219	0	0	0	0	219	1.000	1.000	1.000
logname	66	0	0	0	0	66	1.000	1.000	1.000
ls	615	0	1	0	0	614	0.999	1.000	0.998
md5sum	139	0	0	0	0	139	1.000	1.000	1.000
mkdir	196	0	0	0	0	196	1.000	1.000	1.000
mkfifo	88	0	0	0	0	88	1.000	1.000	1.000
mknod	100	0	0	0	0	100	1.000	1.000	1.000
mktemp	96	0	0	0	0	96	1.000	1.000	1.000
mv	428	0	0	0	2	426	0.999	1.000	0.995
nice	77	0	0	0	0	77	1.000	1.000	1.000
nl	558	0	1	0	0	557	0.999	1.000	0.998
nohup	99	0	0	0	0	99	1.000	1.000	1.000
nproc	86	0	0	0	0	86	1.000	1.000	1.000
numfmt	184	0	0	0	0	184	1.000	1.000	1.000

Table 19: Varnode recovery (metatype = INT) (compilation = debug)

					<u></u>				
cko	gad truth vari	gales gangilet va	prodes matched	@ level NO?	MATCH Me level Over Geographies was	ALAR GEORGE STREET OF THE STRE	A level Alland	Devel MATCH	Dalially reco
od	294	0	1	0	0	293	0.997	1.000	0.997
paste	85	0	0	0	0	85	1.000	1.000	1.000
pathchk	85	0	0	0	0	85	1.000	1.000	1.000
pinky	96	0	0	0	0	96	1.000	1.000	1.000
pr	399	0	0	0	0	399	1.000	1.000	1.000
printenv	68	0	0	0	0	68	1.000	1.000	1.000
printf	168	0	3	0	0	165	0.987	1.000	0.982
ptx	673	0	1	0	0	672	0.999	1.000	0.999
pwd	75	0	0	0	0	75	1.000	1.000	1.000
readlink	111	0	0	0	0	111	1.000	1.000	1.000
realpath	111	0	0	0	0	111	1.000	1.000	1.000
rm	185	0	0	0	0	185	1.000	1.000	1.000
rmdir	139	0	0	0	0	139	1.000	1.000	1.000
runcon	65	0	0	0	0	65	1.000	1.000	1.000
seq	156	0	0	0	0	156	1.000	1.000	1.000
sha1sum	138	0	0	0	0	138	1.000	1.000	1.000
sha224sum	145	0	0	0	0	145	1.000	1.000	1.000
sha256sum	145	0	0	0	0	145	1.000	1.000	1.000

Table 19: Varnode recovery (metatype = INT) (compilation = debug)

	iatrol	es Rigitet varrodes	snatched @ le	vel NO MATO	H. A.	Alast Bater	and Allower Record	and Maricula Rate Search of Particular Varior	itially recover
Crour	d truth variod	mpiler vic	npilet va	npilet ve	ngiler de Decor	ngilet de Vatno	de averice	des fract	Jes fract
sha384sum	301	0	0	0	0	301	1.000	1.000	1.000
sha512sum	301	0	0	0	0	301	1.000	1.000	1.000
shred	238	0	0	0	0	238	1.000	1.000	1.000
shuf	210	0	0	0	0	210	1.000	1.000	1.000
sleep	76	0	0	0	0	76	1.000	1.000	1.000
sort	440	0	1	0	0	439	0.998	1.000	0.998
split	195	0	0	0	0	195	1.000	1.000	1.000
stat	392	0	0	0	0	392	1.000	1.000	1.000
stdbuf	156	0	0	0	0	156	1.000	1.000	1.000
stty	189	0	0	0	0	189	1.000	1.000	1.000
sum	183	0	0	0	0	183	1.000	1.000	1.000
sync	83	0	0	0	0	83	1.000	1.000	1.000
tac	584	0	1	0	0	583	0.999	1.000	0.998
tail	239	0	0	0	0	239	1.000	1.000	1.000
tee	95	0	0	0	0	95	1.000	1.000	1.000
test	155	0	0	0	0	155	1.000	1.000	1.000
timeout	95	0	0	0	0	95	1.000	1.000	1.000
touch	396	0	5	0	0	391	0.991	1.000	0.987

Table 19: Varnode recovery (metatype = INT) (compilation = debug)

_										
_	S	d truth vari	nodes	ndes matched	@ level 10 M	MICH DEVELOYER	J. A. P. L.	sevel Allicated @ l	Devel Marich	atially reco
	Citori	\ \rangle \sqrt{\langle}	20°	s _{co} ,	Secor 2	becox	Decor Astr	Vain	Vain	Ç
tr		153	0	0	0	0	153	1.000	1.000	1.000
true		62	0	0	0	0	62	1.000	1.000	1.000
trunca	ate	91	0	0	0	0	91	1.000	1.000	1.000
tsort		85	0	0	0	0	85	1.000	1.000	1.000
tty		65	0	0	0	0	65	1.000	1.000	1.000
unam	e	67	0	0	0	0	67	1.000	1.000	1.000
unexp	and	101	0	0	0	0	101	1.000	1.000	1.000
uniq		125	0	0	0	0	125	1.000	1.000	1.000
unlinl	ζ	66	0	0	0	0	66	1.000	1.000	1.000
uptim	e	261	0	0	0	0	261	1.000	1.000	1.000
users		73	0	0	0	0	73	1.000	1.000	1.000
vdir		615	0	1	0	0	614	0.999	1.000	0.998
wc		148	0	0	0	0	148	1.000	1.000	1.000
who		158	0	0	0	0	158	1.000	1.000	1.000
whoa	mi	68	0	0	0	0	68	1.000	1.000	1.000
yes		76	0	0	0	0	76	1.000	1.000	1.000

Table 20: Varnode recovery (metatype = FLOAT) (compilation = debug)

	nd tuth	vanode ⁵ Decompler va	modes matche	d@level MO.	MAICH A Bevelowing the state of the state o	RIAR DE STRUCTE	SET ALIGHE	ED MATCH	I Dall Partially res
·									
[h2	2	0	0	0	0	2	1.000	1.000	1.000
b2sum	0	0	0	0	0	0	-	-	-
base32		0					-	-	-
base64	0	0	0	0	0	0	-	-	-
basename	0	0	0	0	0	0	-	-	-
basenc	0	0	0	0	0	0	-	-	-
cat	0	0	0	0	0	0	-	-	-
chcon	3	0	0	0	0	3	1.000	1.000	1.000
chgrp	3	0	0	0	0	3	1.000	1.000	1.000
chmod	3	0	0	0	0	3	1.000	1.000	1.000
chown	3	0	0	0	0	3	1.000	1.000	1.000
chroot	0	0	0	0	0	0	-	-	-
cksum	3	0	0	0	0	3	1.000	1.000	1.000
comm	0	0	0	0	0	0	-	-	-
cp	3	0	0	0	0	3	1.000	1.000	1.000
csplit	0	0	0	0	0	0	-	-	-
cut	0	0	0	0	0	0	-	-	-

Table 20: Varnode recovery (metatype = FLOAT) (compilation = debug)

		Pecolopilet va	akitir	d@level HO?	MATCH A@levelOVF Decompiler	RLAR SUBSTRACTED TO THE SUBSTRAC	SET ALICE OF THE PROPERTY OF T	ED MATCH	0.1)
- Cyc	jund fruith	athodes Decompilet va	Decompiler v	Decompiler ve	Decompiler v	Decompiler wat	Where All I	Devel MA Compare score s	. Partiale.
date	2	0	0	0	0	2	1.000	1.000	1.000
dd	7	0	0	0	0	7	1.000	1.000	1.000
df	13	0	0	0	0	13	1.000	1.000	1.000
dir	6	0	0	0	0	6	1.000	1.000	1.000
dircolors	0	0	0	0	0	0	-	-	-
dirname	0	0	0	0	0	0	-	-	-
du	6	0	0	0	0	6	1.000	1.000	1.000
echo	0	0	0	0	0	0	-	-	-
env	0	0	0	0	0	0	-	-	-
expand	0	0	0	0	0	0	-	-	-
expr	0	0	0	0	0	0	-	-	-
factor	0	0	0	0	0	0	-	-	-
false	0	0	0	0	0	0	-	-	-
fmt	0	0	0	0	0	0	-	-	-
fold	0	0	0	0	0	0	-	-	-
groups	0	0	0	0	0	0	-	-	-
head	0	0	0	0	0	0	-	-	-
hostid	0	0	0	0	0	0	_	-	_

Table 20: Varnode recovery (metatype = FLOAT) (compilation = debug)

					<u> </u>				
ÇŞÝ	and truth	atrodes	Jecompiler V	d@level HO	MATCH de level OVE amodes marche	Ad level 5118	SET ALIGH d@levelALIGH Allodes matched of	ED AATCE	A DAIL DAIL DAIL DAIL DAIL DAIL DAIL DAI
id	0	0	0	0	0	0	-	-	_
join	0	0	0	0	0	0	-	-	-
kill	0	0	0	0	0	0	-	-	-
link	0	0	0	0	0	0	-	-	-
ln	3	0	0	0	0	3	1.000	1.000	1.000
logname	0	0	0	0	0	0	-	-	-
ls	6	0	0	0	0	6	1.000	1.000	1.000
md5sum	0	0	0	0	0	0	-	-	-
mkdir	2	0	0	0	0	2	1.000	1.000	1.000
mkfifo	0	0	0	0	0	0	-	-	-
mknod	0	0	0	0	0	0	-	-	-
mktemp	0	0	0	0	0	0	-	-	-
mv	3	0	0	0	0	3	1.000	1.000	1.000
nice	0	0	0	0	0	0	-	-	-
nl	0	0	0	0	0	0	-	-	-
nohup	0	0	0	0	0	0	-	-	-
nproc	0	0	0	0	0	0	-	-	-
numfmt	7	0	0	0	0	7	1.000	1.000	1.000

Table 20: Varnode recovery (metatype = FLOAT) (compilation = debug)

Groi	ind truth ve	inodes Jeconniler vit	nodes matched	@ level NO.	Marchi © Level Owlift modes matched	And Evel 3 Up.	e level Alland	Devel Maricul	partially reco
od	11	0	0	0	0	11	1.000	1.000	1.000
paste	0	0	0	0	0	0	-	-	-
pathchk	0	0	0	0	0	0	-	-	-
pinky	0	0	0	0	0	0	-	-	-
pr	0	0	0	0	0	0	-	-	-
printenv	0	0	0	0	0	0	-	-	-
printf	7	0	0	0	0	7	1.000	1.000	1.000
ptx	0	0	0	0	0	0	-	-	-
pwd	0	0	0	0	0	0	-	-	-
readlink	3	0	0	0	0	3	1.000	1.000	1.000
realpath	3	0	0	0	0	3	1.000	1.000	1.000
rm	3	0	0	0	0	3	1.000	1.000	1.000
rmdir	2	0	0	0	0	2	1.000	1.000	1.000
runcon	0	0	0	0	0	0	-	-	-
seq	10	0	0	0	0	10	1.000	1.000	1.000
sha1sum	0	0	0	0	0	0	-	-	-
sha224sum	0	0	0	0	0	0	-	-	-
sha256sum	0	0	0	0	0	0	_	_	_

Table 20: Varnode recovery (metatype = FLOAT) (compilation = debug)

	d truth variod	es Inhilet withode	snathed@lessande	well Market Warrange	Ja Januar Paris Ja	welstysted@respective and ward	Wel Allica RED Tracked @ 18	we MATCH in the score Io.	il tially recover
sha384sum	0	0	0 Sec.	0 Sec.	0 Sec.	0	√air	√air	
sha512sum	0	0	0	0	0	0	_	_	_
shred	3	0	0	0	0	3	1.000	1.000	1.000
shuf	3	0	0	0	0	3	1.000	1.000	1.000
sleep	7	0	0	0	0	7	1.000	1.000	1.000
sort	18	0	0	0	0	18	1.000	1.000	1.000
split	0	0	0	0	0	0	-	-	-
stat	2	0	0	0	0	2	1.000	1.000	1.000
stdbuf	2	0	0	0	0	2	1.000	1.000	1.000
stty	2	0	0	0	0	2	1.000	1.000	1.000
sum	3	0	0	0	0	3	1.000	1.000	1.000
sync	0	0	0	0	0	0	-	-	-
tac	0	0	0	0	0	0	-	-	-
tail	11	0	0	0	0	11	1.000	1.000	1.000
tee	0	0	0	0	0	0	-	-	-
test	2	0	0	0	0	2	1.000	1.000	1.000
timeout	8	0	0	0	0	8	1.000	1.000	1.000
touch	2	0	0	0	0	2	1.000	1.000	1.000

Table 20: Varnode recovery (metatype = FLOAT) (compilation = debug)

	Ground truth vat	nodes econolier val	nodes marched for the property of the property	e level NO M	a level over	LAP SUBSI	eil Allandi @ level Allandi & level Al	Devel MAICH Innate score II	J.II
tr	0	0	0	0	0	0	-	-	-
true	0	0	0	0	0	0	-	-	-
truncat	e 0	0	0	0	0	0	-	-	-
tsort	0	0	0	0	0	0	-	-	-
tty	0	0	0	0	0	0	-	-	-
uname	0	0	0	0	0	0	-	-	-
unexpa	and 0	0	0	0	0	0	-	-	-
uniq	0	0	0	0	0	0	-	-	-
unlink	0	0	0	0	0	0	-	-	-
uptime	2	0	0	0	0	2	1.000	1.000	1.0
users	0	0	0	0	0	0	-	-	-
vdir	6	0	0	0	0	6	1.000	1.000	1.0
wc	4	0	0	0	0	4	1.000	1.000	1.0
who	2	0	0	0	0	2	1.000	1.000	1.0
whoan	ni 0	0	0	0	0	0	-	-	-
yes	0	0	0	0	0	0	-	-	-

Table 21: Varnode recovery (metatype = POINTER) (compilation = debug)

					C.	9			
				2	MATE	RIAY 1859	र्त राज्य	il stol	>
				ail to	welow,	Welsur	avel Alix	avel Mix	S
				7 _{©/c}	2 [©] /6	, so	® 16	g le agre	6.,
		, o ^c 5	a Thatch	s matche	- matchi	Finalche	anatche	Mare &C	rtially 1
	4	athode	inodes	athoder	inder	stnodes sar	ioder inge	citor	, Par
	ad truth	miler	mpiler	apiler	mpiler	miler	-de aveil	destrai	Partially f
Cit	and fully	athodes Decompilet va	Decor	d@level.MO	Decorr	RIAR RUNDER TO THE PROPERTY OF	@ Level Ali.	plevel MAR core is core is core in the cor	INOC
[68	0	0	0	0	68	1.000	1.000	1.000
b2sum	56	0	0	0	0	56	1.000	1.000	1.000
base32	41	0	0	0	0	41	1.000	1.000	1.000
base64	41	0	0	0	0	41	1.000	1.000	1.000
basename	38	0	0	0	0	38	1.000	1.000	1.000
basenc	55	0	0	0	0	55	1.000	1.000	1.000
cat	41	0	0	0	0	41	1.000	1.000	1.000
chcon	134	0	0	0	0	134	1.000	1.000	1.000
chgrp	133	0	0	0	0	133	1.000	1.000	1.000
chmod	127	0	0	0	0	127	1.000	1.000	1.000
chown	142	0	0	0	0	142	1.000	1.000	1.000
chroot	67	0	0	0	0	67	1.000	1.000	1.000
cksum	99	0	0	0	0	99	1.000	1.000	1.000
comm	35	0	0	0	0	35	1.000	1.000	1.000
cp	231	0	0	0	0	231	1.000	1.000	1.000
csplit	272	0	0	0	0	272	1.000	1.000	1.000
cut	46	0	0	0	0	46	1.000	1.000	1.000

Table 21: Varnode recovery (metatype = POINTER) (compilation = debug)

				d@level.WO	MATCH Sed @ level OVE Secondilet vo	RLAR BLAR SUBS	<u>.</u>	iD s	<u> </u>
				,40	Mr. Joyf	gu isubs	i Aligh	MATC	•
				. @level	. @lever	@lever	@lever	plever	6,1)
			adche	d natche	ed satche	d satched	natched	nescote	. ally re
	,	rnodes	nolesti	nodesti	nodesti	modes it	nodes fir	OMPL . OF	Pattie .
	1 truth 4	d silet w	a. Silet v	al. Siler v	ai. Silet vo	ar siler val	, average) as fractic	105 Stack
Cit	Jund Fruit V	Decount	Decorrie	Decount	Decomit	Decolult	@ Level Alt.	plevel MAR cone is compare score in the control of	inode
date	125	0	0	0	0	125	1.000	1.000	1.000
dd	98	0	0	0	0	98	1.000	1.000	1.000
df	239	0	0	0	0	239	1.000	1.000	1.000
dir	293	0	0	0	0	293	1.000	1.000	1.000
dircolors	76	0	0	0	0	76	1.000	1.000	1.000
dirname	32	0	0	0	0	32	1.000	1.000	1.000
du	438	0	0	0	0	438	1.000	1.000	1.000
echo	30	0	0	0	0	30	1.000	1.000	1.000
env	54	0	0	0	0	54	1.000	1.000	1.000
expand	35	0	0	0	0	35	1.000	1.000	1.000
expr	259	0	0	0	0	259	1.000	1.000	1.000
factor	98	3	0	0	0	95	0.969	0.969	0.969
false	28	0	0	0	0	28	1.000	1.000	1.000
fmt	52	0	0	0	0	52	1.000	1.000	1.000
fold	33	0	0	0	0	33	1.000	1.000	1.000
groups	40	0	0	0	0	40	1.000	1.000	1.000
head	47	0	0	0	0	47	1.000	1.000	1.000
hostid	29	0	0	0	0	29	1.000	1.000	1.000

Table 21: Varnode recovery (metatype = POINTER) (compilation = debug)

		inade ⁵	Decomplet v	d@level HO	MAICH d@levelOve drindles maiche	RLAR BURGES THE LEE OF	ei level Aller (© level Aller	iD level MATCH	O.1)
Gr	Jund truth "	Decompiler vi	Decompiler vi	Decompiler v	Decompiler w	Decompiler val	athode average	inodes fractic	inades fracti
id	60	0	0	0	0	60	1.000	1.000	1.000
join	66	0	0	0	0	66	1.000	1.000	1.000
kill	36	0	0	0	0	36	1.000	1.000	1.000
link	29	0	0	0	0	29	1.000	1.000	1.000
ln	161	0	0	0	0	161	1.000	1.000	1.000
logname	30	0	0	0	0	30	1.000	1.000	1.000
ls	293	0	0	0	0	293	1.000	1.000	1.000
md5sum	50	0	0	0	0	50	1.000	1.000	1.000
mkdir	71	0	0	0	0	71	1.000	1.000	1.000
mkfifo	36	0	0	0	0	36	1.000	1.000	1.000
mknod	41	0	0	0	0	41	1.000	1.000	1.000
mktemp	44	0	0	0	0	44	1.000	1.000	1.000
mv	254	0	0	0	0	254	1.000	1.000	1.000
nice	33	0	0	0	0	33	1.000	1.000	1.000
nl	247	0	0	0	0	247	1.000	1.000	1.000
nohup	40	0	0	0	0	40	1.000	1.000	1.000
nproc	32	0	0	0	0	32	1.000	1.000	1.000
numfmt	70	0	0	0	0	70	1.000	1.000	1.000

Table 21: Varnode recovery (metatype = POINTER) (compilation = debug)

-					<u></u>				
	÷	nnodes	node ^s matched	Decomplies was	MAICH @ Level Over modes matched	ALAR LOGICAL STREET WATER	Jewel Allows Devel Allows Des trached @	Devel MATCH Jordan Score	D.I.I. Patrially recov
- Char	nd truth vo	econtiples val	Decompiler voi	Decompiler vol	Decomplies va	Decountiler was	inde averass	nodes fractic	nodes fractio
od	93	0	0	0	0	93	1.000	1.000	1.000
paste	37	0	0	0	0	37	1.000	1.000	1.000
pathchk	33	0	0	0	0	33	1.000	1.000	1.000
pinky	57	0	0	0	0	57	1.000	1.000	1.000
pr	102	0	0	0	0	102	1.000	1.000	1.000
printenv	31	0	0	0	0	31	1.000	1.000	1.000
printf	76	0	0	0	0	76	1.000	1.000	1.000
ptx	331	0	0	0	0	331	1.000	1.000	1.000
pwd	41	0	0	0	0	41	1.000	1.000	1.000
readlink	100	0	0	0	0	100	1.000	1.000	1.000
realpath	105	0	0	0	0	105	1.000	1.000	1.000
rm	136	0	0	0	0	136	1.000	1.000	1.000
rmdir	66	0	0	0	0	66	1.000	1.000	1.000
runcon	36	0	0	0	0	36	1.000	1.000	1.000
seq	81	0	0	0	0	81	1.000	1.000	1.000
sha1sum	49	0	0	0	0	49	1.000	1.000	1.000
sha224sum	50	0	0	0	0	50	1.000	1.000	1.000
sha256sum	50	0	0	0	0	50	1.000	1.000	1.000

Table 21: Varnode recovery (metatype = POINTER) (compilation = debug)

Groun	d truth varied	ges Angilet wanode	Snathed & le	vel MO MATC	Jel Over Red & Personal Property Personal Person	wel SUBSET	arakhed@leanakhedwleanakhe	Pale Score 10.	ijally recove
sha384sum	50	0	0	0	0	50	1.000	1.000	1.000
sha512sum	50	0	0	0	0	50	1.000	1.000	1.000
shred	87	0	0	0	0	87	1.000	1.000	1.000
shuf	134	0	0	0	0	134	1.000	1.000	1.000
sleep	35	0	0	0	0	35	1.000	1.000	1.000
sort	299	0	0	0	0	299	1.000	1.000	1.000
split	69	0	0	0	0	69	1.000	1.000	1.000
stat	150	0	0	0	0	150	1.000	1.000	1.000
stdbuf	79	0	0	0	0	79	1.000	1.000	1.000
stty	73	0	0	0	0	73	1.000	1.000	1.000
sum	60	0	0	0	0	60	1.000	1.000	1.000
sync	29	0	0	0	0	29	1.000	1.000	1.000
tac	250	0	0	0	0	250	1.000	1.000	1.000
tail	124	0	0	0	0	124	1.000	1.000	1.000
tee	35	0	0	0	0	35	1.000	1.000	1.000
test	67	0	0	0	0	67	1.000	1.000	1.000
timeout	41	0	0	0	0	41	1.000	1.000	1.000
touch	110	0	0	0	0	110	1.000	1.000	1.000

Table 21: Varnode recovery (metatype = POINTER) (compilation = debug)

			nodes matched	@ level 40)	Maricul Me level Ovlete Modes trached	LAR BUBSE	Jewel All Chief (C) Jewel Author Walls	evel MATCH	, <u>,</u> ,)
	and truth warm	odes ider var	nodes matched	ides matched	nodes hatched	ides matched	Jevel Alic des traiched @ \ node average co	evel Mir serve IC in parties and a serve IC warm	antially reco
Cita	and Des	Ollify	Decount,	ecomy.	Decount,	Secounty. Ast	thode Aath	gde Vair	oder
tr	58	0	0	0	0	58	1.000	1.000	1.000
true	28	0	0	0	0	28	1.000	1.000	1.000
truncate	32	0	0	0	0	32	1.000	1.000	1.000
tsort	52	0	0	0	0	52	1.000	1.000	1.000
tty	29	0	0	0	0	29	1.000	1.000	1.000
uname	30	0	0	0	0	30	1.000	1.000	1.000
unexpand	36	0	0	0	0	36	1.000	1.000	1.000
uniq	50	0	0	0	0	50	1.000	1.000	1.000
unlink	29	0	0	0	0	29	1.000	1.000	1.000
uptime	57	0	0	0	1	56	0.996	1.000	0.982
users	38	0	0	0	0	38	1.000	1.000	1.000
vdir	293	0	0	0	0	293	1.000	1.000	1.000
wc	84	0	0	0	0	84	1.000	1.000	1.000
who	83	0	0	0	0	83	1.000	1.000	1.000
whoami	30	0	0	0	0	30	1.000	1.000	1.000
yes	34	0	0	0	0	34	1.000	1.000	1.000

Table 22: Varnode recovery (metatype = ARRAY) (compilation = debug)

					, CA	9		2	
				de level NO	MATE	Read Revelos Berger Land	iei Align	ED MATCH	A
				ide ler	7° /6 ₂	ig _{() 52} ,	@level Allie nodes matched @	Jevel MA. Compare score	0,1,
		Je ⁵	1es match	125 Match	185 Malch	1es match	1es Malch	annaic sc	I Partially re
	and full v	atrio	inode 1.4	atriode 3. 48	ithode x 4	atriode x vai	hode setage	io Graction	i kac _i
	and true	compiler	compiler	compiler	compiler	compiler	rnole and	modesti	modesti
	~		<u> </u>	→	→	Dec 2	1.91. 1.9	70	
[15	0	0	0	0	15	1.000	1.000	1.000
b2sum	24	0	0	0	0	24	1.000	1.000	1.000
base32	12	0	0	0	0	12	1.000	1.000	1.000
base64	12	0	0	0	0	12	1.000	1.000	1.000
basename	10	0	0	0	0	10	1.000	1.000	1.000
basenc	20	0	0	0	0	20	1.000	1.000	1.000
cat	11	0	0	0	0	11	1.000	1.000	1.000
chcon	18	0	0	0	0	18	1.000	1.000	1.000
chgrp	15	0	0	0	0	15	1.000	1.000	1.000
chmod	19	0	0	0	0	19	1.000	1.000	1.000
chown	16	0	0	0	0	16	1.000	1.000	1.000
chroot	11	0	0	0	0	11	1.000	1.000	1.000
cksum	66	0	0	0	0	66	1.000	1.000	1.000
comm	22	0	0	0	0	22	1.000	1.000	1.000
ср	40	0	1	0	0	39	0.981	1.000	0.975
csplit	35	0	0	1	0	34	0.986	1.000	0.971
cut	12	0	0	0	0	12	1.000	1.000	1.000

Table 22: Varnode recovery (metatype = ARRAY) (compilation = debug)

		vanode ⁵ Decompiler va	matche	d @ level HO	MAICH A Willewell Over Jeographier Willey	Ada level silver de la	SET ALICANO DE LA COMPANIO DEL COMPANIO DE LA COMPANIO DEL COMPANIO DE LA COMPANIO DEL COMPANIO DEL COMPANIO DE LA COMPANIO DEL COMPANIO DEL COMPANIO DEL COMPANIO DEL COMPANIO DE LA COMPANIO DE LA COMPANIO DEL COM	iD AND CE	O.I.
	Jund truth	Variodes Decompiler va	Decompiler v	Decompiler of	Decompiler w	Decompilet was	Watnode average	Jewel MA. Longage score	. Patially re
date	63	0	2	2	0	59	0.960	1.000	0.937
dd	34	0	0	0	0	34	1.000	1.000	1.000
df	25	0	1	0	0	24	0.970	1.000	0.960
dir	71	0	2	3	0	66	0.958	1.000	0.930
dircolors	13	0	0	0	0	13	1.000	1.000	1.000
dirname	10	0	0	0	0	10	1.000	1.000	1.000
du	51	0	0	2	0	49	0.980	1.000	0.961
echo	9	0	0	0	0	9	1.000	1.000	1.000
env	18	0	0	0	0	18	1.000	1.000	1.000
expand	13	0	0	0	0	13	1.000	1.000	1.000
expr	33	0	0	1	0	32	0.985	1.000	0.970
factor	37	5	0	0	0	32	0.865	0.865	0.865
false	9	0	0	0	0	9	1.000	1.000	1.000
fmt	12	0	0	0	0	12	1.000	1.000	1.000
fold	12	0	0	0	0	12	1.000	1.000	1.000
groups	11	0	0	0	0	11	1.000	1.000	1.000
head	18	0	0	0	0	18	1.000	1.000	1.000
hostid	12	0	0	0	0	12	1.000	1.000	1.000

Table 22: Varnode recovery (metatype = ARRAY) (compilation = debug)

		Valrode ⁵ Decombier ¹⁹	odes matche	d@level HO	MAICH A Willewell Over Jeographier Willey	RLAR ALAR SUBSTANTIAL PORTON TO THE SUBSTANTIAL PROPERTY OF THE SUBSTANTIAL PROPERTY O	Fit Allow Allow Warned Co. Warnede average C. Warnede average C.	Level MAICH	O.11
	Sund truth	Valrode ⁵ Decombilet ⁴⁸	Decompiler v	Decompiler v	Decompiler vi	Decompiler was	Vatrode average	inodes fraction	inoles fract
id	14	0	0	0	0	14	1.000	1.000	1.000
join	18	0	0	0	0	18	1.000	1.000	1.000
kill	14	0	0	0	0	14	1.000	1.000	1.000
link	12	0	0	0	0	12	1.000	1.000	1.000
ln	22	0	0	0	0	22	1.000	1.000	1.000
logname	12	0	0	0	0	12	1.000	1.000	1.000
ls	71	0	2	3	0	66	0.958	1.000	0.930
md5sum	16	0	0	0	0	16	1.000	1.000	1.000
mkdir	19	0	1	0	0	18	0.961	1.000	0.947
mkfifo	12	0	0	0	0	12	1.000	1.000	1.000
mknod	12	0	0	0	0	12	1.000	1.000	1.000
mktemp	12	0	0	0	0	12	1.000	1.000	1.000
mv	34	0	1	0	0	33	0.978	1.000	0.971
nice	10	0	0	0	0	10	1.000	1.000	1.000
nl	36	0	0	1	0	35	0.986	1.000	0.972
nohup	13	0	0	0	0	13	1.000	1.000	1.000
nproc	10	0	0	0	0	10	1.000	1.000	1.000
numfmt	20	0	0	0	0	20	1.000	1.000	1.000

Table 22: Varnode recovery (metatype = ARRAY) (compilation = debug)

					. A	0			
CKO)	and truth's	atrodes	nodes hadded	Level NO.	MATCI. MATCI.	ALAR Evel SUBS	er andes nathed @	Devel MAICH Danpare score	Datially rect
od	40	0	0	0	0	40	1.000	1.000	1.000
paste	10	0	0	0	0	10	1.000	1.000	1.000
pathchk	10	0	0	0	0	10	1.000	1.000	1.000
pinky	17	0	0	1	0	16	0.971	1.000	0.941
pr	20	0	0	1	0	19	0.975	1.000	0.950
printenv	10	0	0	0	0	10	1.000	1.000	1.000
printf	17	0	0	0	0	17	1.000	1.000	1.000
ptx	39	0	0	1	0	38	0.987	1.000	0.974
pwd	10	0	0	0	0	10	1.000	1.000	1.000
readlink	12	0	0	0	0	12	1.000	1.000	1.000
realpath	11	0	0	0	0	11	1.000	1.000	1.000
rm	15	0	0	0	0	15	1.000	1.000	1.000
rmdir	14	0	0	0	0	14	1.000	1.000	1.000
runcon	10	0	0	0	0	10	1.000	1.000	1.000
seq	15	0	0	0	0	15	1.000	1.000	1.000
sha1sum	16	0	0	0	0	16	1.000	1.000	1.000
sha224sum	17	0	0	0	0	17	1.000	1.000	1.000
sha256sum	17	0	0	0	0	17	1.000	1.000	1.000

Table 22: Varnode recovery (metatype = ARRAY) (compilation = debug)

					C.				
				@level 140 M	ARIV WER	LAR Georgia Libertian Company of the	Jacobs Allica Military of the State of the S	MAICH	
				@ level !	@level C	alevel 3	Devel Altracted @ loades traterage con	private score In the state of t	,j)
			atched	atched	atched	atched	atched	rescore r	114 reco
	ζ ^κ	nodes	iodes inc	nodes title	iodes inte	iodes tite	odes in	MA SALL	atia
	. Kuth var	ailer var	ilei vai	i. Alei vai	i. Alet vat	i diet vati	a average	as fraction	as fractio
Circur	gd truth vali	ecoluly.	ecount,	pecolity,	ecolul,	secount,	inode Var	joder Vari	patially rection
sha384sum sha512sum	17 17	0	0	0	0	17 17	1.000 1.000	1.000 1.000	1.000 1.000
shred	27	0	0	1	0	26	0.981	1.000	0.963
				0	0				
shuf	12	0	0			12	1.000	1.000	1.000
sleep	12	0	0	0	0	12	1.000	1.000	1.000
sort	46	0	1	0	0	45	0.984	1.000	0.978
split	18	0	1	0	0	17	0.958	1.000	0.944
stat	32	0	0	1	0	31	0.984	1.000	0.969
stdbuf	16	0	0	0	0	16	1.000	1.000	1.000
stty	19	0	0	0	0	19	1.000	1.000	1.000
sum	22	0	0	0	0	22	1.000	1.000	1.000
sync	11	0	0	0	0	11	1.000	1.000	1.000
tac	33	0	0	1	0	32	0.985	1.000	0.970
tail	20	0	1	0	0	19	0.963	1.000	0.950
tee	14	0	0	0	0	14	1.000	1.000	1.000
test	12	0	0	0	0	12	1.000	1.000	1.000
timeout	13	0	0	0	0	13	1.000	1.000	1.000
touch	56	0	2	1	0	53	0.964	1.000	0.946

Table 22: Varnode recovery (metatype = ARRAY) (compilation = debug)

			nodes matched	@ level 10 M	RICH OVER	LAR GLEVELSTER LIBERT VERTICAL SECONDIFIER	Jewel All Cherkle	evel MATCH	,\\
_	Ground truth wa	inodes Decompiler wi	nodes nav	odes trait	peconopiles was	pecondilet ward	Level Allication of the state o	inpate score 10	atially reco
tr	17	0	0	0	0	17	1.000	1.000	1.000
true	9	0	0	0	0	9	1.000	1.000	1.000
truncat	e 10	0	0	0	0	10	1.000	1.000	1.000
tsort	13	0	0	0	0	13	1.000	1.000	1.000
tty	10	0	0	0	0	10	1.000	1.000	1.000
uname	12	0	0	0	0	12	1.000	1.000	1.000
unexpa	nd 11	0	0	0	0	11	1.000	1.000	1.000
uniq	15	0	0	0	0	15	1.000	1.000	1.000
unlink	12	0	0	0	0	12	1.000	1.000	1.000
uptime	18	0	0	1	0	17	0.972	1.000	0.944
users	12	0	0	0	0	12	1.000	1.000	1.000
vdir	71	0	2	3	0	66	0.958	1.000	0.930
wc	16	0	0	0	0	16	1.000	1.000	1.000
who	25	0	0	0	0	25	1.000	1.000	1.000
whoam	ni 12	0	0	0	0	12	1.000	1.000	1.000
yes	12	0	0	0	0	12	1.000	1.000	1.000

Table 23: Varnode recovery (metatype = STRUCT) (compilation = debug)

		₩	as match	ed level 100	pevel NO MARICH Revel NO MARICH Revel OVER LAR Revel STBSET Revel ALLCMED Revel MARICH Reserved To Lord ALLCMED Revel MARICH Variodes Revel MARICH Variodes Fraction part Variodes Revel Mariodes Fraction part Variodes Fraction part Var							
Cr ^C	jund truth	Valrodes Decompiler val	node Decompiler	Decompler 19	Decompiler 1st	Decompler with	ande werage	rot trodes fraction	Tadially re			
[24	0	0	0	0	24	1.000	1.000	1.000			
b2sum	10	0	0	0	0	10	1.000	1.000	1.000			
base32	11	0	0	0	0	11	1.000	1.000	1.000			
base64	11	0	0	0	0	11	1.000	1.000	1.000			
basename	10	0	0	0	0	10	1.000	1.000	1.000			
basenc	11	0	0	0	0	11	1.000	1.000	1.000			
cat	11	0	0	0	0	11	1.000	1.000	1.000			
chcon	23	0	0	0	0	23	1.000	1.000	1.000			
chgrp	22	0	0	0	0	22	1.000	1.000	1.000			
chmod	22	0	0	0	0	22	1.000	1.000	1.000			
chown	22	0	0	0	0	22	1.000	1.000	1.000			
chroot	10	0	0	0	0	10	1.000	1.000	1.000			
cksum	22	0	0	0	0	22	1.000	1.000	1.000			
comm	10	0	0	0	0	10	1.000	1.000	1.000			
ср	46	0	0	0	0	46	1.000	1.000	1.000			
csplit	56	0	0	0	0	56	1.000	1.000	1.000			
cut	10	0	0	0	0	10	1.000	1.000	1.000			

Table 23: Varnode recovery (metatype = STRUCT) (compilation = debug)

			Trades matched @ level 100 Marchel @ level of the level stips of the level at tender land the level marched @						
				. 20	Mr. OVE	ख़ी, जाह	st, Micig	MATC	· '
				@level,	@ level 2	@Jevel"	@ level All. Inodes matched @	e level MA core in the core in	(1,0
			atche	de atche	de	de atched	siched a	, e score	114 te
		nodes	odestria	odes mia	odes mia	odes mia	ades mid	:OMPAIL	Patial.
	dill	Valuades Decomplet va	ine .1ei v	atrie . 1et v	atric .1ex 18	ithe retual	ine average	fraction	, Pathally re
, s ^C	nind ti	- acompile	COMPILE	- acompite	- acompile	COMPIL	inthode a	inodes 10	inoles
		<u> </u>	<u></u>	→	<u></u>	D	7,0 7,0	7.0	<i>r</i>
date	39	0	1	0	0	38	0.981	1.000	0.974
dd	22	0	0	0	0	22	1.000	1.000	1.000
df	37	0	1	0	0	36	0.980	1.000	0.973
dir	46	0	1	0	0	45	0.984	1.000	0.978
dircolors	11	0	0	0	0	11	1.000	1.000	1.000
dirname	10	0	0	0	0	10	1.000	1.000	1.000
du	73	0	0	0	0	73	1.000	1.000	1.000
echo	10	0	0	0	0	10	1.000	1.000	1.000
env	17	0	0	0	0	17	1.000	1.000	1.000
expand	10	0	0	0	0	10	1.000	1.000	1.000
expr	59	0	0	0	0	59	1.000	1.000	1.000
factor	32	2	1	0	0	29	0.914	0.938	0.906
false	10	0	0	0	0	10	1.000	1.000	1.000
fmt	10	0	0	0	0	10	1.000	1.000	1.000
fold	10	0	0	0	0	10	1.000	1.000	1.000
groups	10	0	0	0	0	10	1.000	1.000	1.000
head	12	0	0	0	0	12	1.000	1.000	1.000
hostid	10	0	0	0	0	10	1.000	1.000	1.000

Table 23: Varnode recovery (metatype = STRUCT) (compilation = debug)

		‰ ⁵	as matche	d@level.HO	Decompiler variodes fractived @ Joseph Decompiler variode average compares fraction parties.							
Gr	and huti	Verongilet ve	Decompiler v	Decompiler v	Decompiler va	Decomplies was	noder verage	ndes fraction	.Pid Inodes fraci			
id	10	0	0	0	0	10	1.000	1.000	1.000			
join	14	0	0	0	0	14	1.000	1.000	1.000			
kill	10	0	0	0	0	10	1.000	1.000	1.000			
link	10	0	0	0	0	10	1.000	1.000	1.000			
ln	28	0	0	0	0	28	1.000	1.000	1.000			
logname	10	0	0	0	0	10	1.000	1.000	1.000			
ls	46	0	1	0	0	45	0.984	1.000	0.978			
md5sum	12	0	0	0	0	12	1.000	1.000	1.000			
mkdir	18	0	0	0	0	18	1.000	1.000	1.000			
mkfifo	12	0	0	0	0	12	1.000	1.000	1.000			
mknod	12	0	0	0	0	12	1.000	1.000	1.000			
mktemp	12	0	0	0	0	12	1.000	1.000	1.000			
mv	53	0	0	0	0	53	1.000	1.000	1.000			
nice	10	0	0	0	0	10	1.000	1.000	1.000			
nl	55	0	0	0	0	55	1.000	1.000	1.000			
nohup	10	0	0	0	0	10	1.000	1.000	1.000			
nproc	11	0	0	0	0	11	1.000	1.000	1.000			
numfmt	10	0	0	0	0	10	1.000	1.000	1.000			

Table 23: Varnode recovery (metatype = STRUCT) (compilation = debug)

					A 2					
ó	ind truth "	atrodes	rodes halched	Level NO	MATCH. Me level Ovilla Matcheological conditions and the conditions are considered to the conditions are conditions ar	ALAR STREET OF S	el evel allowing of a strade average of a stra	Devel Maricular on Particular Security of the	patially rect	
od Os	13	0	0	0	0	13	1.000	1.000	1.000	
paste	10	0	0	0	0	10	1.000	1.000	1.000	
pathchk	13	0	0	0	0	13	1.000	1.000	1.000	
pinky	12	0	0	0	0	12	1.000	1.000	1.000	
pr	22	0	0	0	0	22	1.000	1.000	1.000	
printenv	10	0	0	0	0	10	1.000	1.000	1.000	
printf	15	0	0	0	0	15	1.000	1.000	1.000	
ptx	82	0	1	0	0	81	0.991	1.000	0.988	
pwd	17	0	0	0	0	17	1.000	1.000	1.000	
readlink	17	0	0	0	0	17	1.000	1.000	1.000	
realpath	18	0	0	0	0	18	1.000	1.000	1.000	
rm	23	0	0	0	0	23	1.000	1.000	1.000	
rmdir	13	0	0	0	0	13	1.000	1.000	1.000	
runcon	10	0	0	0	0	10	1.000	1.000	1.000	
seq	17	0	0	0	0	17	1.000	1.000	1.000	
sha1sum	12	0	0	0	0	12	1.000	1.000	1.000	
sha224sum	13	0	0	0	0	13	1.000	1.000	1.000	
sha256sum	13	0	0	0	0	13	1.000	1.000	1.000	

Table 23: Varnode recovery (metatype = STRUCT) (compilation = debug)

				@level 120 M	@level Ovlete @level Ovlete geoffpiter var		evel Alto AED MARCH. Stratched @ level MARCH. Stratched @ level MARCH. Stratched @ level MARCH. Variodes fraction partially. Variodes fraction partially.		
				107	iki wek	JA JBSÉ	Jent.	Mich	
				level The	Jevel O.	revel SC	revel Ar	sevel Mr	Ŋ
			hed	@ ' hed	@ ' hed	@ r ched	ed@	, scotell	, reco
		-de ⁵	aes maic.	aes maic.	aes maic.	aes maic.	1es mater	inpate 3	atially
	gd truth vali	no vari	iode rati	iode , var	iode , var	iog rath	arage c	, action i	racios
.S	idtur	Ompiles	Ompiler	Ompiler	ompiler	ompilei	adean	odesfil	odesfil
Chor	Q	, ⁵⁰⁰ 5	Sec. 2	Sec. 2	Dec 2	LAR Georgia State of the Land	Devel Altrade of a least of the state of the	revel Mir.	patially rector
sha384sum	13	0	0	0	0	13	1.000	1.000	1.000
sha512sum	13	0	0	0	0	13	1.000	1.000	1.000
shred	15	0	0	0	0	15	1.000	1.000	1.000
shuf	15	0	0	0	0	15	1.000	1.000	1.000
sleep	13	0	0	0	0	13	1.000	1.000	1.000
sort	44	0	0	0	0	44	1.000	1.000	1.000
split	15	0	0	0	0	15	1.000	1.000	1.000
stat	32	0	0	0	0	32	1.000	1.000	1.000
stdbuf	14	0	0	0	0	14	1.000	1.000	1.000
stty	18	0	0	0	0	18	1.000	1.000	1.000
sum	10	0	0	0	0	10	1.000	1.000	1.000
sync	10	0	0	0	0	10	1.000	1.000	1.000
tac	53	0	0	0	0	53	1.000	1.000	1.000
tail	29	0	0	0	0	29	1.000	1.000	1.000
tee	10	0	0	0	0	10	1.000	1.000	1.000
test	24	0	0	0	0	24	1.000	1.000	1.000
timeout	18	0	0	0	0	18	1.000	1.000	1.000
touch	36	0	1	0	0	35	0.979	1.000	0.972

Table 23: Varnode recovery (metatype = STRUCT) (compilation = debug)

	Ground truth vari	ides with	nodes marked	@ level NO M	A MATCH A M								
	Cround De	COMIL	Decount C	ecolini?	becount 2	peconing was	inode Vain	ode Varn	ode				
 tr	13	0	0	0	0	13	1.000	1.000	1.000				
true	10	0	0	0	0	10	1.000	1.000	1.000				
truncat	e 12	0	0	0	0	12	1.000	1.000	1.000				
tsort	12	0	0	0	0	12	1.000	1.000	1.000				
tty	10	0	0	0	0	10	1.000	1.000	1.000				
uname	11	0	0	0	0	11	1.000	1.000	1.000				
unexpa	nd 10	0	0	0	0	10	1.000	1.000	1.000				
uniq	12	0	0	0	0	12	1.000	1.000	1.000				
unlink	10	0	0	0	0	10	1.000	1.000	1.000				
uptime	15	0	0	0	0	15	1.000	1.000	1.000				
users	10	0	0	0	0	10	1.000	1.000	1.000				
vdir	46	0	1	0	0	45	0.984	1.000	0.978				
wc	16	0	0	0	0	16	1.000	1.000	1.000				
who	14	0	0	0	0	14	1.000	1.000	1.000				
whoam	i 10	0	0	0	0	10	1.000	1.000	1.000				
yes	10	0	0	0	0	10	1.000	1.000	1.000				

Table 24: Varnode recovery (metatype = UNION) (compilation = debug)

			ne.	d @ level to	Jesonater vandes hateled @ level Substituted @ level Attended @ level March. Jesonater vandes hateled @ level Substituted @ level Attended @ level March. Jesonater vandes hateled @ level Substituted @ level Attended @ level March. Jesonater vandes hateled @ level Substituted @ level Marched @ level						
	Jund truth	Valtode ⁵ Decompiler va	Decompiler 1.	Decompiler "	Decompiler "	Decompiler of	umodes match	compares surfaction	n Partially		
[0	0	0	0	0	0	-	-	-		
b2sum	0	0	0	0	0	0	-	-	-		
base32	0	0	0	0	0	0	-	-	-		
base64	0	0	0	0	0	0	-	-	-		
basename	0	0	0	0	0	0	-	-	-		
basenc	0	0	0	0	0	0	-	-	-		
cat	0	0	0	0	0	0	-	-	-		
chcon	0	0	0	0	0	0	-	-	-		
chgrp	0	0	0	0	0	0	-	-	-		
chmod	0	0	0	0	0	0	-	-	-		
chown	0	0	0	0	0	0	-	-	-		
chroot	0	0	0	0	0	0	-	-	-		
cksum	0	0	0	0	0	0	-	-	-		
comm	0	0	0	0	0	0	-	-	-		
cp	1	0	0	0	0	1	1.000	1.000	1.000		
csplit	0	0	0	0	0	0	-	-	-		
cut	0	0	0	0	0	0	-	-	-		

Table 24: Varnode recovery (metatype = UNION) (compilation = debug)

	N	vafnodes va	nodes matche	The contribet was noted to be contribet.								
date	Jund truti	Decomplet was	Jeconditer 0	Decompiler 0	Decompiler 0	Decompiler 2	Varrode arer	indes five	inodes frio			
dd	0	0	0	0	0	0	-	-	-			
df	0	0	0	0	0	0	-	_	-			
dir	0	0	0	0	0	0	-	-	_			
dircolors	0	0	0	0	0	0	-	_	-			
dirname	0	0	0	0	0	0	-	-	-			
du	0	0	0	0	0	0	-	-	-			
echo	0	0	0	0	0	0	-	-	-			
env	0	0	0	0	0	0	-	-	-			
expand	0	0	0	0	0	0	-	-	-			
expr	0	0	0	0	0	0	-	-	-			
factor	1	0	0	0	0	1	1.000	1.000	1.000			
false	0	0	0	0	0	0	-	-	-			
fmt	0	0	0	0	0	0	-	-	-			
fold	0	0	0	0	0	0	-	-	-			
groups	0	0	0	0	0	0	-	-	-			
head	0	0	0	0	0	0	-	-	-			
hostid	0	0	0	0	0	0	-	-	-			

Table 24: Varnode recovery (metatype = UNION) (compilation = debug)

	ound truth	garnodes	undes hatche	d@ level 40 Articles that the	MATCH d@levelOvi	Decomplete	SET ALLICE AND SET OF S	ED RAPICION DE SCORE SCORE SERVICIO SE SER	A (O.1) I Partially f
id	0	0	0	0	0	0	-	_	
join	0	0	0	0	0	0	-	-	-
kill	0	0	0	0	0	0	-	-	-
link	0	0	0	0	0	0	-	-	-
ln	0	0	0	0	0	0	-	-	-
logname	0	0	0	0	0	0	-	-	-
ls	0	0	0	0	0	0	-	-	-
md5sum	0	0	0	0	0	0	-	-	-
mkdir	0	0	0	0	0	0	-	-	-
mkfifo	0	0	0	0	0	0	-	-	-
mknod	0	0	0	0	0	0	-	-	-
mktemp	0	0	0	0	0	0	-	-	-
mv	1	0	0	0	0	1	1.000	1.000	1.000
nice	0	0	0	0	0	0	-	-	-
nl	0	0	0	0	0	0	-	-	-
nohup	0	0	0	0	0	0	-	-	-
nproc	0	0	0	0	0	0	-	-	-
numfmt	0	0	0	0	0	0	-	-	-

Table 24: Varnode recovery (metatype = UNION) (compilation = debug)

GK	ound truth "	amodes	Jeconnier vo	Decomplies was	ARICH @ level Ovill Rodes matched	ALAR Decomplies was	SET ALICANO A LONG AND	ED MAICH	Dalially reco
od	8	0	0	0	0	8	1.000	1.000	1.000
paste	0	0	0	0	0	0	-	-	-
pathchk	0	0	0	0	0	0	-	-	-
pinky	0	0	0	0	0	0	-	-	-
pr	0	0	0	0	0	0	-	-	-
printenv	0	0	0	0	0	0	-	-	-
printf	0	0	0	0	0	0	-	-	-
ptx	1	0	0	0	0	1	1.000	1.000	1.000
pwd	0	0	0	0	0	0	-	-	-
readlink	0	0	0	0	0	0	-	-	-
realpath	0	0	0	0	0	0	-	-	-
rm	0	0	0	0	0	0	-	-	-
rmdir	0	0	0	0	0	0	-	-	-
runcon	0	0	0	0	0	0	-	-	-
seq	0	0	0	0	0	0	-	-	-
sha1sum	0	0	0	0	0	0	-	-	-
sha224sun	n 0	0	0	0	0	0	-	-	-
sha256sun	n 0	0	0	0	0	0	-	-	-

Table 24: Varnode recovery (metatype = UNION) (compilation = debug)

					<u> </u>				
, redu	id truth	vanodes Decompler vitu	sdes mathed	@level NO M	AICH OVER	LAR (elevel Study in a legal tracked in a legal tra	ei level Allichi @ level Allichi indes matched	ED MATCH	Datially rec
sha384sum	0	0	0	0	0	0			
sha512sum	0	0	0	0	0	0	<u>-</u>	-	-
shred	0	0	0	0	0	0	_	_	_
shuf	0	0	0	0	0	0	-	_	_
sleep	0	0	0	0	0	0	_	_	_
sort	0	0	0	0	0	0	_	_	_
split	0	0	0	0	0	0	-	-	-
stat	0	0	0	0	0	0	-	-	_
stdbuf	0	0	0	0	0	0	-	-	_
stty	0	0	0	0	0	0	-	-	-
sum	0	0	0	0	0	0	-	-	-
sync	0	0	0	0	0	0	-	-	-
tac	0	0	0	0	0	0	-	-	-
tail	0	0	0	0	0	0	-	-	-
tee	0	0	0	0	0	0	-	-	-
test	0	0	0	0	0	0	-	-	-
timeout	0	0	0	0	0	0	-	-	-
touch	2	0	0	0	2	0	0.750	1.000	0.000

Table 24: Varnode recovery (metatype = UNION) (compilation = debug)

					TCH	S		D	
			nodes matched	20 %	AICH OVER	Jih SUBS	er sig	@level MATO	À,
				a level !	alevel	alevel 3	alevel fr	@level Missingle scot	(1,0)
			atched	atched	atched	atched	atched		, s 15
	,	nodes	odestria	odesmid	odes mid	odes mid	odestria	compate	n Partiali.
	ruthval	ilei vai	ner vari	ie ilei vair	ile ilet vati	ilei vair	average	e fractis	~ {}; };
C	round truth with	scollibr.	ecompi.	ecompi	econnar	ecolopi.	arnode	athodes	arnodes
	- V						`		•
tr	0	0	0	0	0	0	-	-	-
true	0	0	0	0	0	0	-	-	-
truncate	0	0	0	0	0	0	-	-	-
tsort	0	0	0	0	0	0	-	-	-
tty	0	0	0	0	0	0	-	-	-
uname	0	0	0	0	0	0	-	-	-
unexpand	d 0	0	0	0	0	0	-	-	-
uniq	0	0	0	0	0	0	-	-	-
unlink	0	0	0	0	0	0	-	-	-
uptime	0	0	0	0	0	0	-	-	-
users	0	0	0	0	0	0	-	-	-
vdir	0	0	0	0	0	0	-	-	-
wc	0	0	0	0	0	0	-	-	-
who	0	0	0	0	0	0	-	-	-
whoami	0	0	0	0	0	0	-	-	-
yes	0	0	0	0	0	0	-	-	-

Table 25: Decomposed varnode recovery (compilation = stripped)

			l@level NO?	MATCH WEI OWEI TO LOOK TO WEI TO WE TO WEI TO WE WE WE TO WE	JAP .	J. J. O. 541	ARTCH Score O. 11 See comparison score O. 11 Authore Stration Partially of Warnode's frag		
			ist 40.	isloaki	, शेराष्ट्र	o Palis	31 elyasi	ison scr	314 314
	aC	odes nei	,@ ^{1&7}	√ _{© Je2} ,ei	,@ ^{\&\})@Jez	3@167	compair . or	, Partial
	A truth via	aes match	aes match	aes match	165 Match	aes match	re aretage	1es fractie	3es fract
Citic	and truth vari	inou Va	inou Vo	thou Asi	inou voi	thor 18	ithou 18	ithou 18	inou
[1190	391	129	0	233	437	0.541	0.671	0.367
b2sum	1954	607	174	0	775	398	0.523	0.689	0.204
base32	1169	647	82	0	102	338	0.372	0.447	0.289
base64	1197	679	78	0	102	338	0.363	0.433	0.282
basename	844	359	74	0	98	313	0.480	0.575	0.371
basenc	1847	1276	76	0	128	367	0.261	0.309	0.199
cat	933	394	78	0	129	332	0.480	0.578	0.356
chcon	17348	436	79	0	16395	438	0.735	0.975	0.025
chgrp	1264	463	83	0	291	427	0.527	0.634	0.338
chmod	1305	493	85	0	292	435	0.517	0.622	0.333
chown	1308	466	82	0	320	440	0.536	0.644	0.336
chroot	933	359	75	0	129	370	0.520	0.615	0.397
cksum	31618	11527	17077	0	2434	580	0.211	0.635	0.018
comm	998	367	98	0	202	331	0.508	0.632	0.332
ср	4028	1852	249	0	474	1453	0.464	0.540	0.361
csplit	5511	819	455	0	1885	2352	0.704	0.851	0.427
cut	5022	381	74	0	4232	335	0.702	0.924	0.067
date	8648	2437	238	0	2928	3045	0.613	0.718	0.352
dd	6329	1987	128	0	2993	1221	0.553	0.686	0.193

Table 25: Decomposed varnode recovery (compilation = stripped)

				MCH	JERLAR SURFINACIPED PROPERTY OF THE SURFINACI	ÆD.	MATCH MARICH Jage comparison score 10,11 Jage comparison score 10,11			
			740	Mr	TERL SUB	SE' ALK	JAN MAS	Cr,	sie t	
	Jund truth vari	des	@lever	1@lever	@lever	@lever	@lever	-OMParise	artially	
	uth vatr	naiche	o match	ea naid	hed matched	i natche	d werage	ce staction	r etag	
, s ^C	Jund tru	indes i	inolest	arnodest	1athodes 1	indes i	inde ar	inoles i	inolesi	
	7,0				7,0 7,0					
df	3575	514	189	0	1764	1108	0.693	0.856	0.310	
dir	39259	9090	178	0	16150	13841	0.662	0.768	0.353	
dircolors	5810	5258	77	0	140	335	0.079	0.095	0.058	
dirname	832	352	74	0	94	312	0.482	0.577	0.375	
du	8012	1042	558	0	2843	3569	0.729	0.870	0.445	
echo	810	335	74	0	92	309	0.490	0.586	0.381	
env	1464	751	74	0	218	421	0.412	0.487	0.288	
expand	898	390	74	0	113	321	0.472	0.566	0.357	
expr	5706	930	472	0	2017	2287	0.687	0.837	0.401	
factor	4701	3420	335	0	263	683	0.205	0.272	0.145	
false	801	335	74	0	87	305	0.485	0.582	0.381	
fmt	15915	15374	74	0	132	335	0.028	0.034	0.021	
fold	893	394	74	0	101	324	0.468	0.559	0.363	
groups	865	368	74	0	101	322	0.481	0.575	0.372	
head	33790	392	97	0	24757	8544	0.803	0.988	0.253	
hostid	827	347	74	0	97	309	0.484	0.580	0.374	
id	1007	438	74	0	144	351	0.474	0.565	0.349	
join	1004	381	76	0	178	369	0.519	0.621	0.368	
kill	1325	787	74	0	119	345	0.342	0.406	0.260	

Table 25: Decomposed varnode recovery (compilation = stripped)

			atrodes match	MCH	TERLAR THE DE LEVEL SUBS THE D	AED .	MATCH Son score 10,11 Age comparison score 10,11 Age comparison partially f		
			140	90 Mr	TERL STR	al Alli	A MAS	. son sci	51 ^l 14 ¹⁸
	Jud truth vari	odes	1@Jene	1@ Jeno	h@lexe	company partially			
	ruth vari	Tratche	ic match	, mais	hee matched	matche	o average	Fraction	. Frac
cic	Jund th	indes .	atnodes (1	athodes	Jatnodes (1at	inodes,	inde a	inoles 19	inoles
•	926	247	74		06	200	0.494	0.500	
link		347 604		0		309 982	0.484 0.610	0.580 0.697	0.374
ln	1991 827	347	142 74	0	263 97	309	0.484		0.493
logname		9090	178	0	16150	13841	0.484	0.580 0.768	0.374
ls md5sum	39259		154	0		350	0.460	0.708	0.333
	1170	467			199				
mkdir	3260	449	118	0	2208	485	0.666	0.862	0.149
mkfifo	938	404	80	0	108	346	0.477	0.569	0.369
mknod	955	404	80	0	111	360	0.485	0.577	0.377
mktemp	971	432	94	0	115	330	0.453	0.555	0.340
mv	4056	1781	270	0	538	1467	0.478	0.561	0.362
nice	837	351	74	0	94	318	0.486	0.581	0.380
nl	6094	1656	453	0	1721	2264	0.602	0.728	0.372
nohup	874	347	74	0	134	319	0.501	0.603	0.365
nproc	865	355	76	0	96	338	0.496	0.590	0.391
numfmt	1280	447	142	0	163	528	0.536	0.651	0.412
od	11965	698	117	0	10606	544	0.713	0.942	0.045
paste	857	359	74	0	106	318	0.485	0.581	0.371
pathchk	869	353	96	0	107	313	0.480	0.594	0.360
pinky	3335	425	81	0	2212	617	0.689	0.873	0.185

Table 25: Decomposed varnode recovery (compilation = stripped)

	nd truth vari	indes machel	@ level MO	MAICH d@levelOs	FRIAR SUBSIDERAL SUBSIDERA SUBSIDERA SUBSIDERA SUBSIDERA SUBSIDERA SUBSIDERA SUBSIDERA SUBSIDERA SUBSIDERA SUB	SET ALIC	THED WAS MAN	onpaison sco	Patially reco
pr Croi	2854	529	138	o various	397	1790	0.744	0.815	0.627
printenv	826	351	74	0	89	312	0.481	0.575	0.378
printf	3369	518	120	0	2194	537	0.657	0.846	0.159
ptx	7315	2390	623	0	1869	2433	0.546	0.673	0.333
pwd	969	445	80	0	109	335	0.451	0.541	0.346
readlink	1146	386	99	0	162	499	0.563	0.663	0.435
realpath	1051	410	102	0	163	376	0.498	0.610	0.358
rm	1276	457	121	0	268	430	0.518	0.642	0.337
rmdir	3076	386	107	0	2161	422	0.673	0.875	0.137
runcon	844	367	74	0	96	307	0.471	0.565	0.364
seq	1136	396	121	0	174	445	0.533	0.651	0.392
sha1sum	1178	467	158	0	185	368	0.464	0.604	0.312
sha224sum	1315	531	205	0	206	373	0.440	0.596	0.284
sha256sum	1323	531	205	0	214	373	0.442	0.599	0.282
sha384sum	1599	611	205	0	410	373	0.458	0.618	0.233
sha512sum	1631	611	205	0	442	373	0.463	0.625	0.229
shred	3337	562	90	0	1614	1071	0.690	0.832	0.321
shuf	1168	406	90	0	243	429	0.543	0.652	0.367
sleep	855	347	76	0	107	325	0.496	0.594	0.380

Table 25: Decomposed varnode recovery (compilation = stripped)

				gevel MO MARICH Level MO MARICH Level AND MARICH Level ALICATED Level MARICH Level ALICATED Level MARICH Level ALICATED Level MARICHE Level MARICHE						
			uel 40)	well out	il welsubs	vel ALIC	well MAIL	rison scor	NY rect	
	athoi	jes ned	@ ^{1&} .	,@ ^{1&}	ed ^{©le}	e red	@ [`] \&``	Milipar . On s	gattian : s	
	Atrith	aes match	aes match	res match	aes matcu	aes match	ae averate	restraction (res fracti	
Ctic	Sind truth varied	ou Var	nou Va	inou 1	athou Vath	og Ast	nou Vari	job Vari	ion	
sort	11845	2147	336	0	686	8676	0.783	0.819	0.732	
split	1533	780	80	0	242	431	0.413	0.491	0.281	
stat	3141	741	189	0	416	1795	0.686	0.764	0.571	
stdbuf	2142	375	124	0	1200	443	0.641	0.825	0.207	
stty	1868	1102	108	0	197	461	0.340	0.410	0.247	
sum	2368	382	79	0	1518	389	0.653	0.839	0.164	
sync	847	355	74	0	106	312	0.484	0.581	0.368	
ac	13723	9252	453	0	1756	2262	0.269	0.326	0.165	
ail	34216	566	120	0	33048	482	0.739	0.983	0.014	
tee	9070	367	74	0	8310	319	0.724	0.960	0.035	
est	1126	344	129	0	221	432	0.560	0.694	0.384	
imeout	1334	682	76	0	130	446	0.422	0.489	0.334	
ouch	7107	2125	214	0	2824	1944	0.579	0.701	0.274	
r	10204	9337	345	0	143	379	0.056	0.085	0.037	
rue	801	335	74	0	87	305	0.485	0.582	0.381	
runcate	902	384	90	0	104	324	0.471	0.574	0.359	
sort	876	347	83	0	120	326	0.499	0.604	0.372	
tty	825	355	76	0	88	306	0.474	0.570	0.371	
uname	1274	410	74	0	92	698	0.617	0.678	0.548	

Table 25: Decomposed varnode recovery (compilation = stripped)

Chan	nd truth visited	ges matched	@ level MO?	MAICH Me level Ovi	izel. Revel substi	Level Aller	AED HARTO	ngaison scor	patially reco
unexpand	874	360	74	0	113	327	0.492	0.588	0.374
uniq	962	401	77	0	138	346	0.487	0.583	0.360
unlink	826	347	74	0	96	309	0.484	0.580	0.374
uptime	10379	380	109	0	256	9634	0.949	0.963	0.928
users	842	347	74	0	106	315	0.490	0.588	0.374
vdir	39259	9090	178	0	16150	13841	0.662	0.768	0.353
wc	33888	444	75	0	32916	453	0.742	0.987	0.013
who	1577	472	119	0	221	765	0.609	0.701	0.485
whoami	829	347	74	0	99	309	0.485	0.581	0.373
yes	841	347	74	0	105	315	0.490	0.587	0.375

Table 26: Decomposed varnode recovery (compilation = stripped)

Gro	and truth varie	odes mathed	@ level NO N	Marie of West	JAY O level SUBST	ET ALET	WED MAIN OF THE PROPERTY OF THE PARTY OF THE	III Score of the state of the s	Dalially repaired by the partially repaired by the production of t
[1010	379	116	0	171	344	0.496	0.625	0.341
b2sum	1813	567	169	0	719	358	0.518	0.687	0.197
base32	1061	623	77	0	56	305	0.345	0.413	0.287
base64	1089	655	73	0	56	305	0.335	0.399	0.280
basename	739	335	69	0	52	283	0.459	0.547	0.383
basenc	1707	1236	70	0	75	326	0.234	0.276	0.191
cat	817	362	73	0	82	300	0.465	0.557	0.367
chcon	17106	390	70	0	16271	375	0.736	0.977	0.022
chgrp	1026	418	78	0	168	362	0.495	0.593	0.353
chmod	1080	453	80	0	172	375	0.485	0.581	0.347
chown	1059	420	77	0	192	370	0.504	0.603	0.349
chroot	799	335	70	0	79	315	0.490	0.581	0.394
cksum	31380	11445	17069	0	2354	512	0.209	0.635	0.016
comm	870	339	85	0	146	300	0.495	0.610	0.345
ср	3616	1744	244	0	304	1324	0.446	0.518	0.366
csplit	4073	774	181	0	857	2261	0.724	0.810	0.555
cut	4899	347	69	0	4181	302	0.705	0.929	0.062
date	8190	2255	202	0	2841	2892	0.619	0.725	0.353
dd	6097	1967	112	0	2915	1103	0.544	0.677	0.181

Table 26: Decomposed varnode recovery (compilation = stripped)

				MCH	AMICH OVERLAR SUBSET ALIGNED REVER MATCH. G. Level OVERLAR REVERSIBILITY OF THE CONTROL OF THE					
				30	अंधिय हो ड्यं छ	ol All	si elyasi	ale average compare score 10.11 Jamodes fraction partially for the state of the st		
		nodes	g@Jene	96/646	eg@legg	compare	Partiali.			
	ruth val	Sinatche	, Sinatch	Sinati	the smatche	Smatche	average	Staction	. Strac	
Cic	Jund truth war	inodes 48	stnodes ~	athodes	Varnodes Var	inodes 48	inode	inodes 48	inodes	
df	3126	437	170	0	1620	899	0.690	0.860	0.288	
dir	38591	8808	167	0	15943	13673	0.665	0.772	0.354	
dircolors	5577	5150	72	0	64	291	0.064	0.077	0.052	
dirname	737	332	69	0	51	285	0.462	0.550	0.387	
du	6328	947	277	0	1709	3395	0.750	0.850	0.537	
echo	725	323	69	0	50	283	0.466	0.554	0.390	
env	1323	713	69	0	162	379	0.391	0.461	0.286	
expand	796	367	69	0	66	294	0.453	0.539	0.369	
expr	4280	901	192	0	991	2196	0.698	0.789	0.513	
factor	4491	3399	305	0	174	613	0.183	0.243	0.136	
false	718	323	69	0	45	281	0.462	0.550	0.391	
fmt	13788	13343	69	0	77	299	0.027	0.032	0.022	
fold	793	370	69	0	58	296	0.450	0.533	0.373	
groups	764	350	69	0	56	289	0.456	0.542	0.378	
head	33664	359	92	0	24705	8508	0.804	0.989	0.253	
hostid	733	329	69	0	54	281	0.462	0.551	0.383	
id	872	406	69	0	95	302	0.448	0.534	0.346	
join	854	347	71	0	113	323	0.498	0.594	0.378	
kill	1222	763	69	0	76	314	0.318	0.376	0.257	

Table 26: Decomposed varnode recovery (compilation = stripped)

			2	MATCH	ERLAR B	ATED N	del MATCH average compare score (0,1) average compare score (0,1)		
	S	jodes	d@levelth	in level of	TERLAR TE	o level Alir	1@ level Mr.	compare scone	artially re
	Jund truth vari	nodes match	nodes match	nodes mate	in nodes matche	nodes matche	node average	nodes fractiv	nodes frac
		<u> </u>	dir. 4	atr	√atr. √a	7/2 21.	75 Cr 45	±11. √9	
link	732	329	69	0	53	281			0.384
ln							0.601	0.681	0.521
logname	732	329	69	0	53	281	0.462	0.551	0.384
ls	38591	8808	167	0	15943	13673	0.665	0.772	0.354
md5sum	1037	429	149	0	142	317	0.444	0.586	0.306
mkdir	3057	423	104	0	2140	390	0.661	0.862	0.128
mkfifo	837	382	75	0	59	321	0.459	0.544	0.384
mknod	849	382	75	0	60	332	0.466	0.550	0.391
mktemp	853	402	89	0	65	297	0.431	0.529	0.348
mv	3668	1719	264	0	323	1362	0.455	0.531	0.371
nice	741	331	69	0	52	289	0.466	0.553	0.390
nl	4669	1596	179	0	722	2172	0.591	0.658	0.465
nohup	767	329	69	0	82	287	0.477	0.571	0.374
nproc	768	333	71	0	54	310	0.479	0.566	0.404
numfmt	1088	379	131	0	104	474	0.537	0.652	0.436
od	11712	659	100	0	10534	419	0.712	0.944	0.036
paste	753	335	69	0	60	289	0.466	0.555	0.384
pathchk	771	332	90	0	62	287	0.462	0.569	0.372
pinky	3214	404	76	0	2152	582	0.689	0.874	0.181

Table 26: Decomposed varnode recovery (compilation = stripped)

	nd truth vari	indes hathed	@ level NO	MATCH de level Of	FRIAR STRACTED TO THE STRACTED	SET STREET ALL C	MED AND MAN	TH Sompare score in the second	Dalially less
Crox	Ind it.	indles .	indes,	indes .	Varindes Var	indes.	inde a	modes.	
pr									0.658
printenv	732	331	69	0	47	285	0.461	0.548	0.389
printf	3173	505	98	0	2131	439	0.650	0.841	0.138
ptx	5741	2318	337	0	803	2283	0.517	0.596	0.398
pwd	863	423	75	0	57	308	0.428	0.510	0.357
readlink	948	346	92	0	79	431	0.541	0.635	0.455
realpath	844	366	95	0	75	308	0.460	0.566	0.365
rm	1032	409	116	0	140	367	0.485	0.604	0.356
rmdir	2886	360	94	0	2103	329	0.669	0.875	0.114
runcon	737	339	69	0	47	282	0.454	0.540	0.383
seq	921	372	96	0	112	341	0.488	0.596	0.370
sha1sum	1046	429	153	0	129	335	0.449	0.590	0.320
sha224sum	1182	493	200	0	149	340	0.424	0.583	0.288
sha256sum	1190	493	200	0	157	340	0.427	0.586	0.286
sha384sum	1466	573	200	0	353	340	0.447	0.609	0.232
sha512sum	1498	573	200	0	385	340	0.453	0.617	0.227
shred	3159	523	82	0	1532	1022	0.694	0.834	0.324
shuf	942	370	84	0	137	351	0.504	0.607	0.373
sleep	748	329	71	0	60	288	0.469	0.560	0.385

Table 26: Decomposed varnode recovery (compilation = stripped)

	nd truth variod	ges matched Vari	a level NO N	MAICH @ level Out	ERLAR EVEL SUBSE VIRTURE VIRTU	Aestracted	AED MAIC	nnate scare of sadion for the sadion of the	Ashally rech
- Crous	Vatri	- Vali	√12g	nde 4	atrice Vari	Ast.	not Vati	ige Astr	
sort									0.753
split	1369	734	74	0	176	385	0.391	0.464	0.281
stat	2845	707	174	0	312	1652	0.678	0.751	0.581
stdbuf	1931	348	111	0	1134	338	0.630	0.820	0.175
stty	1527	937	95	0	133	362	0.318	0.386	0.237
sum	2233	358	71	0	1461	343	0.652	0.840	0.154
sync	751	333	69	0	61	288	0.467	0.557	0.383
tac	12312	9213	179	0	744	2176	0.226	0.252	0.177
tail	33975	516	113	0	32951	395	0.740	0.985	0.012
tee	8961	339	69	0	8261	292	0.726	0.962	0.033
test	959	332	116	0	169	342	0.519	0.654	0.357
timeout	1210	654	71	0	81	404	0.399	0.460	0.334
touch	6684	1960	179	0	2744	1801	0.584	0.707	0.269
tr	10057	9300	332	0	82	343	0.048	0.075	0.034
true	718	323	69	0	45	281	0.462	0.550	0.391
truncate	801	358	85	0	60	298	0.455	0.553	0.372
tsort	757	329	77	0	62	289	0.469	0.565	0.382
tty	731	333	71	0	46	281	0.456	0.544	0.384
uname	1155	365	69	0	48	673	0.629	0.684	0.583

Table 26: Decomposed varnode recovery (compilation = stripped)

Grovi	nd truth varno	ges Traiched Var	@ level NO?	MATCH Me level Over	ERLAR Ed@Level SUBSE	Level Aller	ate average of	Andre Score Control of the Station of Statio	patially teed
unexpand	769	335	69	0	66	299	0.476	0.564	0.389
uniq	818	356	72	0	84	306	0.473	0.565	0.374
unlink	732	329	69	0	53	281	0.462	0.551	0.384
uptime	10247	360	104	0	191	9592	0.953	0.965	0.936
users	739	329	69	0	56	285	0.466	0.555	0.386
vdir	38591	8808	167	0	15943	13673	0.665	0.772	0.354
wc	33696	386	71	0	32838	401	0.743	0.989	0.012
who	1345	421	106	0	154	664	0.599	0.687	0.494
whoami	734	329	69	0	55	281	0.463	0.552	0.383
yes	742	329	69	0	59	285	0.467	0.557	0.384

Table 27: Decomposed varnode recovery (compilation = stripped)

	~	vanodes nat	ned@level ^M	Ded @ level C	WERLAR LEVELS	ALICATED AND TOTAL STREET STR			
- Cuc	Jund trutt	vanodes nac	Varnode's inte	Varnode's Inu	Vatnode ^s file	Vatnode's file	Vatuale ave	inales fro	inodes fro
[2	0	1	0	1	0	0.500	1.000	0.000
b2sum	0	0	0	0	0	0	-	-	-
base32	0	0	0	0	0	0	-	-	-
base64	0	0	0	0	0	0	-	-	-
basename	0	0	0	0	0	0	-	-	-
basenc	0	0	0	0	0	0	-	-	-
cat	0	0	0	0	0	0	-	-	-
chcon	7	4	0	0	3	0	0.321	0.429	0.000
chgrp	7	4	0	0	3	0	0.321	0.429	0.000
chmod	7	4	0	0	3	0	0.321	0.429	0.000
chown	7	4	0	0	3	0	0.321	0.429	0.000
chroot	0	0	0	0	0	0	-	-	-
cksum	3	0	3	0	0	0	0.250	1.000	0.000
comm	0	0	0	0	0	0	-	-	-
ср	7	4	0	0	3	0	0.321	0.429	0.000
csplit	0	0	0	0	0	0	-	-	-
cut	0	0	0	0	0	0	-	-	-
date	2	0	1	0	1	0	0.500	1.000	0.000
dd	7	0	4	0	3	0	0.464	1.000	0.000

Table 27: Decomposed varnode recovery (compilation = stripped)

				Mich	JAP.	AST.	ALD	MED MAICH O Level MAICH Authorize score (0,1) O Level MAICH Authorize score (0,1) Authorize score (0,1) Authorize score (0,1)		
		ు ల్	hed@level.Th	o jarelo	March Over Over A. R. Series of Series and the description of the state of the series					
	nin v	atnode mate	hed le mai	thed to spare	thed to inate	thed to make	hed a verage	confraction	i Bac	
Cit	Jund Full V	Vatnodes ,	Vainodes ,	Vainodes ,	Vainodes ,	Vainodes ,	Vatnode d	inodes,	inodes,	
df	17	4	4	0	4	5	0.529	0.765	0.294	
dir	10	4	3	0	3	0	0.300	0.600	0.000	
dircolors	0	0	0	0	0	0	-	-	-	
dirname	0	0	0	0	0	0	-	-	-	
du	10	4	3	0	3	0	0.300	0.600	0.000	
echo	0	0	0	0	0	0	-	-	-	
env	0	0	0	0	0	0	-	-	-	
expand	0	0	0	0	0	0	-	-	-	
expr	0	0	0	0	0	0	-	-	-	
factor	0	0	0	0	0	0	-	-	-	
false	0	0	0	0	0	0	-	-	-	
fmt	0	0	0	0	0	0	-	-	-	
fold	0	0	0	0	0	0	-	-	-	
groups	0	0	0	0	0	0	-	-	-	
head	0	0	0	0	0	0	-	-	-	
hostid	0	0	0	0	0	0	-	-	-	
id	0	0	0	0	0	0	-	-	-	
join	0	0	0	0	0	0	-	-	-	
kill	0	0	0	0	0	0	-	_	_	

Table 27: Decomposed varnode recovery (compilation = stripped)

			کے	O MATCH	VERLAR S	JBSET A	JONED MATCH JAMORE AVERAGE COMPARE SCORE 10.11 JAMORE AVERAGE VARIORES Fraction Partially JAMORE AVERAGE VARIORES Fraction Partially			
	ound truth	attodes trac	ned@level,	O.M. A.T. C. H. A. M. M. A. M.	ned@level	JBSET A	JEMED LEVEL MAY	compare so	Partially L	
link	0	0	0	0	0	$\frac{0}{\gamma_{0}}$	- 7,01 7,0	- - 70	- -	
ln	7	4	0	0	3	0	0.321	0.429	0.000	
logname	0	0	0	0	0	0	-	-	-	
ls	10	4	3	0	3	0	0.300	0.600	0.000	
md5sum	0	0	0	0	0	0	-	-	-	
mkdir	2	0	1	0	1	0	0.500	1.000	0.000	
mkfifo	0	0	0	0	0	0	-	-	-	
mknod	0	0	0	0	0	0	-	-	-	
mktemp	0	0	0	0	0	0	-	-	-	
mv	7	4	0	0	3	0	0.321	0.429	0.000	
nice	0	0	0	0	0	0	-	-	-	
nl	0	0	0	0	0	0	-	-	-	
nohup	0	0	0	0	0	0	-	-	-	
nproc	0	0	0	0	0	0	-	-	-	
numfmt	7	0	6	0	1	0	0.321	1.000	0.000	
od	11	0	4	0	7	0	0.568	1.000	0.000	
paste	0	0	0	0	0	0	-	-	-	
pathchk	0	0	0	0	0	0	-	-	-	
pinky	0	0	0	0	0	0	-	-	-	

Table 27: Decomposed varnode recovery (compilation = stripped)

				- CY	0		2	2			
				MATIC	ERLAY	BSET	CATELL ST	Androdes fraction partially res			
			, evel the	, takelog	, व्याधिय), chally	, evel Mr	aie scoile	. ally reck		
	c	utnodes	regent w	eg@je	ed@je	red@ic	eg@je	onio con	Partie : c		
	Tully	a 125 Maich	. A STRAICI	, as match	i.	is as match) a diversity	105 tractic) as fractic		
Circle	nd fruth vi	Vatnode ~	red@level. AC	athode	FERLAR LEVELSI	BSET BENELAL	Jeneth Raid Mark	inode Vat	node		
pr	0	0	0	0	0	0	-	-	_		
printenv	0	0	0	0	0	0	-	-	-		
printf	7	0	6	0	1	0	0.321	1.000	0.000		
ptx	0	0	0	0	0	0	-	-	-		
pwd	0	0	0	0	0	0	-	-	-		
readlink	7	4	0	0	3	0	0.321	0.429	0.000		
realpath	7	4	0	0	3	0	0.321	0.429	0.000		
rm	7	4	0	0	3	0	0.321	0.429	0.000		
rmdir	2	0	1	0	1	0	0.500	1.000	0.000		
runcon	0	0	0	0	0	0	-	-	-		
seq	14	0	13	0	1	0	0.286	1.000	0.000		
sha1sum	0	0	0	0	0	0	-	-	-		
sha224sum	0	0	0	0	0	0	-	-	-		
sha256sum	0	0	0	0	0	0	-	-	-		
sha384sum	0	0	0	0	0	0	-	-	-		
sha512sum	0	0	0	0	0	0	-	-	-		
shred	3	0	3	0	0	0	0.250	1.000	0.000		
shuf	7	4	0	0	3	0	0.321	0.429	0.000		
sleep	7	0	0	0	2	5	0.929	1.000	0.714		

Table 27: Decomposed varnode recovery (compilation = stripped)

			2	Annodes matched a level substituted are age compare score of the sunder matched are age.					
		NE ^S	@levelty0	" Pension	elevelsu,	@level Al	@ level Mr.	inpare score	atially recu
	nih var	not match	ed e match	ed e match	ed matche	id e matché	id e astage of	staction's	zi. Fracijo
Cit	ound truth wat	athodes.	athodes .	athodes .	athodes t	athodes t	atnode a	jodes i	iodes i
sort	22	4	5	0	11	2	0.523	0.818	0.091
split	0	0	0	0	0	0	-	-	-
stat	2	0	1	0	1	0	0.500	1.000	0.000
stdbuf	2	0	1	0	1	0	0.500	1.000	0.000
stty	2	0	1	0	1	0	0.500	1.000	0.000
sum	3	0	3	0	0	0	0.250	1.000	0.000
sync	0	0	0	0	0	0	-	-	-
tac	0	0	0	0	0	0	-	-	-
tail	15	4	0	0	6	5	0.633	0.733	0.333
tee	0	0	0	0	0	0	-	-	-
test	2	0	1	0	1	0	0.500	1.000	0.000
timeout	8	0	0	0	4	4	0.875	1.000	0.500
touch	2	0	1	0	1	0	0.500	1.000	0.000
tr	0	0	0	0	0	0	-	-	-
true	0	0	0	0	0	0	-	-	-
truncate	0	0	0	0	0	0	-	-	-
tsort	0	0	0	0	0	0	-	-	-
tty	0	0	0	0	0	0	-	-	-
uname	0	0	0	0	0	0	-	-	-

Table 27: Decomposed varnode recovery (compilation = stripped)

Groi	ind truth var	inodes mach	ed@level.100	and level of	etel. AP substitute of the sub	astrodes match	CIVED HARTCE	Andre Score In The State of the	natially recovered patially recovered and all and a station exacts and a
unexpand	0	0	0	0	0	0	-	-	-
uniq	0	0	0	0	0	0	-	-	-
unlink	0	0	0	0	0	0	-	-	-
uptime	5	0	0	0	4	1	0.800	1.000	0.200
users	0	0	0	0	0	0	-	-	-
vdir	10	4	3	0	3	0	0.300	0.600	0.000
wc	4	0	0	0	4	0	0.750	1.000	0.000
who	2	0	1	0	1	0	0.500	1.000	0.000
whoami	0	0	0	0	0	0	-	-	-
yes	0	0	0	0	0	0	-	-	-

Table 28: Decomposed varnode recovery (compilation = stripped)

Gra	and hull vari	indes mathed	@ level NO N	ARICH @ level OVER	LAR General Stilled National N	ET ALCO	ACD REAL MAY S	onpate score land	Partially re
[170	12	4	0	61	93	0.822	0.929	0.547
b2sum	140	40	4	0	56	40	0.593	0.714	0.286
base32	107	24	4	0	46	33	0.640	0.776	0.308
base64	107	24	4	0	46	33	0.640	0.776	0.308
basename	104	24	4	0	46	30	0.630	0.769	0.288
basenc	138	40	4	0	53	41	0.592	0.710	0.297
cat	115	32	4	0	47	32	0.593	0.722	0.278
chcon	234	42	8	0	121	63	0.666	0.821	0.269
chgrp	230	41	4	0	120	65	0.678	0.822	0.283
chmod	217	36	4	0	117	60	0.685	0.834	0.276
chown	241	42	4	0	125	70	0.684	0.826	0.290
chroot	133	24	4	0	50	55	0.703	0.820	0.414
cksum	234	82	4	0	80	68	0.551	0.650	0.291
comm	127	28	12	0	56	31	0.598	0.780	0.244
ср	403	104	4	0	167	128	0.631	0.742	0.318
csplit	1416	44	266	0	1023	83	0.647	0.969	0.059
cut	122	34	4	0	51	33	0.592	0.721	0.270
date	426	182	5	0	86	153	0.513	0.573	0.359
dd	216	20	4	0	75	117	0.807	0.907	0.542

Table 28: Decomposed varnode recovery (compilation = stripped)

			31 ⁴⁰	MATCH	IERLAR alsur	GINED al MAT	LAMATICH Score 10.11 Letage compare score 10.11 Letage compare score 10.11 Variodes fraction partially		
	Jund truth was	nodes match	ed @ leve	ed@leae	Jepel AR Jepel SUP Jeed @ Jewel SUP Jeed @ Jewel Supplied The Jeep Jeep Jeep Jeep Jeep Jeep Jeep Je	d@leae	ed @ leader alerage	compate fraction	, patiali,
df Cgs	419	71	ath 2	Quitit 0	140	202	0.736	0.831	grit
dir	642	267	7	0	204	164	0.496	0.584	0.255
dircolors	229	105	4	0	76	44	0.445	0.541	0.192
dirname	94	20	4	0	43	27	0.641	0.787	0.287
du	1650	90	267	0	1126	167	0.653	0.945	0.101
echo	84	12	4	0	42	26	0.696	0.857	0.310
env	138	38	4	0	56	40	0.601	0.725	0.290
expand	101	23	4	0	47	27	0.626	0.772	0.267
expr	1399	28	266	0	1021	84	0.655	0.980	0.060
factor	196	21	18	0	88	69	0.712	0.893	0.352
false	82	12	4	0	42	24	0.689	0.854	0.293
fmt	2126	2031	4	0	55	36	0.037	0.045	0.017
fold	99	24	4	0	43	28	0.619	0.758	0.283
groups	100	18	4	0	45	33	0.677	0.820	0.330
head	125	33	4	0	52	36	0.608	0.736	0.288
hostid	93	18	4	0	43	28	0.659	0.806	0.301
id	134	32	4	0	49	49	0.647	0.761	0.366
join	149	34	4	0	65	46	0.643	0.772	0.309
kill	102	24	4	0	43	31	0.630	0.765	0.304

Table 28: Decomposed varnode recovery (compilation = stripped)

				A 28 0.659						
				MAIL	ERLA	askir	GAEN S	THED MATCH Scare scare 10.11 Ed @ level MATCH Scare scare 10.11 Ed We level MATCH Scaring Partially standes from the stande		
			al AC	' weld	यं स्थाद्री	ate scott	relia.			
	4	nodes	20 Ex	² 0@16	eg@16	compi	a Partiu			
	ruinva	- Inatel	ile spatch	That	ine straigh	a match	average	_e fractic	Stack	
cá ^s	Jund truth was	athodes	athodes	arnodes	1athodes	athodes	athole 19	inodes 19	indes	
							7, 7,			
link	93	18	4	0	43	28	0.659	0.806	0.301	
ln	276	54	5	0	122	95	0.680	0.804	0.344	
logname	94	18	4	0	44	28	0.660	0.809	0.298	
ls	642	267	7	0	204	164	0.496	0.584	0.255	
md5sum	132	38	4	0	57	33	0.581	0.712	0.250	
mkdir	192	26	4	0	67	95	0.762	0.865	0.495	
mkfifo	100	22	4	0	49	25	0.627	0.780	0.250	
mknod	105	22	4	0	51	28	0.640	0.790	0.267	
mktemp	117	30	4	0	50	33	0.611	0.744	0.282	
mv	379	58	5	0	212	104	0.697	0.847	0.274	
nice	95	20	4	0	42	29	0.647	0.789	0.305	
nl	1404	59	266	0	994	85	0.639	0.958	0.061	
nohup	106	18	4	0	52	32	0.679	0.830	0.302	
nproc	96	22	4	0	42	28	0.630	0.771	0.292	
numfmt	184	68	4	0	58	54	0.535	0.630	0.293	
od	226	39	4	0	64	119	0.743	0.827	0.527	
paste	103	24	4	0	46	29	0.626	0.767	0.282	
pathchk	95	20	4	0	45	26	0.639	0.789	0.274	
pinky	120	21	4	0	60	35	0.675	0.825	0.292	

Table 28: Decomposed varnode recovery (compilation = stripped)

	Yatr	jak ^{es}	ed Evel HO	MATCH de level Or	ARRIAR REPORTED FOR THE REPORT OF THE REPORT	SET OR REVEN ALLY	inde average of	onnate score in the state of th	Datially rect
Grovi	nd trith vari	inodes mar	athodes that	urodes mat	Vatrodes trian Va	indes ma	athode aver.	nodes frac	nodes frac
pr	218	68	5	0	89	56	0.569	0.688	0.257
printenv	93	20	4	0	42	27	0.640	0.785	0.290
printf	178	13	5	0	62	98	0.819	0.927	0.551
ptx	1540	71	266	0	1060	143	0.652	0.954	0.093
pwd	105	22	4	0	52	27	0.638	0.790	0.257
readlink	187	34	5	0	80	68	0.691	0.818	0.364
realpath	196	38	5	0	85	68	0.679	0.806	0.347
rm	236	44	4	0	125	63	0.668	0.814	0.267
rmdir	180	26	4	0	57	93	0.760	0.856	0.517
runcon	106	28	4	0	49	25	0.592	0.736	0.236
seq	193	24	4	0	61	104	0.781	0.876	0.539
sha1sum	131	38	4	0	56	33	0.580	0.710	0.252
sha224sum	132	38	4	0	57	33	0.581	0.712	0.250
sha256sum	132	38	4	0	57	33	0.581	0.712	0.250
sha384sum	132	38	4	0	57	33	0.581	0.712	0.250
sha512sum	132	38	4	0	57	33	0.581	0.712	0.250
shred	174	39	4	0	82	49	0.641	0.776	0.282
shuf	218	32	5	0	103	78	0.718	0.853	0.358
sleep	99	18	4	0	45	32	0.674	0.818	0.323

Table 28: Decomposed varnode recovery (compilation = stripped)

			@ level NO?	MAICH	ERLAR Ed@levelsUBS	jer ve	RED TO	P		
		. ₀ 5	level 40	a level on	level SUL	a level Alix	level MA.	apate score	rtially rect	
	Jud Hull varie	atched	de adiched	o atich	ed antihed	. atched	s estate	Mr. sactions	gar Sacit	
م م	Jund trute	nodes in	modes ni	inodes ni	athodes fir	nodes ili	inode and	nodes fix	nodestr	
	102	111			70	146	0.641	0.760		
sort									0.297	
split	162	46	5	0	66	45	0.591	0.716	0.278	
stat	286	34	6	0	103	143	0.775	0.881	0.500	
stdbuf	201	27	4	0	65	105	0.770	0.866	0.522	
stty	331	165	4	0	63	99	0.445	0.502	0.299	
sum	131	24	4	0	57	46	0.685	0.817	0.351	
sync	95	22	4	0	45	24	0.618	0.768	0.253	
tac	1390	38	266	0	1007	79	0.648	0.973	0.057	
tail	225	46	6	0	91	82	0.674	0.796	0.364	
tee	108	28	4	0	49	27	0.600	0.741	0.250	
test	157	12	4	0	51	90	0.823	0.924	0.573	
timeout	113	28	4	0	45	36	0.626	0.752	0.319	
touch	391	165	4	0	79	143	0.520	0.578	0.366	
tr	146	37	12	0	61	36	0.580	0.747	0.247	
true	82	12	4	0	42	24	0.689	0.854	0.293	
truncate	100	26	4	0	44	26	0.600	0.740	0.260	
	118	18	5	0	58	37	0.693	0.740	0.200	
tsort										
tty	93	22	4	0	42	25	0.618	0.763	0.269	
uname	118	45	4	0	44	25	0.500	0.619	0.212	

Table 28: Decomposed varnode recovery (compilation = stripped)

Grov	nd truth varia	indes hached	@ level 140	MATCH OUT RED BY	RIAR SUBSIDE	ET Evel ALIC	Mide average co	A Staction for the state of the	patially recting to the statistics of the statis
unexpand	104	25	4	0	47	28	0.618	0.760	0.269
uniq	143	45	4	0	54	40	0.570	0.685	0.280
unlink	93	18	4	0	43	28	0.659	0.806	0.301
uptime	126	20	4	0	61	41	0.696	0.841	0.325
users	102	18	4	0	50	30	0.672	0.824	0.294
vdir	642	267	7	0	204	164	0.496	0.584	0.255
wc	176	49	4	0	74	49	0.599	0.722	0.278
who	222	51	4	0	66	101	0.682	0.770	0.455
whoami	94	18	4	0	44	28	0.660	0.809	0.298
yes	98	18	4	0	46	30	0.668	0.816	0.306

Table 29: Decomposed varnode recovery (compilation = standard)

				, ATCH	TERLAR SURFINATION AND AND AND AND AND AND AND AND AND AN	<u> </u>	4 10,11			
			140	Jan.	FRI JSIB	SE AL	CITY I MAY	i edisole		
	and truth vari	odes	2@lexer	@lever	a@lever	@lever	2@Jever	RED MATCH @ level MATCH Rode average comparison scare 10.11		
	ruth vari	Tratche	matche	match	net matched	match	an etage	fraction	Frac	
cici	Jund li	indes 1	atnodes 18	inodes	Jathodes 12	inodes	athode to	indes 18	nodes	
	1100	47	150	-	404	507	0.762	0.061		
[1190	47	152	0	484	507			0.426	
b2sum							0.712	0.976	0.203	
base32	1169	79 47	145	0	609	336	0.709	0.932 0.961	0.287	
base64	1197	47	141	0	673	336	0.732		0.281	
basename	844	47	137		349	311	0.719	0.944		
basenc	1847	308	171	0	1003	365	0.628	0.833	0.198	
cat	933	47	153	0	390	343	0.722	0.950	0.368	
chcon	17348	49	180	0	16645	474	0.750	0.997	0.027	
chgrp	1264	50	171	0	539	504	0.752	0.960	0.399	
chmod	1305	70	163	0	543	529	0.749	0.946	0.405	
chown	1308	49	175	0	566	518	0.754	0.963	0.396	
chroot	933	47	138	0	380	368	0.737	0.950	0.394	
cksum	31618	8266	19512	0	3271	569	0.250	0.739	0.018	
comm	998	47	171	0	451	329	0.711	0.953	0.330	
cp	4028	205	399	0	1746	1678	0.766	0.949	0.417	
csplit	5511	455	584	0	2122	2350	0.742	0.917	0.426	
cut	5022	47	157	0	4485	333	0.744	0.991	0.066	
date	8648	338	790	0	4470	3050	0.763	0.961	0.353	
dd	6329	625	208	0	4278	1218	0.708	0.901	0.192	

Table 29: Decomposed varnode recovery (compilation = standard)

				TOH	Alted @ level sylps: Liked @ level sylps: Variodes marched Variodes marched 19731	D	MATCH AMATCH AMATCH Astrodes fraction partially fractions Astrodes fraction partial partia		
			20 ²	MAX	WERLY SUB	EL MI	AN MA	ich Ch	siele
		NE ^S	@ level,	@levell	@level?	711Patisor	artially		
	Jund truth vari	iot adiché	id atched	ک ه	ched catched	, Calchei	orage	cor	7. Sr.
	aind trutt	nodestile	modes the	nodestiv	nolestit	nodestile	node and	nodesfie	nodesfil
- Gri		7°	70 70		1911 191	75	78	ili Vi	
df	3575	49	342	0	2002	1182	0.775	0.986	0.331
dir	39259	4924	745	0	19731	13859	0.735	0.875	0.353
dircolors	5810	4855	238	0	386	331	0.117	0.164	0.057
dirname	832	47	129	0	346	310	0.723	0.944	0.373
du	8012	514	789	0	3107	3602	0.765	0.936	0.450
echo	810	47	113	0	343	307	0.731	0.942	0.379
env	1464	362	197	0	486	419	0.569	0.753	0.286
expand	898	47	135	0	398	318	0.724	0.948	0.354
expr	5706	601	552	0	2268	2285	0.723	0.895	0.400
factor	4701	281	1750	0	1989	681	0.555	0.940	0.145
false	801	47	113	0	338	303	0.730	0.941	0.378
fmt	15915	47	10153	0	5382	333	0.434	0.997	0.021
fold	893	47	137	0	387	322	0.724	0.947	0.361
groups	865	47	125	0	373	320	0.729	0.946	0.370
head	33790	47	155	0	25008	8580	0.810	0.999	0.254
hostid	827	47	125	0	348	307	0.725	0.943	0.371
id	1007	47	153	0	458	349	0.726	0.953	0.347
join	1004	47	166	0	424	367	0.724	0.953	0.366
kill	1325	475	137	0	370	343	0.494	0.642	0.259

Table 29: Decomposed varnode recovery (compilation = standard)

				MCH	A.	Paison score (0,1)			
			140	30	Jepla P	al Alic	NAN SIMAN	. son sci	3i ^U
	.c	iode ⁵	9@Jeng	-9@JE40	al@leve	comparti	Partiall'		
	THIN VAIL	Thatch	Thatch	. Tratê	ine matche	natche	average	fraction	Frac
Cit	Jund truth water	indes 4	atnodes J	athodes	Vainodes Va	inodes Va	inode v	indes 49	inodes
link	826	47	atrodes match	0	Jepel AR SUBSTRACTED AND AND AND AND AND AND AND AND AND AN	307	0.725	0.943	0.372
ln	1991	112	210	0	525	1144	0.799	0.944	0.575
logname	827	47	125	0	348	307	0.725	0.943	0.371
ls	39259	4924	745	0	19731	13859	0.735	0.875	0.353
md5sum	1170	63	245	0	514	348	0.679	0.946	0.297
mkdir	3260	64	182	0	2456	558	0.750	0.980	0.171
mkfifo	938	64	133	0	358	383	0.730	0.932	0.408
mknod	955	64	133	0	361	397	0.734	0.933	0.416
mktemp	971	110	148	0	366	347	0.678	0.887	0.357
mv	4056	257	296	0	1795	1708	0.771	0.937	0.421
nice	837	47	129	0	345	316	0.725	0.944	0.378
nl	6094	478	617	0	2737	2262	0.733	0.922	0.371
nohup	874	47	125	0	385	317	0.729	0.946	0.363
nproc	865	47	133	0	349	336	0.729	0.946	0.388
numfmt	1280	47	297	0	414	522	0.708	0.963	0.408
od	11965	103	313	0	10991	558	0.742	0.991	0.047
paste	857	47	137	0	357	316	0.721	0.945	0.369
pathchk	869	47	133	0	358	331	0.728	0.946	0.381
pinky	3335	47	137	0	2518	633	0.766	0.986	0.190

Table 29: Decomposed varnode recovery (compilation = standard)

CRON	nd truth vari	nodes marche	d@level NO	MATCH de level of	TERLAR STREET	SET ALLE	THED WELLINGS	TH STREET	Partially rect
pr	2854	102	293	0	651	1808	0.830	0.964	0.633
printenv	826	47	129	0	340	310	0.723	0.943	0.375
printf	3369	222	164	0	2447	536	0.716	0.934	0.159
ptx	7315	663	821	0	3383	2448	0.710	0.909	0.335
pwd	969	47	142	0	358	422	0.749	0.951	0.436
readlink	1146	49	166	0	414	517	0.758	0.957	0.451
realpath	1051	49	174	0	415	413	0.730	0.953	0.393
rm	1276	66	183	0	517	510	0.739	0.948	0.400
rmdir	3076	47	178	0	2412	439	0.745	0.985	0.143
runcon	844	47	145	0	347	305	0.713	0.944	0.361
seq	1136	47	191	0	458	440	0.732	0.959	0.387
sha1sum	1178	63	247	0	502	366	0.683	0.947	0.311
sha224sum	1315	63	360	0	521	371	0.648	0.952	0.282
sha256sum	1323	63	360	0	529	371	0.648	0.952	0.280
sha384sum	1599	143	296	0	789	371	0.648	0.911	0.232
sha512sum	1631	143	296	0	821	371	0.650	0.912	0.227
shred	3337	112	231	0	1871	1123	0.774	0.966	0.337
shuf	1168	47	160	0	496	465	0.751	0.960	0.398
sleep	855	47	127	0	358	323	0.729	0.945	0.378

Table 29: Decomposed varnode recovery (compilation = standard)

	ngo	્ર ^{દુક}	1. Level NO No. 1. Level No. 1.	March Ovi	ERLAR EVEL SUBSE	S Pend William	AED MAIC	innatison scor	e 10,11 reco
Gre	Jund Huth Walnot	ades match	inodes match	nodes match	atrodes fratell	odes match	node average	godes fractic	ndes fracin
sort	11845	269	574	0	2293	8709	0.893	0.977	0.735
split	1533	379	237	0	490	427	0.557	0.753	0.279
stat	3141	225	310	0	785	1821	0.792	0.928	0.580
stdbuf	2142	47	187	0	1449	459	0.743	0.978	0.214
stty	1868	53	697	0	662	456	0.603	0.972	0.244
sum	2368	63	143	0	1778	384	0.740	0.973	0.162
sync	847	47	133	0	357	310	0.721	0.945	0.366
tac	13723	455	556	0	10453	2259	0.746	0.967	0.165
tail	34216	68	203	0	33300	645	0.750	0.998	0.019
tee	9070	47	146	0	8561	316	0.747	0.995	0.035
test	1126	0	152	0	472	502	0.794	1.000	0.446
timeout	1334	362	147	0	381	444	0.575	0.729	0.333
touch	7107	313	733	0	4095	1966	0.735	0.956	0.277
tr	10204	50	424	0	9354	376	0.735	0.995	0.037
true	801	47	113	0	338	303	0.730	0.941	0.378
truncate	902	47	141	0	355	359	0.732	0.948	0.398
tsort	876	47	132	0	373	324	0.727	0.946	0.370
tty	825	47	133	0	341	304	0.719	0.943	0.368
uname	1274	55	181	0	343	695	0.783	0.957	0.546

Table 29: Decomposed varnode recovery (compilation = standard)

Chart	nd truth varied	ges matched	@level NO?	Majeth @ level Ovi	ERLAR LEVEL SUBSE	Jevel Alleri Jes Inached	ED HATC	A Jan	e 10.11 Partially reco
unexpand	874	47	139	0	364	324	0.723	0.946	0.371
uniq	962	47	184	0	389	342	0.707	0.951	0.356
unlink	826	47	125	0	347	307	0.725	0.943	0.372
uptime	10379	49	184	0	514	9632	0.970	0.995	0.928
users	842	47	125	0	357	313	0.727	0.944	0.372
vdir	39259	4924	745	0	19731	13859	0.735	0.875	0.353
wc	33888	87	164	0	33168	469	0.749	0.997	0.014
who	1577	47	243	0	505	782	0.775	0.970	0.496
whoami	829	47	125	0	350	307	0.725	0.943	0.370
yes	841	47	125	0	356	313	0.727	0.944	0.372

Table 30: Decomposed varnode recovery (compilation = standard)

ó	Jind truth wath	indes matche	d@level MO?	MAICH Level	Westland Brevel Silber	seit Cerelati	Active are take	CH COMPARE SCORE	JO.11 I Partially re
[1010	47	123	0	424	416	0.757	0.953	0.412
b2sum	1813	47	228	0	1180	358	0.717	0.974	0.197
base32	1061	79	112	0	565	305	0.713	0.926	0.287
base64	1089	47	108	0	629	305	0.738	0.957	0.280
basename	739	47	104	0	305	283	0.728	0.936	0.383
basenc	1707	308	121	0	952	326	0.627	0.820	0.191
cat	817	47	112	0	342	316	0.735	0.942	0.387
chcon	17106	47	123	0	16523	413	0.750	0.997	0.024
chgrp	1026	47	120	0	418	441	0.765	0.954	0.430
chmod	1080	68	116	0	425	471	0.758	0.937	0.436
chown	1059	47	122	0	440	450	0.765	0.956	0.425
chroot	799	47	105	0	332	315	0.739	0.941	0.394
cksum	31380	8266	19409	0	3193	512	0.247	0.737	0.016
comm	870	47	126	0	397	300	0.723	0.946	0.345
ср	3616	202	280	0	1579	1555	0.777	0.944	0.430
csplit	4073	444	272	0	1096	2261	0.774	0.891	0.555
cut	4899	47	114	0	4436	302	0.747	0.990	0.062
date	8190	333	557	0	4388	2912	0.774	0.959	0.356
dd	6097	625	167	0	4202	1103	0.705	0.897	0.181

Table 30: Decomposed varnode recovery (compilation = standard)

				MAICH	Wheel AR superior Sup	ALED S	Articles fraction partially and the Warnades fra		
	,	iode ⁵	r@lengling	i @ level c	y establish	@level Al.	@level Mr.	compare scon	Partiallyr
	Jund truth vari	des matché	des matche	ne des mai	chec des matchec	des matche	ne average	des fraction	n des frac
- Ctic	Julie 1/2	strat 4	athor 4	athor	Variate Var	That 18	inde 48	athor 48	ITHOU
df	3126	47	242	0	1860	977	0.778	0.985	0.313
dir	38591	4921	431	0	19529	13710	0.738	0.872	0.355
dircolors	5577	4855	115	0	316	291	0.100	0.129	0.052
dirname	737	47	100	0	305	285	0.731	0.936	0.387
du	6328	500	421	0	1974	3433	0.793	0.921	0.543
echo	725	47	92	0	303	283	0.736	0.935	0.390
env	1323	362	150	0	432	379	0.560	0.726	0.286
expand	796	47	102	0	353	294	0.734	0.941	0.369
expr	4280	590	250	0	1244	2196	0.746	0.862	0.513
factor	4491	280	1694	0	1904	613	0.549	0.938	0.136
false	718	47	92	0	298	281	0.735	0.935	0.391
fmt	13788	47	8112	0	5330	299	0.459	0.997	0.022
fold	793	47	104	0	346	296	0.733	0.941	0.373
groups	764	47	98	0	330	289	0.734	0.938	0.378
head	33664	47	112	0	24958	8547	0.811	0.999	0.254
hostid	733	47	98	0	307	281	0.731	0.936	0.383
id	872	47	112	0	411	302	0.732	0.946	0.346
join	854	47	120	0	364	323	0.733	0.945	0.378
kill	1222	475	104	0	329	314	0.480	0.611	0.257

Table 30: Decomposed varnode recovery (compilation = standard)

	Jund truth war	indes match	and level ho	MATCH andlesid	JEPLAR Jed@level SUR Jedoles machel	SET ALL	THED THE MAI	CHI COMPATE SCORE	10,11 Indially for the land of
link	732	47	98	0	306	281	0.731	0.936	0.384
ln	1704	110	139	0	402	1053	0.815	0.935	0.618
logname	732	47	98	0	306	281	0.731	0.936	0.384
ls	38591	4921	431	0	19529	13710	0.738	0.872	0.355
md5sum	1037	63	198	0	459	317	0.685	0.939	0.306
mkdir	3057	64	138	0	2390	465	0.750	0.979	0.152
mkfifo	837	64	102	0	311	360	0.739	0.924	0.430
mknod	849	64	102	0	312	371	0.743	0.925	0.437
mktemp	853	110	108	0	318	317	0.683	0.871	0.372
mv	3668	252	227	0	1585	1604	0.777	0.931	0.437
nice	741	47	100	0	305	289	0.732	0.937	0.390
nl	4669	467	289	0	1741	2172	0.760	0.900	0.465
nohup	767	47	98	0	335	287	0.734	0.939	0.374
nproc	768	47	102	0	309	310	0.739	0.939	0.404
numfmt	1088	47	210	0	357	474	0.730	0.957	0.436
od	11712	103	251	0	10921	437	0.742	0.991	0.037
paste	753	47	104	0	313	289	0.730	0.938	0.384
pathchk	771	47	102	0	315	307	0.738	0.939	0.398
pinky	3214	47	107	0	2460	600	0.769	0.985	0.187

Table 30: Decomposed varnode recovery (compilation = standard)

	nd truth valo	gode ^s matche	d@level tro	MATCH A MATCH	TERLAR SUBSTRACTED AND WAS SESSION TO SESSION OF SESSIO	SET MALIC	JACO LEVEL MAY	JH Sompare score of	D.I.I Partially reco
	nd tre	thodes i	athode's t	inodes .	Vatrodes 1	nodes l	thole's var	nodes t	
pr									0.665
printenv	732	47	100	0	300	285	0.731	0.936	0.389
printf	3173	222	126	0	2386	439	0.712	0.930	0.138
ptx	5741 863	652 47	454 111	0	2334 308	2301 397	0.725 0.760	0.886 0.946	0.401
pwd readlink	948	47	111	0	333	397 451	0.760	0.946	0.460
realpath	844	47	121	0	329	347	0.770	0.930	0.470
rm	1032	64	127	0	392	449	0.759	0.944	0.411
rmdir	2886	47	135	0	2356	348	0.731	0.984	0.433
runcon	737	47	108	0	300	282	0.725	0.936	0.383
seq	921	47	138	0	398	338	0.729	0.949	0.367
sha1sum	1046	63	200	0	448	335	0.689	0.940	0.320
sha224sum	1182	63	313	0	466	340	0.650	0.947	0.288
sha256sum	1190	63	313	0	474	340	0.650	0.947	0.286
sha384sum	1466	143	249	0	734	340	0.650	0.902	0.232
sha512sum	1498	143	249	0	766	340	0.652	0.905	0.227
shred	3159	112	178	0	1792	1077	0.780	0.965	0.341
shuf	942	47	114	0	393	388	0.755	0.950	0.412
sleep	748	47	100	0	313	288	0.732	0.937	0.385

Table 30: Decomposed varnode recovery (compilation = standard)

				Jewel NO MARICH OVERLAR SUBSET ALIGNED Level MARICH OVERLAR OF EAST OF THE SUBSET OF T						
		Ć-	revel to?	Jewelon	tr level 3118.	Jewel Alike	Jevel MAI	gate score t	ially rec	
	and truth water	ses xchei	1. Tehed	, , ,	ed Lached	g r	@ `	otion s	gart. git	
	ind truth	odes mat	aodes mai	aodes mar	ades mar	odes mat	ode aver	odesfrae	odestrat	
- Gio	Jati	72	in Jai		ati Vati	<u></u>	is Vali	.i. 4211	, 	
sort	11317	243	450	0	2063	8561	0.903	0.979	0.756	
split	1369	379	181	0	426	383	0.546	0.723	0.280	
stat	2845	224	257	0	682	1682	0.794	0.921	0.591	
stdbuf	1931	47	139	0	1387	358	0.742	0.976	0.185	
stty	1527	53	512	0	600	362	0.616	0.965	0.237	
sum	2233	63	104	0	1723	343	0.744	0.972	0.154	
sync	751	47	102	0	314	288	0.731	0.937	0.383	
tac	12312	444	247	0	9445	2176	0.757	0.964	0.177	
tail	33975	68	141	0	33205	561	0.751	0.998	0.017	
tee	8961	47	108	0	8514	292	0.748	0.995	0.033	
test	959	0	123	0	422	414	0.794	1.000	0.432	
timeout	1210	362	110	0	334	404	0.564	0.701	0.334	
touch	6684	308	519	0	4017	1840	0.745	0.954	0.275	
tr	10057	50	369	0	9295	343	0.736	0.995	0.034	
true	718	47	92	0	298	281	0.735	0.935	0.391	
truncate	801	47	106	0	313	335	0.744	0.941	0.418	
tsort	757	47	104	0	317	289	0.730	0.938	0.382	
tty	731	47	102	0	301	281	0.728	0.936	0.384	
uname	1155	55	126	0	301	673	0.805	0.952	0.583	

Table 30: Decomposed varnode recovery (compilation = standard)

Chan	nd truth varno	des matched	@ level NO?	Marchi. © level of	ERLAR STREET	Level Alica Des matched	ED HARIC	Andrew Station Foodes Fraction F	patially reco
unexpand	769	47	104	0	319	299	0.734	0.939	0.389
uniq	818	47	128	0	337	306	0.722	0.943	0.374
unlink	732	47	98	0	306	281	0.731	0.936	0.384
uptime	10247	48	157	0	450	9592	0.973	0.995	0.936
users	739	47	98	0	309	285	0.732	0.936	0.386
vdir	38591	4921	431	0	19529	13710	0.738	0.872	0.355
wc	33696	62	124	0	33091	419	0.750	0.998	0.012
who	1345	47	175	0	440	683	0.786	0.965	0.508
whoami	734	47	98	0	308	281	0.731	0.936	0.383
yes	742	47	98	0	312	285	0.732	0.937	0.384

Table 31: Decomposed varnode recovery (compilation = standard)

		vatnodes trati		O MATCH thed @ level C	B	Á	Idande average compare score 10,11 Jamode average compare score 10,11 Jamode average compare score 10,11 Jamode average compare score 10,11				
			, -2	O Mir O	Weld AR Sted Branch	JBSE, A					
		vatnodes mai	@level	, @level	@level!	@level	@level	@level ampare autially			
	.W.	vatno maic	ned mali	thed mai	thed make	ned nati	hed letage	cu Exaction	:43G		
.c	und tru	modestr	modesti	modesti	modesti	modesti	inde at	inodesti	modestr		
— Gir		751	7.gr	191		7.51		7.			
[2	0	1	0	1	0	0.500	1.000	0.000		
b2sum	0	0	0	0	0	0	-	-	-		
base32	0	0	0	0	0	0	-	-	-		
base64	0	0	0	0	0	0	-	-	-		
basename	0	0	0	0	0	0	-	-	-		
basenc	0	0	0	0	0	0	-	-	-		
cat	0	0	0	0	0	0	-	-	-		
chcon	7	0	4	0	3	0	0.464	1.000	0.000		
chgrp	7	0	4	0	3	0	0.464	1.000	0.000		
chmod	7	0	4	0	3	0	0.464	1.000	0.000		
chown	7	0	4	0	3	0	0.464	1.000	0.000		
chroot	0	0	0	0	0	0	-	-	-		
cksum	3	0	3	0	0	0	0.250	1.000	0.000		
comm	0	0	0	0	0	0	-	-	-		
ср	7	0	4	0	3	0	0.464	1.000	0.000		
csplit	0	0	0	0	0	0	-	-	-		
cut	0	0	0	0	0	0	-	_	_		
date	2	0	1	0	1	0	0.500	1.000	0.000		
dd	7	0	4	0	3	0	0.464	1.000	0.000		

Table 31: Decomposed varnode recovery (compilation = standard)

		Jun varnodes mached @ level no Mariodes mached @ level of the level and							~\foots		
			. J. J.	9 July 9 0	AFRICA SIST	JBSI , el A	IIGI BINAS	all Marich Level Maria Landra			
		rnoles	ed legge	ed@lext	ed@lext	ed@1ext	ed lex	onnpare	a Partiali.		
	a truth v	ar 1es mais	Ar 185 Mali	in les mai	in les mai	in les mais	de average	125 tractio	1es fract		
Cir	Jund Hull V	Varnou	Varnod	Varnod	Varnod	Varnou	Varnod	inou.	ande		
df	17	0	8	0	4	5	0.588	1.000	0.294		
dir	10	0	7	0	3	0	0.400	1.000	0.000		
dircolors	0	0	0	0	0	0	-	-	-		
dirname	0	0	0	0	0	0	-	-	-		
du	10	0	7	0	3	0	0.400	1.000	0.000		
echo	0	0	0	0	0	0	-	-	-		
env	0	0	0	0	0	0	-	-	-		
expand	0	0	0	0	0	0	-	-	-		
expr	0	0	0	0	0	0	-	-	-		
factor	0	0	0	0	0	0	-	-	-		
false	0	0	0	0	0	0	-	-	-		
fmt	0	0	0	0	0	0	-	-	-		
fold	0	0	0	0	0	0	-	-	-		
groups	0	0	0	0	0	0	-	-	-		
head	0	0	0	0	0	0	-	-	-		
hostid	0	0	0	0	0	0	-	-	-		
id	0	0	0	0	0	0	-	-	-		
join	0	0	0	0	0	0	-	-	-		
kill	0	0	0	0	0	0	-	_	_		

Table 31: Decomposed varnode recovery (compilation = standard)

			7	eevel MO MATCH Level MATC					
	ound truth	atrodes train	ned@lever	thed lever	thed level	thed lever	ned@lever	citi compare score	Datially thodes fract
link	0	0	0	0	0	0	- 7.0 7.0	- - ~	y
ln	7	0	4	0	3	0	0.464	1.000	0.000
logname	0	0	0	0	0	0	-	-	-
ls	10	0	7	0	3	0	0.400	1.000	0.000
md5sum	0	0	0	0	0	0	-	-	-
mkdir	2	0	1	0	1	0	0.500	1.000	0.000
mkfifo	0	0	0	0	0	0	-	-	-
mknod	0	0	0	0	0	0	-	-	-
mktemp	0	0	0	0	0	0	-	-	-
mv	7	0	4	0	3	0	0.464	1.000	0.000
nice	0	0	0	0	0	0	-	-	-
nl	0	0	0	0	0	0	-	-	-
nohup	0	0	0	0	0	0	-	-	-
nproc	0	0	0	0	0	0	-	-	-
numfmt	7	0	6	0	1	0	0.321	1.000	0.000
od	11	0	4	0	7	0	0.568	1.000	0.000
paste	0	0	0	0	0	0	-	-	-
pathchk	0	0	0	0	0	0	-	-	-
pinky	0	0	0	0	0	0	-	-	-

Table 31: Decomposed varnode recovery (compilation = standard)

				WO MARICH AND MAR					
	nd truth vi	htnodes	ed@level.W	ed@levelo	hed@levelsd	ned@level A	Jenetle Level Mari	TH GOT PARTY STATE OF THE TRANSPORT OF T	partially rec
pr Groi	0	Varing 0	Autho 1	aging 4	Varing 6	Varing 4	Vatric Vat	ric Vat	<u>-</u>
printenv	0	0	0	0	0	0	-	-	_
printf	7	0	6	0	1	0	0.321	1.000	0.000
ptx	0	0	0	0	0	0	-	-	-
pwd	0	0	0	0	0	0	-	-	-
readlink	7	0	4	0	3	0	0.464	1.000	0.000
realpath	7	0	4	0	3	0	0.464	1.000	0.000
rm	7	0	4	0	3	0	0.464	1.000	0.000
rmdir	2	0	1	0	1	0	0.500	1.000	0.000
runcon	0	0	0	0	0	0	-	-	-
seq	14	0	13	0	1	0	0.286	1.000	0.000
sha1sum	0	0	0	0	0	0	-	-	-
sha224sum	0	0	0	0	0	0	-	-	-
sha256sum	0	0	0	0	0	0	-	-	-
sha384sum	0	0	0	0	0	0	-	-	-
sha512sum	0	0	0	0	0	0	-	-	-
shred	3	0	3	0	0	0	0.250	1.000	0.000
shuf	7	0	4	0	3	0	0.464	1.000	0.000
sleep	7	0	0	0	2	5	0.929	1.000	0.714

Table 31: Decomposed varnode recovery (compilation = standard)

			ed@level.Wo	AMATCH AMATCH					
			Other	Mr. Selon	ik jelsuk	SLAI	is and it	escotell	114 rect
	ď	nodes	2d@161	² 9@ ₁₆₁	29 26 26 26 26 26 26 26 26 26 26 26 26 26	9 _{© 164}	⁵⁹ @ ₁₆₄	MPar : OFF	Partial :
	Atuth	des match	des match	des match	des match.	des match	ae average	des fractie	des fracti
Cit	Jund truth vari	atriot 4	arnol 4	athor 4	athor 4	athor 4	arnot Jari	Jari	jot
sort	22	0	9	0	11	2	0.568	1.000	0.091
split	0	0	0	0	0	0	-	-	-
stat	2	0	1	0	1	0	0.500	1.000	0.000
stdbuf	2	0	1	0	1	0	0.500	1.000	0.000
stty	2	0	1	0	1	0	0.500	1.000	0.000
sum	3	0	3	0	0	0	0.250	1.000	0.000
sync	0	0	0	0	0	0	-	-	-
tac	0	0	0	0	0	0	-	-	-
tail	15	0	4	0	6	5	0.700	1.000	0.333
tee	0	0	0	0	0	0	-	-	-
test	2	0	1	0	1	0	0.500	1.000	0.000
timeout	8	0	0	0	4	4	0.875	1.000	0.500
touch	2	0	1	0	1	0	0.500	1.000	0.000
tr	0	0	0	0	0	0	-	-	-
true	0	0	0	0	0	0	-	-	-
runcate	0	0	0	0	0	0	-	-	-
tsort	0	0	0	0	0	0	-	-	-
tty	0	0	0	0	0	0	-	-	-
uname	0	0	0	0	0	0	-	-	_

Table 31: Decomposed varnode recovery (compilation = standard)

Gro	and ruth var	nodes mach	ed@level.TO	MATCH ON Read	ed@levelsuf	astrodes mach	CHIED HALC	Andes fraction f	patially recove
unexpand	0	0	0	0	0	0	-	-	-
uniq	0	0	0	0	0	0	-	-	-
unlink	0	0	0	0	0	0	-	-	-
uptime	5	0	0	0	4	1	0.800	1.000	0.200
users	0	0	0	0	0	0	-	-	-
vdir	10	0	7	0	3	0	0.400	1.000	0.000
wc	4	0	0	0	4	0	0.750	1.000	0.000
who	2	0	1	0	1	0	0.500	1.000	0.000
whoami	0	0	0	0	0	0	-	-	-
yes	0	0	0	0	0	0	-	-	-

Table 32: Decomposed varnode recovery (compilation = standard)

				MATCH	MATICH AREAL ARE STUBSET ALICATED AND CHAIN AN					
		دے۔	level 140	, level o						
	jund fruith visi	inodes	thed atch	zd [©]	thed atch	ed [®]	ied arage	conflix	a Parte	
á	and truth	nodes nid	modes mid	nodesnia	nodes mid	nodes mid	node aver	nodestra	moles fra	
	· 4	ali	1211 1	att.	1011 1	all c	1911 15	78	<u></u>	
[170	0	20	0	59	91	0.825	1.000	0.535	
b2sum	140	0	48	0	54	38	0.646	1.000	0.271	
base32	107	0	32	0	44	31	0.673	1.000	0.290	
base64	107	0	32	0	44	31	0.673	1.000	0.290	
basename	104	0	32	0	44	28	0.663	1.000	0.269	
basenc	138	0	48	0	51	39	0.647	1.000	0.283	
cat	115	0	40	0	48	27	0.635	1.000	0.235	
chcon	234	2	52	0	119	61	0.698	0.991	0.261	
chgrp	230	3	46	0	118	63	0.709	0.987	0.274	
chmod	217	2	42	0	115	58	0.713	0.991	0.267	
chown	241	2	48	0	123	68	0.715	0.992	0.282	
chroot	133	0	32	0	48	53	0.729	1.000	0.398	
cksum	234	0	99	0	78	57	0.599	1.000	0.244	
comm	127	0	44	0	54	29	0.634	1.000	0.228	
cp	403	3	114	0	164	122	0.679	0.993	0.303	
csplit	1416	10	304	0	1021	81	0.652	0.993	0.057	
cut	122	0	42	0	49	31	0.641	1.000	0.254	
date	426	5	202	0	81	138	0.585	0.988	0.324	
dd	216	0	29	0	73	114	0.815	1.000	0.528	

Table 32: Decomposed varnode recovery (compilation = standard)

				MATCH	AMICH AM					
		nodes	1@ level 40	a@levelC	onnpare score	ore partially r				
	Jund truth was	i. des maic	nee des matche	des mai	ched des matche	des match	er average	destraction	. des frac	
- Gre	Juli 4	atrioe 4	Varnoe V	IIIIOC	Varnot Va	strice 4	athor 18	ithoc 18	JINOU	
df	419	0	83	0	138	198	0.769	1.000	0.473	
dir	642	1	297	0	199	145	0.574	0.998	0.226	
dircolors	229	0	119	0	70	40	0.534	1.000	0.175	
dirname	94	0	28	0	41	25	0.668	1.000	0.266	
du	1650	13	350	0	1125	162	0.663	0.992	0.098	
echo	84	0	20	0	40	24	0.702	1.000	0.286	
env	138	0	46	0	54	38	0.652	1.000	0.275	
expand	101	0	32	0	45	24	0.651	1.000	0.238	
expr	1399	10	288	0	1019	82	0.656	0.993	0.059	
factor	196	1	44	0	84	67	0.719	0.995	0.342	
false	82	0	20	0	40	22	0.695	1.000	0.268	
fmt	2126	0	2040	0	52	34	0.274	1.000	0.016	
fold	99	0	32	0	41	26	0.654	1.000	0.263	
groups	100	0	26	0	43	31	0.698	1.000	0.310	
head	125	0	42	0	50	33	0.648	1.000	0.264	
hostid	93	0	26	0	41	26	0.680	1.000	0.280	
id	134	0	40	0	47	47	0.688	1.000	0.351	
join	149	0	45	0	60	44	0.673	1.000	0.295	
kill	102	0	32	0	41	29	0.664	1.000	0.284	

Table 32: Decomposed varnode recovery (compilation = standard)

		<u> </u>	level 40	MATCH	WERLAR LEVELSU	BSET LEVEL AT	JONED LEVEL MAY	article average compare score (0,1) Authore fraction partials Authore fraction partials 0.680 1.000 0.28		
Çst	Sund truth was	nodes mais	hed evel ho	ed @ strades trad	Welklar Evel SU	ed ® stratch	sed@ / surrage	eome Inodes fraction	n pare	
link	93	0	26	0	41	26	0.680	1.000	0.280	
ln	276	0	65	0	120	91	0.715	1.000	0.330	
logname	94	0	26	0	42	26	0.681	1.000	0.277	
ls	642	1	297	0	199	145	0.574	0.998	0.226	
md5sum	132	0	46	0	55	31	0.634	1.000	0.235	
mkdir	192	0	34	0	65	93	0.783	1.000	0.484	
mkfifo	100	0	30	0	47	23	0.657	1.000	0.230	
mknod	105	0	30	0	49	26	0.669	1.000	0.248	
mktemp	117	0	39	0	48	30	0.647	1.000	0.256	
mv	379	5	64	0	207	103	0.724	0.987	0.272	
nice	95	0	28	0	40	27	0.674	1.000	0.284	
nl	1404	10	320	0	991	83	0.645	0.993	0.059	
nohup	106	0	26	0	50	30	0.698	1.000	0.283	
nproc	96	0	30	0	40	26	0.661	1.000	0.271	
numfmt	184	0	80	0	56	48	0.598	1.000	0.261	
od	226	0	49	0	62	115	0.769	1.000	0.509	
paste	103	0	32	0	44	27	0.660	1.000	0.262	
pathchk	95	0	28	0	43	24	0.666	1.000	0.253	
pinky	120	0	29	0	58	33	0.698	1.000	0.275	

Table 32: Decomposed varnode recovery (compilation = standard)

			40.	MAICH	yi ne (reloil (
	h watt	ode ⁵	ed Pevel NO annotes matches annotes matches 75	d@JevelO	FRIAR RED SUBSUBSUBSUBSUBSUBSUBSUBSUBSUBSUBSUBSUBS	@level Ar	THED MAN	JH onpare score l	Partially rec
<u> </u>	nd truth vari	inodes niu	athodes nice	indes nu	Varnodes nor Va	indes niu	unde aver	nodes fro	ndes fra
pr	218	1	75	0	88	54	0.636	0.995	0.248
printenv	93	0	28	0	40	25	0.667	1.000	0.269
printf	178	0	21	0	60	97	0.827	1.000	0.545
ptx	1540	10	347	0	1043	140	0.655	0.994	0.091
pwd	105	0	30	0	50	25	0.667	1.000	0.238
readlink	187	0	43	0	78	66	0.723	1.000	0.353
realpath	196	0	47	0	83	66	0.714	1.000	0.337
rm	236	2	51	0	122	61	0.700	0.992	0.258
rmdir	180	0	34	0	55	91	0.782	1.000	0.506
runcon	106	0	36	0	47	23	0.634	1.000	0.217
seq	193	0	32	0	59	102	0.799	1.000	0.528
sha1sum	131	0	46	0	54	31	0.634	1.000	0.237
sha224sum	132	0	46	0	55	31	0.634	1.000	0.235
sha256sum	132	0	46	0	55	31	0.634	1.000	0.235
sha384sum	132	0	46	0	55	31	0.634	1.000	0.235
sha512sum	132	0	46	0	55	31	0.634	1.000	0.235
shred	174	0	49	0	79	46	0.675	1.000	0.264
shuf	218	0	41	0	100	77	0.744	1.000	0.353
sleep	99	0	26	0	43	30	0.694	1.000	0.303

Table 32: Decomposed varnode recovery (compilation = standard)

			d@level NO?	AMCH	iped. AP stateled warmode's matched	jći sije	Devel MARCHA One we was a second pare score to a second to the second t		
	Jund truth varies	de ⁵	d@level! ned	@level O	ed@level?	@level fr	o level in e co	mpare su	partially to
	ind truth var	odes match	aodes match	aodes matel	andes match	odes match	aode average	odes fractiv	odes fracti
- Gro		7,	dir Va		agir Jai	79	in Agn	√211	
sort	492	17	113	0	219	143	0.682	0.965	0.291
split	162	0	55	0	64	43	0.647	1.000	0.265
stat	286	1	44	0	102	139	0.792	0.997	0.486
stdbuf	201	0	39	0	61	101	0.779	1.000	0.502
stty	331	0	176	0	61	94	0.555	1.000	0.284
sum	131	0	35	0	55	41	0.695	1.000	0.313
sync	95	0	30	0	43	22	0.650	1.000	0.232
tac	1390	10	301	0	1003	76	0.650	0.993	0.055
tail	225	0	57	0	89	79	0.711	1.000	0.351
tee	108	0	37	0	47	24	0.634	1.000	0.222
test	157	0	20	0	49	88	0.826	1.000	0.561
timeout	113	0	36	0	43	34	0.666	1.000	0.301
touch	391	5	183	0	77	126	0.587	0.987	0.322
tr	146	0	54	0	59	33	0.622	1.000	0.226
true	82	0	20	0	40	22	0.695	1.000	0.268
truncate	100	0	34	0	42	24	0.640	1.000	0.240
tsort	118	0	27	0	56	35	0.710	1.000	0.297
tty	93	0	30	0	40	23	0.651	1.000	0.247
uname	118	0	54	0	42	22	0.568	1.000	0.186

Table 32: Decomposed varnode recovery (compilation = standard)

Grovi	nd truth vari	indes mach	ed @ level NO.	Majeria de la	Field Bevel Substituted	ET ALLE	ATED MAIC	A Staction for the state of the	natially reco
unexpand	104	0	34	0	45	25	0.647	1.000	0.240
uniq	143	0	55	0	52	36	0.621	1.000	0.252
unlink	93	0	26	0	41	26	0.680	1.000	0.280
uptime	126	1	26	0	60	39	0.718	0.992	0.310
users	102	0	26	0	48	28	0.691	1.000	0.275
vdir	642	1	297	0	199	145	0.574	0.998	0.226
wc	176	16	40	0	73	47	0.635	0.909	0.267
who	222	0	59	0	64	99	0.729	1.000	0.446
whoami	94	0	26	0	42	26	0.681	1.000	0.277
yes	98	0	26	0	44	28	0.689	1.000	0.286

Table 33: Decomposed varnode recovery (compilation = debug)

	પ્રાથમ	Truth water des matched @ level Two Matters matched @ level of the lev							re (0,1) The dialy re
Crc	Jund truth	inodes ma	Varnode's mark	Vatnode's Inal	Vatnode's Inal	Varnodes man	node averer	inodes fract	inodes frac
[1190	0	0	0	0	1190	1.000	1.000	1.000
b2sum	1954	0	0	0	0	1954	1.000	1.000	1.000
base32	1169	0	0	0	0	1169	1.000	1.000	1.000
base64	1197	0	0	0	0	1197	1.000	1.000	1.000
basename	844	0	0	0	0	844	1.000	1.000	1.000
basenc	1847	0	0	0	0	1847	1.000	1.000	1.000
cat	933	0	0	0	0	933	1.000	1.000	1.000
chcon	17348	0	0	0	0	17348	1.000	1.000	1.000
chgrp	1264	0	0	0	0	1264	1.000	1.000	1.000
chmod	1305	0	0	0	0	1305	1.000	1.000	1.000
chown	1308	0	0	0	0	1308	1.000	1.000	1.000
chroot	933	0	1	0	0	932	0.999	1.000	0.999
cksum	31618	0	0	0	0	31618	1.000	1.000	1.000
comm	998	0	0	0	0	998	1.000	1.000	1.000
cp	4028	0	2	0	2	4024	1.000	1.000	0.999
csplit	5511	295	2	0	0	5214	0.946	0.946	0.946
cut	5022	0	0	0	0	5022	1.000	1.000	1.000
date	8648	9	6	0	0	8633	0.998	0.999	0.998
dd	6329	0	0	0	0	6329	1.000	1.000	1.000

Table 33: Decomposed varnode recovery (compilation = debug)

				MATCH	cRIA?	TCH songaison score 10,11 Configuration partially fathodes from			
	viatr	ioge _e	id@levelty	O.M.ATCH Ded@level.O. Varrodes hard	hed@levels	JBSFT. JBSFT. Jamodes mached Vamodes mached	@levelMA	compairson su	A Partially re
Ctc	Jund truth water	modes mau	atnodes mar	Varnode's mae	Varnode's Ina.	Vatrades mai	node avere	inodes frac	indes fra
df	3575	0	7	0	0	3568	0.999	1.000	0.998
dir	39259	1255	21	0	0	37983	0.968	0.968	0.967
dircolors	5810	3	0	0	0	5807	0.999	0.999	0.999
dirname	832	0	0	0	0	832	1.000	1.000	1.000
du	8012	295	3	0	0	7714	0.963	0.963	0.963
echo	810	0	0	0	0	810	1.000	1.000	1.000
env	1464	0	0	0	0	1464	1.000	1.000	1.000
expand	898	0	0	0	0	898	1.000	1.000	1.000
expr	5706	302	2	0	0	5402	0.947	0.947	0.947
factor	4701	53	7	0	0	4641	0.988	0.989	0.987
false	801	0	0	0	0	801	1.000	1.000	1.000
fmt	15915	4000	0	0	0	11915	0.749	0.749	0.749
fold	893	0	0	0	0	893	1.000	1.000	1.000
groups	865	0	0	0	0	865	1.000	1.000	1.000
head	33790	0	0	0	0	33790	1.000	1.000	1.000
hostid	827	0	0	0	0	827	1.000	1.000	1.000
id	1007	0	0	0	0	1007	1.000	1.000	1.000
join	1004	0	0	0	0	1004	1.000	1.000	1.000
kill	1325	0	0	0	0	1325	1.000	1.000	1.000

Table 33: Decomposed varnode recovery (compilation = debug)

		æs	@ level 1 ⁵	O MARCH O MARIO LEVELO Vario des road	JERLAR @ level S	JBSET JBSET Liked Revel All Control Jathodes matched	CH compatison score 10.11 compatison score 10.11 compatison score 10.11		
Gss	Jund truth vari	indes match	athodes mai	Liked Varnodes mais	hed Varnodes man	tred warnodes matched	nade average	nodes fraction	ithodes fract
link	826	0	0	0	0	826	1.000	1.000	1.000
ln	1991	0	0	0	0	1991	1.000	1.000	1.000
logname	827	0	0	0	0	827	1.000	1.000	1.000
ls	39259	1255	21	0	0	37983	0.968	0.968	0.967
md5sum	1170	0	0	0	0	1170	1.000	1.000	1.000
mkdir	3260	0	2	0	0	3258	1.000	1.000	0.999
mkfifo	938	0	0	0	0	938	1.000	1.000	1.000
mknod	955	0	0	0	0	955	1.000	1.000	1.000
mktemp	971	0	0	0	0	971	1.000	1.000	1.000
mv	4056	0	1	0	2	4053	1.000	1.000	0.999
nice	837	0	0	0	0	837	1.000	1.000	1.000
nl	6094	316	2	0	0	5776	0.948	0.948	0.948
nohup	874	0	0	0	0	874	1.000	1.000	1.000
nproc	865	0	0	0	0	865	1.000	1.000	1.000
numfmt	1280	0	0	0	0	1280	1.000	1.000	1.000
od	11965	0	1	0	0	11964	1.000	1.000	1.000
paste	857	0	0	0	0	857	1.000	1.000	1.000
pathchk	869	0	0	0	0	869	1.000	1.000	1.000
pinky	3335	224	0	0	0	3111	0.933	0.933	0.933

Table 33: Decomposed varnode recovery (compilation = debug)

				~CX	R	•	CH CHI Score 10.11 compatisally recurrence fraction partially recurred to the compatisally recurred to			
			٠, ۵	MAI	ERLA	Bestir	MEL A	ich score (0,1) compaison score (0,1) compaison score (0,1) compaison score (0,1)		
		<u>~</u>	level 14	Jevel O	level 5	level Ar	level Mr.	Odison!	riallyred	
	Watr	iode ³	,S [®] ′	ged "c	red. "S	ned. "ched	@ '	onit	Pate	
	ad truth.	desmale	desmale	desmale	desmale	desmale	he averious	destract	Jes Fraci	
Circle	nd truth vali	thos 1	atriou .	And Chi	Valinge	Besteri Red@level Alles Astrodes mathed	inde 1at	ing 1/at	1000	
pr	2854	0	0	0	0	2854	1.000	1.000	1.000	
printenv	826	0	0	0	0	826	1.000	1.000	1.000	
printf	3369	0	3	0	0	3366	0.999	1.000	0.999	
ptx	7315	325	9	0	0	6981	0.955	0.956	0.954	
pwd	969	0	0	0	0	969	1.000	1.000	1.000	
readlink	1146	0	0	0	0	1146	1.000	1.000	1.000	
realpath	1051	0	0	0	0	1051	1.000	1.000	1.000	
rm	1276	0	0	0	0	1276	1.000	1.000	1.000	
rmdir	3076	0	0	0	0	3076	1.000	1.000	1.000	
runcon	844	0	0	0	0	844	1.000	1.000	1.000	
seq	1136	0	0	0	0	1136	1.000	1.000	1.000	
sha1sum	1178	0	0	0	0	1178	1.000	1.000	1.000	
sha224sum	1315	0	0	0	0	1315	1.000	1.000	1.000	
sha256sum	1323	0	0	0	0	1323	1.000	1.000	1.000	
sha384sum	1599	0	0	0	0	1599	1.000	1.000	1.000	
sha512sum	1631	0	0	0	0	1631	1.000	1.000	1.000	
shred	3337	631	0	0	0	2706	0.811	0.811	0.811	
shuf	1168	0	0	0	0	1168	1.000	1.000	1.000	
sleep	855	0	0	0	0	855	1.000	1.000	1.000	

Table 33: Decomposed varnode recovery (compilation = debug)

				MATCH OVER OVER AND	ed@level5Uf	SSET ALICA Sed @ Level ALICA Sethodes matched Man	ED TO	H Indestraction	20,11
	,	, o ⁵ 2	a level 70	level On	level 5U	evel Alic	a level MA.	Maison sco	rtially reco
	sind fruit varied	ac natched	s atch	ed W	ed w	ed the gratched to	e Jejage co	oraction's	iraction
csc	Jund trill	odes ii.	indesti	athodes it.	athodes it.	athodes fix	ode and	iodes li	iodesti
sort	11845	9	1	0	0	11835	0.999	0.999	0.999
split	1533	0	2	0	0	1531	0.999	1.000	0.999
stat	3141	0	0	0	0	3141	1.000	1.000	1.000
stdbuf	2142	0	0	0	0	2142	1.000	1.000	1.000
stty	1868	0	0	0	0	1868	1.000	1.000	1.000
sum	2368	0	0	0	0	2368	1.000	1.000	1.000
sync	847	0	0	0	0	847	1.000	1.000	1.000
tac	13723	302	2	0	0	13419	0.978	0.978	0.978
tail	34216	0	6	0	0	34210	1.000	1.000	1.000
tee	9070	0	0	0	0	9070	1.000	1.000	1.000
test	1126	0	0	0	0	1126	1.000	1.000	1.000
timeout	1334	0	0	0	0	1334	1.000	1.000	1.000
touch	7107	9	6	0	0	7092	0.998	0.999	0.998
tr	10204	0	0	0	0	10204	1.000	1.000	1.000
true	801	0	0	0	0	801	1.000	1.000	1.000
truncate	902	0	0	0	0	902	1.000	1.000	1.000
tsort	876	0	0	0	0	876	1.000	1.000	1.000
tty	825	0	0	0	0	825	1.000	1.000	1.000
uname	1274	0	0	0	0	1274	1.000	1.000	1.000

Table 33: Decomposed varnode recovery (compilation = debug)

Gravi	nd truth victor	ges Thatched	@level 140	Marich Andrewalow Andrewalow	ed@levelsUf	SSET BURNER ALICHE	ED Level MATC	A some some some some some some some some	patially reco
unexpand	874	0	0	0	0	874	1.000	1.000	1.000
uniq	962	0	0	0	0	962	1.000	1.000	1.000
unlink	826	0	0	0	0	826	1.000	1.000	1.000
uptime	10379	0	0	0	1	10378	1.000	1.000	1.000
users	842	0	0	0	0	842	1.000	1.000	1.000
vdir	39259	1255	21	0	0	37983	0.968	0.968	0.967
wc	33888	9	0	0	0	33879	1.000	1.000	1.000
who	1577	0	0	0	0	1577	1.000	1.000	1.000
whoami	829	0	0	0	0	829	1.000	1.000	1.000
yes	841	0	0	0	0	841	1.000	1.000	1.000

Table 34: Decomposed varnode recovery (compilation = debug)

ÇKÛ	and truth warn's	ndes hatchel	L@ Level NO.	Matchi Me level Owlift	A Pare Substituted was	ET Evel ALLE	ACID MATE	JII Songare score in the second secon	patially re
[1010	0	0	0	0	1010	1.000	1.000	1.000
b2sum	1813	0	0	0	0	1813	1.000	1.000	1.000
base32	1061	0	0	0	0	1061	1.000	1.000	1.000
base64	1089	0	0	0	0	1089	1.000	1.000	1.000
basename	739	0	0	0	0	739	1.000	1.000	1.000
basenc	1707	0	0	0	0	1707	1.000	1.000	1.000
cat	817	0	0	0	0	817	1.000	1.000	1.000
chcon	17106	0	0	0	0	17106	1.000	1.000	1.000
chgrp	1026	0	0	0	0	1026	1.000	1.000	1.000
chmod	1080	0	0	0	0	1080	1.000	1.000	1.000
chown	1059	0	0	0	0	1059	1.000	1.000	1.000
chroot	799	0	1	0	0	798	0.999	1.000	0.999
cksum	31380	0	0	0	0	31380	1.000	1.000	1.000
comm	870	0	0	0	0	870	1.000	1.000	1.000
cp	3616	0	2	0	2	3612	0.999	1.000	0.999
csplit	4073	295	2	0	0	3776	0.927	0.928	0.927
cut	4899	0	0	0	0	4899	1.000	1.000	1.000
date	8190	8	6	0	0	8176	0.998	0.999	0.998
dd	6097	0	0	0	0	6097	1.000	1.000	1.000

Table 34: Decomposed varnode recovery (compilation = debug)

				TCH.					
			~	MAI	TERLA 1	BSET JE	Mer A	CH SE	0,11
		ر جي	[level 7	level O	(levels	anate sco	rtially re		
	Vall	ioder "che	,S [®] (hed ®	hed @	thed their) (0)	contin	1 Pate
	ad truth	adesmail	adesmai	adesmai	desmai	ades mail	adeavertu	adestrati	adestrac
Cit	Jund Hull vari	inic 4	atric .	Vario	Varia	Aating Aa	1910 A8	Cli compare score	III
df	3126	0	7	O MATCH O Mathodes had	0	JBSET ALLE	0.998	1.000	0.998
dir	38591	1255	21	0	0	37315	0.967	0.967	0.967
dircolors	5577	3	0	0	0	5574	0.999	0.999	0.999
dirname	737	0	0	0	0	737	1.000	1.000	1.000
du	6328	295	3	0	0	6030	0.953	0.953	0.953
echo	725	0	0	0	0	725	1.000	1.000	1.000
env	1323	0	0	0	0	1323	1.000	1.000	1.000
expand	796	0	0	0	0	796	1.000	1.000	1.000
expr	4280	302	2	0	0	3976	0.929	0.929	0.929
factor	4491	41	5	0	0	4445	0.990	0.991	0.990
false	718	0	0	0	0	718	1.000	1.000	1.000
fmt	13788	4000	0	0	0	9788	0.710	0.710	0.710
fold	793	0	0	0	0	793	1.000	1.000	1.000
groups	764	0	0	0	0	764	1.000	1.000	1.000
head	33664	0	0	0	0	33664	1.000	1.000	1.000
hostid	733	0	0	0	0	733	1.000	1.000	1.000
id	872	0	0	0	0	872	1.000	1.000	1.000
join	854	0	0	0	0	854	1.000	1.000	1.000
kill	1222	0	0	0	0	1222	1.000	1.000	1.000

Table 34: Decomposed varnode recovery (compilation = debug)

				MATCH	ERLAR	185ET (C	Alternate average compare score 10,11 Annote average compare score 10,11 Variode stration partially 1 1.000 1.000 1.000 1.000			
	n water	node ⁵	d@levelty	O MATCH thed @ level O	ned@levels	thed @ level All	. age	compare scor	, Partially re	
Gr	Jund truth vari	inodes mar	athodes ma	Vatnodes mar	Vatnodes ma	Varnode's mar	inde aver	inodes frat	indes frae	
link	732	0	0	0	0	732	1.000	1.000	1.000	
ln	1704	0	0	0	0	1704	1.000	1.000	1.000	
logname	732	0	0	0	0	732	1.000	1.000	1.000	
ls	38591	1255	21	0	0	37315	0.967	0.967	0.967	
md5sum	1037	0	0	0	0	1037	1.000	1.000	1.000	
mkdir	3057	0	2	0	0	3055	1.000	1.000	0.999	
mkfifo	837	0	0	0	0	837	1.000	1.000	1.000	
mknod	849	0	0	0	0	849	1.000	1.000	1.000	
mktemp	853	0	0	0	0	853	1.000	1.000	1.000	
mv	3668	0	1	0	2	3665	1.000	1.000	0.999	
nice	741	0	0	0	0	741	1.000	1.000	1.000	
nl	4669	316	2	0	0	4351	0.932	0.932	0.932	
nohup	767	0	0	0	0	767	1.000	1.000	1.000	
nproc	768	0	0	0	0	768	1.000	1.000	1.000	
numfmt	1088	0	0	0	0	1088	1.000	1.000	1.000	
od	11712	0	1	0	0	11711	1.000	1.000	1.000	
paste	753	0	0	0	0	753	1.000	1.000	1.000	
pathchk	771	0	0	0	0	771	1.000	1.000	1.000	
pinky	3214	224	0	0	0	2990	0.930	0.930	0.930	

Table 34: Decomposed varnode recovery (compilation = debug)

	nd trith var	iodes matche	d @level A	D. Matter D. Matter C. Mat	FRIAR level St.	BSET BERGE ALLO	MED MAIN COLOR WAS	id on pare score i	Patially reco
pr Grai	2634	ino o	atric .	Varing 4	Varing 4	2634	1.000	ne vai	1.000
printenv	732	0	0	0	0	732	1.000	1.000	1.000
printf	3173	0	3	0	0	3170	0.999	1.000	0.999
ptx	5741	325	7	0	0	5409	0.942	0.943	0.942
pwd	863	0	0	0	0	863	1.000	1.000	1.000
readlink	948	0	0	0	0	948	1.000	1.000	1.000
realpath	844	0	0	0	0	844	1.000	1.000	1.000
rm	1032	0	0	0	0	1032	1.000	1.000	1.000
rmdir	2886	0	0	0	0	2886	1.000	1.000	1.000
runcon	737	0	0	0	0	737	1.000	1.000	1.000
seq	921	0	0	0	0	921	1.000	1.000	1.000
sha1sum	1046	0	0	0	0	1046	1.000	1.000	1.000
sha224sum	1182	0	0	0	0	1182	1.000	1.000	1.000
sha256sum	1190	0	0	0	0	1190	1.000	1.000	1.000
sha384sum	1466	0	0	0	0	1466	1.000	1.000	1.000
sha512sum	1498	0	0	0	0	1498	1.000	1.000	1.000
shred	3159	631	0	0	0	2528	0.800	0.800	0.800
shuf	942	0	0	0	0	942	1.000	1.000	1.000
sleep	748	0	0	0	0	748	1.000	1.000	1.000

Table 34: Decomposed varnode recovery (compilation = debug)

				a level NO MARICHI Alamales matched a level of the lamb and					
			_0	MAI	ERIA CU	ssei Jic i	SER MAJO	Maria de Straction f),),
		ş	level 7	a level C	Jewel St	level A	least de	apate sce	riallyte
	Vatno	se rchei	\@ \@	zd	,ch	zd [®] ,ched [®]	ي موي موي	oni, citou	ija Jau
	जाती प्राप्ती	odes mar	ades mai	ades mai	ades mai	desmal	de aveil	adestrat	ales frail
Cit	Sind truth varied	70	int 4	atric 4	atric 4	atric Vatri	Jar	Jari	je.
sort	11317	9	1	0	0	11307	0.999	0.999	0.999
split	1369	0	2	0	0	1367	0.999	1.000	0.999
stat	2845	0	0	0	0	2845	1.000	1.000	1.000
stdbuf	1931	0	0	0	0	1931	1.000	1.000	1.000
stty	1527	0	0	0	0	1527	1.000	1.000	1.000
sum	2233	0	0	0	0	2233	1.000	1.000	1.000
sync	751	0	0	0	0	751	1.000	1.000	1.000
tac	12312	302	2	0	0	12008	0.975	0.975	0.975
tail	33975	0	6	0	0	33969	1.000	1.000	1.000
tee	8961	0	0	0	0	8961	1.000	1.000	1.000
test	959	0	0	0	0	959	1.000	1.000	1.000
timeout	1210	0	0	0	0	1210	1.000	1.000	1.000
touch	6684	8	6	0	0	6670	0.998	0.999	0.998
tr	10057	0	0	0	0	10057	1.000	1.000	1.000
true	718	0	0	0	0	718	1.000	1.000	1.000
truncate	801	0	0	0	0	801	1.000	1.000	1.000
tsort	757	0	0	0	0	757	1.000	1.000	1.000
tty	731	0	0	0	0	731	1.000	1.000	1.000
uname	1155	0	0	0	0	1155	1.000	1.000	1.000

Table 34: Decomposed varnode recovery (compilation = debug)

Circui	nd truth varied	ges Jaes matched Var	@level 100	MATCH AMAGE AND CHEST AND	RIAR LEVEL SUR	SET BY ALICATED BY AND	ED Level MAIC	innate scare of the state of th	atially recon
unexpand	769	0	0	0	0	769	1.000	1.000	1.000
uniq	818	0	0	0	0	818	1.000	1.000	1.000
unlink	732	0	0	0	0	732	1.000	1.000	1.000
uptime	10247	0	0	0	0	10247	1.000	1.000	1.000
users	739	0	0	0	0	739	1.000	1.000	1.000
vdir	38591	1255	21	0	0	37315	0.967	0.967	0.967
wc	33696	9	0	0	0	33687	1.000	1.000	1.000
who	1345	0	0	0	0	1345	1.000	1.000	1.000
whoami	734	0	0	0	0	734	1.000	1.000	1.000
yes	742	0	0	0	0	742	1.000	1.000	1.000

Table 35: Decomposed varnode recovery (compilation = debug)

		valides nat		MICH	And the standard of the standa						
			a let	Obra 1610	रिहेट	183r rel A	ildi gama	THED MATCH A @ level MATCH A @ level Matricel A attrodes fraction partially for the level of			
		arnodes	red@lex	reg@Jer	reg@jer	reg@jer	vej@jez	conpair	. Partial		
	Atrith	. Var des Male	ii 3es mai	di destrati	di destrat	des mate	di de average	165 fractic	aes frac		
Cito	June	Valudes mais	Valinou	Varnot	Varnot	Vatnot	Varnou Va	ithou 18	inou		
[2	0	0	0	0	2	1.000	1.000	1.000		
b2sum	0	0	0	0	0	0	-	-	-		
base32	0	0	0	0	0	0	-	-	-		
base64	0	0	0	0	0	0	-	-	-		
basename	0	0	0	0	0	0	-	-	-		
basenc	0	0	0	0	0	0	-	-	-		
cat	0	0	0	0	0	0	-	-	-		
chcon	7	0	0	0	0	7	1.000	1.000	1.000		
chgrp	7	0	0	0	0	7	1.000	1.000	1.000		
chmod	7	0	0	0	0	7	1.000	1.000	1.000		
chown	7	0	0	0	0	7	1.000	1.000	1.000		
chroot	0	0	0	0	0	0	-	-	-		
cksum	3	0	0	0	0	3	1.000	1.000	1.000		
comm	0	0	0	0	0	0	-	-	-		
cp	7	0	0	0	0	7	1.000	1.000	1.000		
csplit	0	0	0	0	0	0	-	-	-		
cut	0	0	0	0	0	0	-	-	-		
date	2	0	0	0	0	2	1.000	1.000	1.000		
dd	7	0	0	0	0	7	1.000	1.000	1.000		

Table 35: Decomposed varnode recovery (compilation = debug)

		atrodes frais	ed@level.H	Ded level of the Astrode's real	Wild AR Street Street Street Street	Jenet @ level MAN	MATCH Tage compare score [0,1] Tage compare score [0,1] Variodes fraction partially for the score score [0,1]		
	Jund truth	Varnode's mai	Varnode's mar	Varnodes mai	Varnode's mai	Vatnodes matel	Vatrode average	inodes fractio	inodes fract
df	17	0	0	0	0	17	1.000	1.000	1.000
dir	10	0	0	0	0	10	1.000	1.000	1.000
dircolors	0	0	0	0	0	0	-	-	-
dirname	0	0	0	0	0	0	-	-	-
du	10	0	0	0	0	10	1.000	1.000	1.000
echo	0	0	0	0	0	0	-	-	-
env	0	0	0	0	0	0	-	-	-
expand	0	0	0	0	0	0	-	-	-
expr	0	0	0	0	0	0	-	-	-
factor	0	0	0	0	0	0	-	-	-
false	0	0	0	0	0	0	-	-	-
fmt	0	0	0	0	0	0	-	-	-
fold	0	0	0	0	0	0	-	-	-
groups	0	0	0	0	0	0	-	-	-
head	0	0	0	0	0	0	-	-	-
hostid	0	0	0	0	0	0	-	-	-
id	0	0	0	0	0	0	-	-	-
join	0	0	0	0	0	0	-	-	-
kill	0	0	0	0	0	0	_	-	-

Table 35: Decomposed varnode recovery (compilation = debug)

			۸(MATCH	JERLAR 1	BSET 1	Jeneth March Jed@level.March Jednode average compares core lo.il			
	- 2	athodesc	ned@level?	hed level o	hed@level5	ited evel A	ited least Mr	compare sco	, Partially re	
Cit	and full v	Vainodes mai	Varnodes mail	O.M. A.T. C. II. C. Matrodes train	Varnodes mail	Jastificade strate	Vathode averos	inodes fract	inodes frac	
link	0	0	0	0	0	0	-	-	-	
ln	7	0	0	0	0	7	1.000	1.000	1.000	
logname	0	0	0	0	0	0	-	-	-	
1s	10	0	0	0	0	10	1.000	1.000	1.000	
md5sum	0	0	0	0	0	0	-	-	-	
mkdir	2	0	0	0	0	2	1.000	1.000	1.000	
mkfifo	0	0	0	0	0	0	-	-	-	
mknod	0	0	0	0	0	0	-	-	-	
mktemp	0	0	0	0	0	0	-	-	-	
mv	7	0	0	0	0	7	1.000	1.000	1.000	
nice	0	0	0	0	0	0	-	-	-	
nl	0	0	0	0	0	0	-	-	-	
nohup	0	0	0	0	0	0	-	-	-	
nproc	0	0	0	0	0	0	-	-	-	
numfmt	7	0	0	0	0	7	1.000	1.000	1.000	
od	11	0	0	0	0	11	1.000	1.000	1.000	
paste	0	0	0	0	0	0	-	-	-	
pathchk	0	0	0	0	0	0	-	-	-	
pinky	0	0	0	0	0	0	-	-	-	

Table 35: Decomposed varnode recovery (compilation = debug)

			ned@level.W	Annodes mate	Æ)	evel MATCH evel MATCH Evel MATCH Evel MATCH Evel MATCH Variodes fraction partially ref			
			, / 2	MATCH Jed@levelor	ERL SI	BSEIL BERGER WALLE	ed © level Mari	Sk, score	'sec
		odes	1@Jever	1@Jever	1@ lever	1@Jener	1@1e4e1	Ompare .	Partially
	THIN VE	inac	net match	net match	net match	net match	er andrage	fraction	Fracis
Cicli	nd truth vo	latnodes .	Varnodes .	lathodes .	Vatnodes .	Varnodes	athode to	nodes Jai	nodes
pr	0	0	0	0	0	0	· · ·		
printenv	0	0	0	0	0	0	-	-	_
printf	7	0	0	0	0	7	1.000	1.000	1.000
ptx	0	0	0	0	0	0	-	-	-
pwd	0	0	0	0	0	0	-	-	-
readlink	7	0	0	0	0	7	1.000	1.000	1.000
realpath	7	0	0	0	0	7	1.000	1.000	1.000
rm	7	0	0	0	0	7	1.000	1.000	1.000
rmdir	2	0	0	0	0	2	1.000	1.000	1.000
runcon	0	0	0	0	0	0	-	-	-
seq	14	0	0	0	0	14	1.000	1.000	1.000
sha1sum	0	0	0	0	0	0	-	-	-
sha224sum	0	0	0	0	0	0	-	-	-
sha256sum	0	0	0	0	0	0	-	-	-
sha384sum	0	0	0	0	0	0	-	-	-
sha512sum	0	0	0	0	0	0	-	-	-
shred	3	0	0	0	0	3	1.000	1.000	1.000
shuf	7	0	0	0	0	7	1.000	1.000	1.000
sleep	7	0	0	0	0	7	1.000	1.000	1.000

Table 35: Decomposed varnode recovery (compilation = debug)

				cCA	Q		Level A. L. C. T. C. L.				
			40	MAIL	ERLA.	SET W	in significant	it rel			
		ے	level the	level 07	level St	level Ar	level Mr	odie scor	rially rec		
	_M W	nodes	zd	isg _@ ,	zd	ed @ ,) [®] ,	ion s	gati		
	druin	desmale	des male	des male	desmale	desmall	de averiae	destract	des fract		
Cic	Jund truth was	atriote 4	ed@levelAO	MATCH andesnath	athor 1	athor 18	athor Astr	ige Astr	ioc		
sort	22	0	0	0	0	22	1.000	1.000	1.000		
split	0	0	0	0	0	0	-	-	-		
stat	2	0	0	0	0	2	1.000	1.000	1.000		
stdbuf	2	0	0	0	0	2	1.000	1.000	1.000		
stty	2	0	0	0	0	2	1.000	1.000	1.000		
sum	3	0	0	0	0	3	1.000	1.000	1.000		
sync	0	0	0	0	0	0	-	-	-		
tac	0	0	0	0	0	0	-	-	-		
tail	15	0	0	0	0	15	1.000	1.000	1.000		
tee	0	0	0	0	0	0	-	-	-		
test	2	0	0	0	0	2	1.000	1.000	1.000		
timeout	8	0	0	0	0	8	1.000	1.000	1.000		
touch	2	0	0	0	0	2	1.000	1.000	1.000		
tr	0	0	0	0	0	0	-	-	-		
true	0	0	0	0	0	0	-	-	-		
truncate	0	0	0	0	0	0	-	-	-		
tsort	0	0	0	0	0	0	-	-	-		
tty	0	0	0	0	0	0	-	-	-		
uname	0	0	0	0	0	0	-	-	-		

Table 35: Decomposed varnode recovery (compilation = debug)

Groi	und truth vist	hodes hatch	ed@level.wo	MAICH ed@levelOvi	ed@levelsUf	strides matche	The Bull Marie	in Antiques fraction for the state of the st	patially res
unexpand	0	0	0	0	0	0	-	-	-
uniq	0	0	0	0	0	0	-	-	-
unlink	0	0	0	0	0	0	-	-	-
uptime	5	0	0	0	0	5	1.000	1.000	1.00
users	0	0	0	0	0	0	-	-	-
vdir	10	0	0	0	0	10	1.000	1.000	1.000
wc	4	0	0	0	0	4	1.000	1.000	1.000
who	2	0	0	0	0	2	1.000	1.000	1.000
whoami	0	0	0	0	0	0	-	-	-
yes	0	0	0	0	0	0	-	-	-

Table 36: Decomposed varnode recovery (compilation = debug)

ر میرند در میرند در میرند از این ا	und truth vo	indes hat	thed@level. Marked Wartholdes trade	O. MATCH Ded@levelO	JERLAR JERGES TRANS	TREET ALL STREET AND THE TRANSPORT OF TH	JAED ANT	CH COMPATE SCORE	10,11 Partially re
[170	0	0	0	0	170	1.000	1.000	1.000
b2sum	140	0	0	0	0	140	1.000	1.000	1.000
base32	107	0	0	0	0	107	1.000	1.000	1.000
base64	107	0	0	0	0	107	1.000	1.000	1.000
basename	104	0	0	0	0	104	1.000	1.000	1.000
basenc	138	0	0	0	0	138	1.000	1.000	1.000
cat	115	0	0	0	0	115	1.000	1.000	1.000
chcon	234	0	0	0	0	234	1.000	1.000	1.000
chgrp	230	0	0	0	0	230	1.000	1.000	1.000
chmod	217	0	0	0	0	217	1.000	1.000	1.000
chown	241	0	0	0	0	241	1.000	1.000	1.000
chroot	133	0	0	0	0	133	1.000	1.000	1.000
cksum	234	0	0	0	0	234	1.000	1.000	1.000
comm	127	0	0	0	0	127	1.000	1.000	1.000
ср	403	0	0	0	0	403	1.000	1.000	1.000
csplit	1416	0	0	0	0	1416	1.000	1.000	1.000
cut	122	0	0	0	0	122	1.000	1.000	1.000
date	426	1	0	0	0	425	0.998	0.998	0.998
dd	216	0	0	0	0	216	1.000	1.000	1.000

Table 36: Decomposed varnode recovery (compilation = debug)

	Jund truth vist	nodes train	ned@level.Th	Ded @ level of	HERLAY Thed@levelst	JBSET JBSET Liked @ level ALI Variodes matche 419	JACO Level MAN	CH Compare score	O.I. Patialy re
df Cgg	419	ativ .	Vatir 0	Qarir 0	Qafir 0	419	1.000	1.000	1.000
dir	642	0	0	0	0	642	1.000	1.000	1.000
dircolors	229	0	0	0	0	229	1.000	1.000	1.000
dirname	94	0	0	0	0	94	1.000	1.000	1.000
du	1650	0	0	0	0	1650	1.000	1.000	1.000
echo	84	0	0	0	0	84	1.000	1.000	1.000
env	138	0	0	0	0	138	1.000	1.000	1.000
expand	101	0	0	0	0	101	1.000	1.000	1.000
expr	1399	0	0	0	0	1399	1.000	1.000	1.000
factor	196	12	1	0	0	183	0.935	0.939	0.934
false	82	0	0	0	0	82	1.000	1.000	1.000
fmt	2126	0	0	0	0	2126	1.000	1.000	1.000
fold	99	0	0	0	0	99	1.000	1.000	1.000
groups	100	0	0	0	0	100	1.000	1.000	1.000
head	125	0	0	0	0	125	1.000	1.000	1.000
hostid	93	0	0	0	0	93	1.000	1.000	1.000
id	134	0	0	0	0	134	1.000	1.000	1.000
join	149	0	0	0	0	149	1.000	1.000	1.000
kill	102	0	0	0	0	102	1.000	1.000	1.000

Table 36: Decomposed varnode recovery (compilation = debug)

	Jund truth was	node ⁵	Elled @ level A	AMATCH Develor	JERLAR Ined Develor	JBSET Jed@level ALI Jed@level ALI Variodes matche	THED AND AND AND AND AND AND AND AND AND AN	compare score	O.11 Datially re
	June V	athou	Varnou	Vatnou	Vatnou	Varnou V	strott 48	ithor 48	
link									1.000
ln	276	0	0	0	0	276	1.000	1.000	1.000
logname	94	0	0	0	0	94	1.000	1.000	1.000
ls	642	0	0	0	0	642	1.000	1.000	1.000
md5sum	132	0	0	0	0	132	1.000	1.000	1.000
mkdir	192	0	0	0	0	192	1.000	1.000	1.000
mkfifo	100	0	0	0	0	100	1.000	1.000	1.000
mknod	105	0	0	0	0	105	1.000	1.000	1.000
mktemp	117	0	0	0	0	117	1.000	1.000	1.000
mv	379	0	0	0	0	379	1.000	1.000	1.000
nice	95	0	0	0	0	95	1.000	1.000	1.000
nl	1404	0	0	0	0	1404	1.000	1.000	1.000
nohup	106	0	0	0	0	106	1.000	1.000	1.000
nproc	96	0	0	0	0	96	1.000	1.000	1.000
numfmt	184	0	0	0	0	184	1.000	1.000	1.000
od	226	0	0	0	0	226	1.000	1.000	1.000
paste	103	0	0	0	0	103	1.000	1.000	1.000
pathchk	95	0	0	0	0	95	1.000	1.000	1.000
pinky	120	0	0	0	0	120	1.000	1.000	1.000

Table 36: Decomposed varnode recovery (compilation = debug)

				- CH	•				
			C	MAIL	ERLAI	BSET C	AEU ST	yt cel	977
			iewel A), Jensila	, १९५६। द्रा), Jenel Wir	Jewel Mr.	atescon	ight rec
	ati	jodes ,	ned ® le	ied@le	red®le	ned ned)	onite on	Qartic
	1 truth Vi	125 Maic	i las maic	i as mate	r 125 maic	1. 125 Match	15 average	105 fraction	125 Fracil
Circui	nd truth vari	thode .	ned@level.W	Varnode	AERLAR Ined @ Level St.	Besteri Red@level Alle Annodes mached	Mid evel Mari	Jil ompare score i ompare score i ompare score i	hode
pr	218	0	0	0	0	218	1.000	1.000	1.000
printenv	93	0	0	0	0	93	1.000	1.000	1.000
printf	178	0	0	0	0	178	1.000	1.000	1.000
ptx	1540	0	1	0	0	1539	1.000	1.000	0.999
pwd	105	0	0	0	0	105	1.000	1.000	1.000
readlink	187	0	0	0	0	187	1.000	1.000	1.000
realpath	196	0	0	0	0	196	1.000	1.000	1.000
rm	236	0	0	0	0	236	1.000	1.000	1.000
rmdir	180	0	0	0	0	180	1.000	1.000	1.000
runcon	106	0	0	0	0	106	1.000	1.000	1.000
seq	193	0	0	0	0	193	1.000	1.000	1.000
sha1sum	131	0	0	0	0	131	1.000	1.000	1.000
sha224sum	132	0	0	0	0	132	1.000	1.000	1.000
sha256sum	132	0	0	0	0	132	1.000	1.000	1.000
sha384sum	132	0	0	0	0	132	1.000	1.000	1.000
sha512sum	132	0	0	0	0	132	1.000	1.000	1.000
shred	174	0	0	0	0	174	1.000	1.000	1.000
shuf	218	0	0	0	0	218	1.000	1.000	1.000
sleep	99	0	0	0	0	99	1.000	1.000	1.000

Table 36: Decomposed varnode recovery (compilation = debug)

				@ level MO MARCH ONERLAR LONG level SUBSET ALLOWED REVEL MARCH. @ level MO Marched Revel ONERLAR REVEL SUBSET. Indes tratched @ level ONERLAR REVEL BURGES tratched @ level Allowed Revel Marched Re						
			nel 70	y selou	eje sejsti	33r Jel Alia	, el Maje	rescore	, 114 tec	
	athi	de ⁵	ed@1ez	ig _{©164}	eg@ _{Jez}	igo lex	@\e^ @\e^	mpai . m	attar	
	3 truth vide	125 Match	125 Match	125 match	125 Match	125 Match) e average	125 fractio	305 Fracti	
Citc	Jund Hullh water	hode 1	athode 4	athode 4	athode 4	athode Vat	yarr	iode 1ati	ode	
sort	492	0	0	0	0	492	1.000	1.000	1.000	
split	162	0	0	0	0	162	1.000	1.000	1.000	
stat	286	0	0	0	0	286	1.000	1.000	1.000	
stdbuf	201	0	0	0	0	201	1.000	1.000	1.000	
stty	331	0	0	0	0	331	1.000	1.000	1.000	
sum	131	0	0	0	0	131	1.000	1.000	1.000	
sync	95	0	0	0	0	95	1.000	1.000	1.000	
tac	1390	0	0	0	0	1390	1.000	1.000	1.000	
tail	225	0	0	0	0	225	1.000	1.000	1.000	
tee	108	0	0	0	0	108	1.000	1.000	1.000	
test	157	0	0	0	0	157	1.000	1.000	1.000	
timeout	113	0	0	0	0	113	1.000	1.000	1.000	
touch	391	1	0	0	0	390	0.997	0.997	0.997	
tr	146	0	0	0	0	146	1.000	1.000	1.000	
true	82	0	0	0	0	82	1.000	1.000	1.000	
truncate	100	0	0	0	0	100	1.000	1.000	1.000	
tsort	118	0	0	0	0	118	1.000	1.000	1.000	
tty	93	0	0	0	0	93	1.000	1.000	1.000	
uname	118	0	0	0	0	118	1.000	1.000	1.000	

Table 36: Decomposed varnode recovery (compilation = debug)

Grot	nd trith var	indes mach	ed@level. 100	MATCH and level Over a strong to the strong	ERLAR SUR	SEIT ALLE	Will waterage con	A Inpare score (Contradiction Contradiction	atially reco
unexpand	104	0	0	0	0	104	1.000	1.000	1.000
uniq	143	0	0	0	0	143	1.000	1.000	1.000
unlink	93	0	0	0	0	93	1.000	1.000	1.000
uptime	126	0	0	0	1	125	0.998	1.000	0.992
users	102	0	0	0	0	102	1.000	1.000	1.000
vdir	642	0	0	0	0	642	1.000	1.000	1.000
wc	176	0	0	0	0	176	1.000	1.000	1.000
who	222	0	0	0	0	222	1.000	1.000	1.000
whoami	94	0	0	0	0	94	1.000	1.000	1.000
yes	98	0	0	0	0	98	1.000	1.000	1.000

Table 37: Data bytes recovery (compilation = stripped)

e	goind truth data's	Nies Byles found	Byles hissed	Byles recovery fraction
[4463	3500	963	0.784
b2sum	4472	3152	1320	0.705
base32	2671	1668	1003	0.624
			Cont	inued on next page

Table 37: Data bytes recovery (compilation = stripped)

	, Pri			
	und truth data by	sound .	niissed	Byles tecover
Cic	June	Bytes found	Bytes filissed	Bylest
base64	2699	1664	1035	0.617
basename	2193	1478	715	0.674
basenc	3793	1919	1874	0.506
cat	2644	1771	873	0.670
chcon	20631	19308	1323	0.936
chgrp	4803	3263	1540	0.679
chmod	4776	3154	1622	0.660
chown	4964	3400	1564	0.685
chroot	2626	1911	715	0.728
cksum	161248	10363	150885	0.064
comm	2785	2002	783	0.719
ср	12062	7133	4929	0.591
csplit	31324	29232	2092	0.933
cut	6800	5916	884	0.870
date	18373	13069	5304	0.711
dd	11354	8493	2861	0.748
df	13944	10093	3851	0.724
dir	52738	37069	15669	0.703
dircolors	8180	1922	6258	0.235
dirname	2101	1449	652	0.690
du	37523	34187	3336	0.911
echo	1915	1392	523	0.727

Table 37: Data bytes recovery (compilation = stripped)

	, 30 N		દ્રસ્ત્ર	
	Ground truth data by the	Bytes found	Bylestitissed	Bytes recovery fra
env	4112	2469	1643	0.600
expand	2319	1593	726	0.687
expr	30656	28585	2071	0.932
factor	23027	9450	13577	0.410
false	1885	1362	523	0.723
fmt	47599	1764	45835	0.037
fold	2276	1525	751	0.670
groups	2165	1525	640	0.704
head	35911	34944	967	0.973
hostid	2057	1430	627	0.695
id	2721	1815	906	0.667
join	3126	2223	903	0.711
kill	2834	1586	1248	0.560
link	2053	1426	627	0.695
ln	9661	5479	4182	0.567
lognam	ne 2061	1434	627	0.696
ls	52738	37069	15669	0.703
md5su	m 3345	2318	1027	0.693
mkdir	6846	5566	1280	0.813
mkfifo	2546	1610	936	0.632
mknod	2655	1719	936	0.647
mktem	p 2681	1823	858	0.680

Table 37: Data bytes recovery (compilation = stripped)

	abytes			દ્રવર્ષ
Ć	ound truth data by	Byles found	Bytes this sed	Bytes recovery fra
mv	12285	7791	4494	0.634
nice	2122	1471	651	0.693
nl	31091	27958	3133	0.899
nohup	2299	1668	631	0.726
nproc	2358	1675	683	0.710
numfmt	4029	2668	1361	0.662
od	16365	14702	1663	0.898
paste	2217	1502	715	0.677
pathchk	2344	1685	659	0.719
pinky	5002	4172	830	0.834
pr	6996	5411	1585	0.773
printenv	2052	1401	651	0.683
printf	6293	5526	767	0.878
ptx	38535	34166	4369	0.887
pwd	3093	1738	1355	0.562
readlink	6662	3695	2967	0.555
realpath	6753	3602	3151	0.533
rm	5075	3610	1465	0.711
rmdir	5987	5080	907	0.849
runcon	2214	1435	779	0.648
seq	4357	3526	831	0.809
sha1sum	3349	2322	1027	0.693

Table 37: Data bytes recovery (compilation = stripped)

	704	(E ^S		
	ruth data	und	.ssed	covery
Grai	nd truth data by	Bytes found	Byles nissed	Bylestecovery
sha224sum	3869	2586	1283	0.668
sha256sum	3877	2594	1283	0.669
sha384sum	6229	4494	1735	0.721
sha512sum	6261	4526	1735	0.723
shred	6721	5128	1593	0.763
shuf	4465	3382	1083	0.757
sleep	2255	1620	635	0.718
sort	20811	16580	4231	0.797
split	4729	2821	1908	0.597
stat	9167	7372	1795	0.804
stdbuf	5343	4516	827	0.845
stty	8535	3418	5117	0.400
sum	4413	3681	732	0.834
sync	2146	1459	687	0.680
tac	38578	28162	10416	0.730
tail	38862	36536	2326	0.940
tee	10555	9788	767	0.927
test	4288	3376	912	0.787
timeout	3663	2456	1207	0.670
touch	15837	10984	4853	0.694
tr	12260	2461	9799	0.201
true	1885	1362	523	0.723

Table 37: Data bytes recovery (compilation = stripped)

	134203	e ^c			
ÇK	hind huth data by	Byles found	Bytes filissed	Byles recovery from	
truncate	2585	1654	931	0.640	
tsort	2391	1756	635	0.734	
tty	2062	1379	683	0.669	
uname	2860	1793	1067	0.627	
unexpand	2344	1621	723	0.692	
uniq	2943	1912	1031	0.650	
unlink	2053	1426	627	0.695	
uptime	13110	12351	759	0.942	
users	2167	1540	627	0.711	
vdir	52738	37069	15669	0.703	
wc	36613	2619	33994	0.072	
who	5007	3714	1293	0.742	
whoami	2069	1442	627	0.697	
yes	2166	1539	627	0.711	

Table 38: Data bytes recovery (compilation = standard)

	kata bu	e ^s		۵
Ckc	jund truth data by	Bytes found	Bytes this sed	Bylestecovery
[4463	4320	143	0.968
b2sum	4472	4304	168	0.962
base32	2671	2548	123	0.954
base64	2699	2608	91	0.966
basename	2193	2102	91	0.959
basenc	3793	3423	370	0.902
cat	2644	2553	91	0.966
chcon	20631	20496	135	0.993
chgrp	4803	4651	152	0.968
chmod	4776	4602	174	0.964
chown	4964	4820	144	0.971
chroot	2626	2535	91	0.965
cksum	161248	29876	131372	0.185
comm	2785	2690	95	0.966
cp	12062	11214	848	0.930
csplit	31324	30228	1096	0.965
cut	6800	6709	91	0.987
date	18373	17641	732	0.960
dd	11354	10131	1223	0.892
df	13944	11740	2204	0.842
dir	52738	44599	8139	0.846

Table 38: Data bytes recovery (compilation = standard)

	791 ^{kes}				
cst	and truth data bi	Bytes found	Bylesthissed	Bylestecover	
dircolors	8180		4899	0.401	
dirname		3281 2010	4899 91	0.401	
	2101				
du	37523	36212	1311 91	0.965	
echo	1915	1824		0.952	
env	4112	3590	522	0.873	
expand	2319	2227	92	0.960	
expr	30656	29313	1343	0.956	
factor	23027	22319	708	0.969	
false	1885	1794	91	0.952	
fmt	47599	47508	91	0.998	
fold	2276	2184	92	0.960	
groups	2165	2074	91	0.958	
head	35911	35820	91	0.997	
hostid	2057	1958	99	0.952	
id	2721	2630	91	0.967	
join	3126	3023	103	0.967	
kill	2834	2210	624	0.780	
link	2053	1954	99	0.952	
ln	9661	7423	2238	0.768	
logname	2061	1962	99	0.952	
1s	52738	44599	8139	0.846	
md5sum	3345	3230	115	0.966	

Table 38: Data bytes recovery (compilation = standard)

	900	_		
. *	ound truth data by	Byles found	Bytes filissed	Bytestecovery
	•		\$2	\$2
mkdir	6846	6714	132	0.981
mkfifo	2546	2438	108	0.958
mknod	2655	2547	108	0.959
mktemp	2681	2527	154	0.943
mv	12285	11168	1117	0.909
nice	2122	2031	91	0.957
nl	31091	29976	1115	0.964
nohup	2299	2196	103	0.955
nproc	2358	2267	91	0.961
numfmt	4029	3924	105	0.974
od	16365	16171	194	0.988
paste	2217	2126	91	0.959
pathchk	2344	2253	91	0.961
pinky	5002	4911	91	0.982
pr	6996	6799	197	0.972
printenv	2052	1961	91	0.956
printf	6293	5994	299	0.952
ptx	38535	37006	1529	0.960
pwd	3093	3002	91	0.971
readlink	6662	4499	2163	0.675
realpath	6753	4590	2163	0.680
rm	5075	4806	269	0.947

Table 38: Data bytes recovery (compilation = standard)

	200	Ke ⁵				
	\ Ituth data	and	is sed	acovery h		
Croi	ind truth data by	Bytes found	Byle ^s His ^s ed	Byles tecovery fr		
rmdir	5987	5884	103	0.983		
runcon	2214	2123	91	0.959		
seq	4357	4208	149	0.966		
sha1sum	3349	3234	115	0.966		
sha224sum	3869	3754	115	0.970		
sha256sum	3877	3762	115	0.970		
sha384sum	6229	5470	759	0.878		
sha512sum	6261	5502	759	0.879		
shred	6721	6533	188	0.972		
shuf	4465	4362	103	0.977		
sleep	2255	2148	107	0.953		
sort	20811	19990	821	0.961		
split	4729	4074	655	0.861		
stat	9167	8617	550	0.940		
stdbuf	5343	5240	103	0.981		
stty	8535	8403	132	0.985		
sum	4413	4290	123	0.972		
sync	2146	2051	95	0.956		
tac	38578	37482	1096	0.972		
tail	38862	38568	294	0.992		
tee	10555	10460	95	0.991		
test	4288	4196	92	0.979		

Table 38: Data bytes recovery (compilation = standard)

	rabi	ye ⁵			
Ctc	jud full data bi	Bytes found	Byles hissed	Bytes tecovery from	
timeout	3663	3144	519	0.858	
touch	15837	15142	695	0.956	
tr	12260	12165	95	0.992	
true	1885	1794	91	0.952	
truncate	2585	2494	91	0.965	
tsort	2391	2284	107	0.955	
tty	2062	1971	91	0.956	
uname	2860	2761	99	0.965	
unexpand	2344	2253	91	0.961	
uniq	2943	2844	99	0.966	
unlink	2053	1954	99	0.952	
uptime	13110	12971	139	0.989	
users	2167	2068	99	0.954	
vdir	52738	44599	8139	0.846	
wc	36613	3528	33085	0.096	
who	5007	4904	103	0.979	
whoami	2069	1970	99	0.952	
yes	2166	2067	99	0.954	

Table 39: Data bytes recovery (compilation = debug)

	at a ba	Rep.				
Ċ	round truth data be	Bytes found	Bytes tilssed	Bylestecover		
[4463	4463	0	1.000		
b2sum	4472	4472	0	1.000		
base32	2671	2671	0	1.000		
base64	2699	2699	0	1.000		
basename	2193	2193	0	1.000		
basenc	3793	3793	0	1.000		
cat	2644	2644	0	1.000		
chcon	20631	20631	0	1.000		
chgrp	4803	4803	0	1.000		
chmod	4776	4776	0	1.000		
chown	4964	4964	0	1.000		
chroot	2626	2626	0	1.000		
cksum	161248	161248	0	1.000		
comm	2785	2785	0	1.000		
cp	12062	12062	0	1.000		
csplit	31324	31084	240	0.992		
cut	6800	6800	0	1.000		
date	18373	18321	52	0.997		
dd	11354	11354	0	1.000		
df	13944	13944	0	1.000		
dir	52738	51468	1270	0.976		

Table 39: Data bytes recovery (compilation = debug)

				દ્રવ
Cic	jud full data b	Bytes found	Byte ^s nis ^{sed}	Bytes recovery fro
dircolors	8180	8180	0	1.000
dirname	2101	2101	0	1.000
du	37523	37283	240	0.994
echo	1915	1915	0	1.000
env	4112	4112	0	1.000
expand	2319	2319	0	1.000
expr	30656	30416	240	0.992
factor	23027	22782	245	0.989
false	1885	1885	0	1.000
fmt	47599	47599	0	1.000
fold	2276	2276	0	1.000
groups	2165	2165	0	1.000
head	35911	35911	0	1.000
hostid	2057	2057	0	1.000
id	2721	2721	0	1.000
join	3126	3126	0	1.000
kill	2834	2834	0	1.000
link	2053	2053	0	1.000
ln	9661	9661	0	1.000
logname	2061	2061	0	1.000
1s	52738	51468	1270	0.976
md5sum	3345	3345	0	1.000

Table 39: Data bytes recovery (compilation = debug)

	ي الم	(E.)		
Ć	ound truth data by	Bytes found	Bytes tilssed	Bytestecovery
mkdir	6846	6846	0	1.000
mkfifo	2546	2546	0	1.000
mknod	2655	2655	0	1.000
mktemp	2681	2681	0	1.000
mv	12285	12285	0	1.000
nice	2122	2122	0	1.000
nl	31091	30851	240	0.992
nohup	2299	2299	0	1.000
nproc	2358	2358	0	1.000
numfmt	4029	4029	0	1.000
od	16365	16365	0	1.000
paste	2217	2217	0	1.000
pathchk	2344	2344	0	1.000
pinky	5002	4778	224	0.955
pr	6996	6996	0	1.000
printenv	2052	2052	0	1.000
printf	6293	6293	0	1.000
ptx	38535	38279	256	0.993
pwd	3093	3093	0	1.000
readlink	6662	6662	0	1.000
realpath	6753	6753	0	1.000
rm	5075	5075	0	1.000

Table 39: Data bytes recovery (compilation = debug)

	20%	్మార్		م ،
	A truth data	cound	તાંકુહો	ECOVERY
Cicoi	nd truth data by	Bytes found	Bytes filissed	Bytes recovery fr
rmdir	5987	5987	0	1.000
runcon	2214	2214	0	1.000
seq	4357	4357	0	1.000
sha1sum	3349	3349	0	1.000
sha224sum	3869	3869	0	1.000
sha256sum	3877	3877	0	1.000
sha384sum	6229	6229	0	1.000
sha512sum	6261	6261	0	1.000
shred	6721	6090	631	0.906
shuf	4465	4465	0	1.000
sleep	2255	2255	0	1.000
sort	20811	20811	0	1.000
split	4729	4729	0	1.000
stat	9167	9167	0	1.000
stdbuf	5343	5343	0	1.000
stty	8535	8535	0	1.000
sum	4413	4413	0	1.000
sync	2146	2146	0	1.000
tac	38578	38338	240	0.994
tail	38862	38862	0	1.000
tee	10555	10555	0	1.000
test	4288	4288	0	1.000

Table 39: Data bytes recovery (compilation = debug)

	xabi	ye ⁵		- cxac ^x		
Ctic	jud full data bi	Bytes found	Bytes filissed	Bytes recovery fra		
timeout	3663	3663	0	1.000		
touch	15837	15785	52	0.997		
tr	12260	12260	0	1.000		
true	1885	1885	0	1.000		
truncate	2585	2585	0	1.000		
tsort	2391	2391	0	1.000		
tty	2062	2062	0	1.000		
uname	2860	2860	0	1.000		
unexpand	2344	2344	0	1.000		
uniq	2943	2943	0	1.000		
unlink	2053	2053	0	1.000		
uptime	13110	13110	0	1.000		
users	2167	2167	0	1.000		
vdir	52738	51468	1270	0.976		
wc	36613	36613	0	1.000		
who	5007	5007	0	1.000		
whoami	2069	2069	0	1.000		
yes	2166	2166	0	1.000		

Table 40: Array recovery (compilation = stripped)

Crown	d truth atray	athodes compaisons Array	vatrodes infer	red as array	red as alray fr	action Aray Aray	ior instancing et instancing instancing	rotratio Etale estor	erage endra	ido generale element
[15	6	6	0.400	3.667	0.132	4.833	0.132	1.000	0.833
b2sum	24	23	13	0.542	30.522	26.451	37.348	0.522	1.000	0.319
base32	12	3	3	0.250	2.667	0.042	5.000	0.042	1.000	0.889
base64	12	3	3	0.250	2.667	0.042	5.000	0.042	1.000	0.889
basename	10	3	3	0.300	2.667	0.042	5.000	0.042	1.000	0.889
basenc	20	4	4	0.200	2.000	0.032	3.750	0.032	1.000	0.917
cat	11	3	3	0.273	2.667	0.042	5.000	0.042	1.000	0.889
chcon	18	8	8	0.444	6.000	0.048	6.875	0.048	1.000	0.792
chgrp	15	5	5	0.333	2.800	0.083	4.200	0.083	1.000	0.800
chmod	19	6	6	0.316	4.667	0.194	5.833	0.194	1.000	0.833
chown	16	6	6	0.375	2.833	0.093	4.000	0.093	1.000	0.778
chroot	11	4	4	0.364	2.750	0.068	4.500	0.068	1.000	0.833
cksum	66	39	27	0.409	755.590	16.511	6749.25	6 0.501	1.000	0.444
comm	22	12	12	0.545	18.250	2.054	4.000	0.138	0.750	0.750
cp	40	10	9	0.225	8.200	1.485	9.300	0.185	1.000	0.767
csplit	35	23	21	0.600	123.261	0.537	359.087	0.150	0.957	0.754
cut	12	4	4	0.333	4.000	0.032	5.750	0.032	1.000	0.833

Table 40: Array recovery (compilation = stripped)

		rnole ⁵		ad as atray	ed as atray fro	action	ot Saverage eri	ortatio	rage effor rai	o mscore [0,1]
Grand	Array C	ongaisons Aray	atrodes interf	ed as atray	ength elemen	action as a verage est ength element	or Array	or raido or	Array a	o historie (0.1) herage elemen
date	63	28	26	0.413	85.071	0.571	81.036	0.357	1.000	0.845
dd	34	11	9	0.265	360.455	0.230	361.091	0.230	0.727	0.788
df	25	8	8	0.320	86.125	3.893	87.000	3.893	1.000	0.792
dir	71	32	31	0.437	156.688	5.807	156.906	5.807	0.969	0.781
dircolors	13	3	3	0.231	2.667	0.042	5.000	0.042	1.000	0.889
dirname	10	3	3	0.300	2.667	0.042	5.000	0.042	1.000	0.889
du	51	26	23	0.451	148.962	0.536	357.577	0.194	0.962	0.795
echo	9	3	3	0.333	2.667	0.042	5.000	0.042	1.000	0.889
env	18	8	8	0.444	4.125	0.180	5.000	0.180	1.000	0.750
expand	13	3	3	0.231	2.667	0.042	5.000	0.042	1.000	0.889
expr	33	20	18	0.545	141.550	0.590	412.750	0.145	0.950	0.767
factor	37	18	18	0.486	15.667	13.571	3.667	0.168	1.000	0.222
false	9	3	3	0.333	2.667	0.042	5.000	0.042	1.000	0.889
fmt	12	3	3	0.250	2.667	0.042	5.000	0.042	1.000	0.889
fold	12	3	3	0.250	2.667	0.042	5.000	0.042	1.000	0.889
groups	11	3	3	0.273	2.667	0.042	5.000	0.042	1.000	0.889
head	18	10	10	0.556	4.900	0.192	7.700	0.192	1.000	0.767
hostid	12	3	3	0.250	2.667	0.042	5.000	0.042	1.000	0.889

Table 40: Array recovery (compilation = stripped)

				Refered as a tray length elements a verage error average error ratio Array length elements a verage error by the average error ratio Array length elements a verage error ratio error ra						
				Pa.	and the	مي مي	itigi geet	ું ડુંગ	ot to	jio (
		nodes		das after	A as affice	averate	averate	age etio	age estiv	nscore,
	For	vati.	15 .10°	jetiec infer	jee Jenen	iz, Jelli	ents, es an	યુષ કુર્ો	avell andis	jicir Ne
	. Kuthati	MPailse	amodes	athodes	ngh er	ngh ei	.18 OHE	re Costie	inensior	Tetage of
Citalia	d truth atray	vair. Compatisor	,23 ¹ 70 D21 ²	deredas arad	ic. Ariay	e, Attal	grid anglage er Street anglas ang Street Arrest	ar Atia	average error re	8
id	14	4	4	0.286	2.750	0.068	4.500	0.068	1.000	0.833
join	18	5	5	0.278	2.800	0.625	3.000	0.025	1.000	0.867
kill	14	5	5	0.357	3.600	0.131	5.000	0.131	1.000	0.867
link	12	3	3	0.250	2.667	0.042	5.000	0.042	1.000	0.889
ln	22	5	5	0.227	4.800	0.038	6.200	0.038	1.000	0.933
logname	12	3	3	0.250	2.667	0.042	5.000	0.042	1.000	0.889
ls	71	32	31	0.437	156.688	5.807	156.906	5.807	0.969	0.781
md5sum	16	5	5	0.312	3.200	0.105	4.600	0.105	1.000	0.800
mkdir	19	7	7	0.368	4.857	0.381	7.571	0.381	1.000	0.857
mkfifo	12	4	4	0.333	5.500	0.166	7.250	0.166	1.000	0.917
mknod	12	4	4	0.333	5.500	0.166	7.250	0.166	1.000	0.917
mktemp	12	3	3	0.250	2.667	0.042	5.000	0.042	1.000	0.889
mv	34	10	9	0.265	8.200	1.485	9.300	0.185	1.000	0.767
nice	10	3	3	0.300	2.667	0.042	5.000	0.042	1.000	0.889
nl	36	19	17	0.472	148.579	0.620	434.053	0.151	0.947	0.772
nohup	13	3	3	0.231	2.667	0.042	5.000	0.042	1.000	0.889
-	10	3	3	0.300	2.667	0.042	5.000	0.042	1.000	0.889
nproc										
numfmt	20	5	5	0.250	12.600	0.185	5.400	0.050	1.000	0.867

Table 40: Array recovery (compilation = stripped)

						ion		ratio		
				te.	.N. (Y.	acir need	ioi geeti	or or	3 ⁷⁸	io 10.j
		nodes		a as affect	A as attice	averate	averate	age errici	age estiv	n score l
	જ	A varir	.45°	jeriet juler	iec Jennen	is,	ग्रं ^{द्र} ।	ુકો જે જ	etter mind	icir Aemi
	truth air	MilPatis	arnodes	amodes	ngh er	ngth (er	:18 03/10 :-	16 CONTE	inensio,	Netage C
Cround	S. S	A variode's	All ATT	jeredasaray Aray	ed as atray fr	Ariay	not greenge est international distribution of the control of the c	ATT ATT AN	dinension na	ich score i
od	40	12	12	0.300	3.917	0.146	5.667	0.146	1.000	0.778
paste	10	3	3	0.300	2.667	0.042	5.000	0.042	1.000	0.889
pathchk	10	3	3	0.300	2.667	0.042	5.000	0.042	1.000	0.889
pinky	17	8	8	0.471	33.500	0.916	34.375	0.916	1.000	0.833
pr	20	10	9	0.450	103.500	0.192	104.200	0.192	1.000	0.933
printenv	10	3	3	0.300	2.667	0.042	5.000	0.042	1.000	0.889
printf	17	8	8	0.471	27.750	0.185	28.625	0.185	1.000	0.917
ptx	39	20	18	0.462	141.30	0.596	412.500	0.151	0.950	0.783
pwd	10	3	3	0.300	2.667	0.042	5.000	0.042	1.000	0.889
readlink	12	4	4	0.333	4.000	0.047	5.750	0.047	1.000	0.917
realpath	11	3	3	0.273	2.667	0.042	5.000	0.042	1.000	0.889
rm	15	3	3	0.200	2.667	0.042	5.000	0.042	1.000	0.889
rmdir	14	5	5	0.357	3.200	0.026	4.600	0.026	1.000	0.867
runcon	10	3	3	0.300	2.667	0.042	5.000	0.042	1.000	0.889
seq	15	4	4	0.267	2.000	0.032	3.750	0.032	1.000	0.917
sha1sum	16	6	6	0.375	3.333	0.146	10.500	0.146	1.000	0.833
sha224sum	17	6	6	0.353	6.000	0.230	13.167	0.230	1.000	0.833
sha256sum	17	6	6	0.353	4.667	0.183	11.833	0.183	1.000	0.833

Table 40: Array recovery (compilation = stripped)

					į	ion		Tailo		
				ta.	tay frac	o se estroi	, as stroi	, S	or ratio	10,1
	, c	odes	ء - 2	1 de dite	Jasaire 2	average	average	rie etic	respective to	score
	त्रवी ^{प्रवी}	, cons	inferte	inferre	dements	dement	, ^{१६} ८) श्राहर,	्र _ट ड़ी खाटा	an match	alemen
X	ruin ai	inparis ia	inodes	nodes , en	gin (e)	gin (e)	503/10 11:	s Carles	nensity	Jiage C
Ground	Array co	npaisons	nodes intered	Jasaray nodesintered	las atray fracti	ArraySi	average error	Array	age error ratio	
										0.833
sha384sum	17	6	6	0.353	3.333	0.146	18.500	0.146	1.000	
sha512sum	17	6	6	0.353	3.333	0.146	18.500	0.146	1.000	0.833
shred	27	10	10	0.370	68.600	3.114	69.300	3.114	1.000	0.800
shuf	12	4	4	0.333	2.000	0.032	3.750	0.032	1.000	0.917
sleep	12	3	3	0.250	2.667	0.042	5.000	0.042	1.000	0.889
sort	46	12	11	0.239	5.917	0.299	7.833	0.216	0.833	0.778
split	18	6	6	0.333	3.167	0.113	4.333	0.113	1.000	0.833
stat	32	10	9	0.281	103.900	0.197	104.600	0.197	1.000	0.933
stdbuf	16	5	5	0.312	3.200	0.027	4.600	0.027	1.000	0.867
stty	19	5	5	0.263	2.000	0.125	4.600	0.125	1.000	0.867
sum	22	8	8	0.364	5.875	0.066	6.750	0.066	1.000	0.750
sync	11	3	3	0.273	2.667	0.042	5.000	0.042	1.000	0.889
tac	33	19	17	0.515	148.579	0.620	434.053	0.151	0.947	0.772
tail	20	8	8	0.400	5.500	0.034	6.375	0.034	1.000	0.750
tee	14	4	4	0.286	4.000	0.032	5.750	0.032	1.000	0.833
test	12	5	5	0.417	4.200	0.139	4.200	0.139	1.000	0.867
timeout	13	5	5	0.385	3.600	0.131	5.000	0.131	1.000	0.867
touch	56	23	22	0.393	59.087	0.618	54.174	0.357	1.000	0.826

Table 40: Array recovery (compilation = stripped)

۵.	ruth array var	nodes	indes inferie	dasatay nodesintened	Jas atray fraci	non Daverage enfor	Artial sid	TailO Lige effor Seloyles) aner	age enfort ratio	score 10.11
Chang	Array	Array	Array	Attay	Array	Array	Atray	Array	Array	_
tr	17	4	4	0.235	57.750	0.250	5.750	0.040	1.000	0.833
true	9	3	3	0.333	2.667	0.042	5.000	0.042	1.000	0.889
truncate	10	3	3	0.300	2.667	0.042	5.000	0.042	1.000	0.889
tsort	13	4	4	0.308	11.000	2.282	5.750	0.094	1.000	0.833
tty	10	3	3	0.300	2.667	0.042	5.000	0.042	1.000	0.889
uname	12	3	3	0.250	2.667	0.042	5.000	0.042	1.000	0.889
unexpand	11	3	3	0.273	2.667	0.042	5.000	0.042	1.000	0.889
uniq	15	4	4	0.267	2.250	0.157	5.750	0.157	1.000	0.917
unlink	12	3	3	0.250	2.667	0.042	5.000	0.042	1.000	0.889
uptime	18	8	7	0.389	129.500	0.220	130.375	0.220	1.000	0.958
users	12	3	3	0.250	2.667	0.042	5.000	0.042	1.000	0.889
vdir	71	32	31	0.437	156.688	5.807	156.906	5.807	0.969	0.781
wc	16	6	6	0.375	5455.500	0.378	5456.667	7 0.378	1.000	0.889
who	25	13	13	0.520	1.615	0.024	2.154	0.024	1.000	0.949
whoami	12	3	3	0.250	2.667	0.042	5.000	0.042	1.000	0.889
yes	12	3	3	0.250	2.667	0.042	5.000	0.042	1.000	0.889

Table 41: Array recovery (compilation = standard)

	druttaray d	arrodes	Agray Array	red as array	redas atray fr	action average ef	got got average er gyes) average size (bytes) average	ortailo Stage estor	erage error ra	gio generale element
<u> </u>	Atray	Attal	Array	Array	Array	Array	Array	Attay	Atray	
[15	10	10	0.667	15.000	1.379	2.900	0.079	1.000	0.767
b2sum	24	30	20	0.833	43.300	21.879	28.633	0.400	0.967	0.378
base32	12	8	8	0.667	37.625	5.141	1.875	0.016	1.000	0.667
base64	12	9	9	0.750	33.444	4.570	1.667	0.014	1.000	0.667
basename	10	7	7	0.700	43.000	5.875	2.143	0.018	1.000	0.667
basenc	20	13	13	0.650	42.231	3.164	1.154	0.010	1.000	0.692
cat	11	8	8	0.727	53.125	5.141	1.875	0.016	1.000	0.667
chcon	18	12	12	0.667	49.083	3.449	4.583	0.032	1.000	0.694
chgrp	15	9	9	0.600	58.222	4.601	2.333	0.046	1.000	0.667
chmod	19	10	10	0.526	47.600	4.217	3.500	0.117	1.000	0.700
chown	16	10	10	0.625	55.800	4.156	2.400	0.056	1.000	0.667
chroot	11	8	8	0.727	38.000	5.159	2.250	0.034	1.000	0.667
cksum	66	62	50	0.758	738.516	12.144	4245.500	0.315	0.968	0.516
comm	22	16	16	0.727	35.875	4.103	3.000	0.103	0.812	0.688
cp	40	27	26	0.650	52.630	4.476	3.741	0.078	1.000	0.654
csplit	35	30	28	0.800	115.433	2.345	275.300	0.115	0.967	0.711
cut	12	8	8	0.667	58.000	5.141	2.875	0.016	1.000	0.667

Table 41: Array recovery (compilation = standard)

					red as atray fro	rion	got Jishaverage eri Side Onteshavi	ratio .		
				Ros	call from	مورد مورون	ion age est	ior ior	orrai	ò S
		modes		.dasati	ad as att	. को अपटा ^{रता}	. डो अपटा ^{रवर}	rageerite	rage ente	n score
	7734	air .sons	Sinfer	ric sinfer	ie alemen	il. Aeiner	ili. Kes) avi	. હકો જા ^પ	on mai). }}
,	Tuth at	OHIPATI	arnodes	atnodes	engin (e	engin (e	ide Gift	ve byl	imensie	verage .
Cicolin	d truth atray	edir Compaisons	Array	redas aray	red as atray fro	Atray	its average en	Array (erage error rati	Actuals als
date	63	57	55	0.873	91.842	3.351	39.807	0.175	0.930	— 0.649
dd	34	23	21	0.618	182.913		172.696		0.870	0.696
df	25	16	16	0.640	120.562		43.500	1.947	1.000	0.646
dir	71	61	60	0.845	135.951		82.311	3.046	0.934	0.694
dircolors	13	9	9	0.692	102.889	6.125	1.667	0.014	1.000	0.667
dirname	10	7	7	0.700	34.143	5.875	2.143	0.018	1.000	0.667
du	51	41	38	0.745	124.683	2.608	226.756	0.123	0.951	0.732
echo	9	6	6	0.667	19.167	1.688	2.500	0.021	1.000	0.778
env	18	13	13	0.722	41.769	3.265	3.077	0.111	1.000	0.667
expand	13	9	9	0.692	31.556	5.347	1.667	0.014	1.000	0.667
expr	33	27	25	0.758	118.593	2.585	305.741	0.108	0.963	0.716
factor	37	27	27	0.730	394.889	11.232	2.444	0.112	1.000	0.321
false	9	6	6	0.667	19.167	1.688	2.500	0.021	1.000	0.778
fmt	12	9	9	0.750	4380.556	6 8.903	1.667	0.014	1.000	0.593
fold	12	8	8	0.667	37.625	5.141	1.875	0.016	1.000	0.667
groups	11	8	8	0.727	26.000	5.141	1.875	0.016	1.000	0.667
head	18	15	15	0.833	32.000	3.328	5.133	0.128	1.000	0.689
hostid	12	7	7	0.583	29.714	5.875	2.143	0.018	1.000	0.667

Table 41: Array recovery (compilation = standard)

				red as atray		ation	id is a verage er is a verage er is a verage	or ratio		2
			athodes infer	172 ³	ength elemen	ridge est	Array	igos igos	trage effortul	do score lo.11
	Array C	amodes	, c	isg az ar	isy as ar	is again	te) gran	Figs of	tiage er	ith score the second of the se
	natray 1	onpaisons Aray	des infer	desinfer	h elemer	h elemes	, wheel an	nyles) an	asion ma	ge eleme
ni	A Truth	OMPL	vatnoe 34	Varinou 34 V	englir	englir .v.	Me Oi	ile O'i	Minelly 34 8	Netab
Groti	ATria.	Atria,	ATria.	Afria,	Afria,	Atria,	Afria,	Atria,	Atria,	
id	14	11	11	0.786	38.909	3.752	1.636	0.025	1.000	0.667
join	18	13	13	0.722	32.692	5.548	1.154	0.010	1.000	0.692
kill	14	9	9	0.643	34.556	4.628	2.778	0.073	1.000	0.704
link	12	7	7	0.583	29.714	5.875	2.143	0.018	1.000	0.667
ln	22	13	13	0.591	56.538	4.476	2.385	0.015	1.000	0.718
logname	12	7	7	0.583	29.714	5.875	2.143	0.018	1.000	0.667
ls	71	61	60	0.845	135.951	8.784	82.311	3.046	0.934	0.694
md5sum	16	10	10	0.625	52.600	4.153	2.300	0.053	1.000	0.667
mkdir	19	11	11	0.579	34.091	4.061	3.364	0.061	1.000	0.727
mkfifo	12	8	8	0.667	35.500	5.208	3.625	0.083	1.000	0.708
mknod	12	8	8	0.667	35.500	5.208	3.625	0.083	1.000	0.708
mktemp	12	8	8	0.667	48.000	6.016	1.875	0.016	1.000	0.667
mv	34	21	20	0.588	36.857	4.326	4.810	0.100	1.000	0.651
nice	10	7	7	0.700	34.143	5.875	2.143	0.018	1.000	0.667
nl	36	28	26	0.722	125.393	2.385	294.536	0.103	0.964	0.714
nohup	13	7	7	0.538	29.714	5.875	2.143	0.018	1.000	0.667
nproc	10	7	7	0.700	38.571	5.875	2.143	0.018	1.000	0.667
numfmt	20	17	17	0.850	56.882	4.819	1.588	0.015	1.000	0.686

Table 41: Array recovery (compilation = standard)

						ion	,	ratio		
				to.	: 87 Ft?		रंग	ia	A 13	do (0)
		modes		ad as aint	ad as arri	a) average	a average	t 3ge office	r 20°E Stree	w score r
	, (8	y vair		jerio cinfer	ie	alene	प्रदेश हुड़ी वर्ष	હા	er an ma	ici glein
3	truth at	Onparis	athodes	iatnodes	engin (e	ngine	iste 19th	is le layer	inensit	werage .
Choling) Vi	A variodes	Art	jeredas array	red as atray fro	Array	not average of his average of size to pleas average of the size of	Array	eride enotra	idiscore t
od	40	28	28	0.700	31.821	2.884	2.429	0.063	0.964	0.690
paste	10	7	7	0.700	43.000	5.875	2.143	0.018	1.000	0.667
pathchk	10	7	7	0.700	34.143	5.875	2.143	0.018	1.000	0.667
pinky	17	14	14	0.824	33.429	3.452	19.643	0.523	1.000	0.714
pr	20	15	14	0.700	133.667	2.928	69.467	0.128	0.933	0.800
printenv	10	7	7	0.700	34.143	5.875	2.143	0.018	1.000	0.667
printf	17	12	12	0.706	29.167	1.206	19.083	0.123	1.000	0.833
ptx	39	31	29	0.744	119.806	5 2.481	266.12	9 0.097	0.968	0.720
pwd	10	7	7	0.700	38.571	5.875	2.143	0.018	1.000	0.667
readlink	12	8	8	0.667	58.000	5.149	2.875	0.024	1.000	0.708
realpath	11	7	7	0.636	74.000	5.875	2.143	0.018	1.000	0.667
rm	15	9	9	0.600	61.556	5.681	1.667	0.014	1.000	0.667
rmdir	14	10	10	0.714	36.100	4.413	2.300	0.013	1.000	0.700
runcon	10	7	7	0.700	51.857	5.875	2.143	0.018	1.000	0.667
seq	15	10	10	0.667	32.200	4.413	1.500	0.013	1.000	0.700
sha1sum	16	11	11	0.688	48.182	3.807	5.727	0.080	1.000	0.697
sha224sum	17	12	12	0.706	61.500	3.781	6.583	0.115	1.000	0.694
sha256sum	17	12	12	0.706	60.833	3.758	5.917	0.092	1.000	0.694

Table 41: Array recovery (compilation = standard)

				Jasatiay nodesintened Arraylen	ن در مون	gon syd	Daverage error	ratio	di [©]	
		des	nodes intered	Jasaray Indesinfered Arrayler	as atray li	average er	Daverage error	ge etior	ge ettor ran	score lo.11
	Artay cor	ie ;sons	Sinferres	3 Sinferies	a lements	alements.	ते. १८८२ व्यवस्थ	res aver	de on match	i score i si s
ndr	juth io	npatisons	node	inode	gine	gin C sil	e logic	s logic	heliste 1 av	yid [©]
Croun	Array	Array	Arran	Arran	Array	Arran	Arran	Arran	Attan	
sha384sum	17	11	11	0.647	48.182	3.807	10.091	0.080	1.000	0.697
sha512sum	17	11	11	0.647	48.182	3.807	10.091	0.080	1.000	0.697
shred	27	19	19	0.704	71.421	4.850	36.474	1.639	1.000	0.702
shuf	12	8	8	0.667	53.125	5.141	1.875	0.016	1.000	0.708
sleep	12	7	7	0.583	29.714	5.875	2.143	0.018	1.000	0.667
sort	46	27	26	0.565	52.926	2.837	3.481	0.096	0.926	0.667
split	18	12	12	0.667	54.917	3.723	2.167	0.056	1.000	0.694
stat	32	22	21	0.656	68.591	2.589	47.545	0.089	0.955	0.758
stdbuf	16	11	11	0.688	36.273	6.103	2.091	0.012	1.000	0.636
stty	19	14	14	0.737	311.143	8.688	1.643	0.045	1.000	0.548
sum	22	16	16	0.727	20.438	3.908	3.375	0.033	1.000	0.667
sync	11	7	7	0.636	38.571	5.875	2.143	0.018	1.000	0.667
tac	33	28	26	0.788	117.036	2.635	294.536	0.103	0.964	0.714
tail	20	14	14	0.700	48.000	3.591	4.357	0.064	1.000	0.619
tee	14	10	10	0.714	35.600	5.113	2.300	0.013	1.000	0.667
test	12	9	9	0.750	16.556	1.522	2.333	0.077	1.000	0.778
timeout	13	9	9	0.692	41.444	4.628	2.778	0.073	1.000	0.704
touch	56	50	49	0.875	79.260	4.084	24.920	0.164	0.960	0.607

Table 41: Array recovery (compilation = standard)

Grand	Julh atray vari	Rodes Regatisons	nodes inferred	Jas atiak Inodes intered	Jas atray fracti	non Daverage error Rein elemente	Arriay sil	Legido Age entor Age entor Artay dir 0.012	age effor ratio	Jacote 10,11 Jacote dement by 16 Jacote dement by 16 Jacote 10,111 Jacote 10,111 Jacote 10,111 Jacote 10,111 Jacote 10,111 Jacote 10,111
tr	17	13	13	0.765	49.154	3.769	1.769	0.012	1.000	0.667
true	9	6	6	0.667	19.167	1.688	2.500	0.021	1.000	0.778
truncate	10	7	7	0.700	47.429	5.875	2.143	0.018	1.000	0.667
tsort	13	8	8	0.615	30.500	6.266	2.875	0.047	1.000	0.667
tty	10	7	7	0.700	38.571	5.875	2.143	0.018	1.000	0.667
uname	12	8	8	0.667	80.250	9.016	1.875	0.016	1.000	0.583
unexpand	11	8	8	0.727	39.375	6.016	1.875	0.016	1.000	0.667
uniq	15	12	12	0.800	50.250	5.136	1.917	0.052	1.000	0.694
unlink	12	7	7	0.583	29.714	5.875	2.143	0.018	1.000	0.667
uptime	18	13	12	0.667	97.077	3.366	80.231	0.136	0.923	0.795
users	12	7	7	0.583	29.714	5.875	2.143	0.018	1.000	0.667
vdir	71	61	60	0.845	135.951	8.784	82.311	3.046	0.934	0.694
wc	16	11	11	0.688	3015.818	3 4.206	2976.36	4 0.206	1.000	0.727
who	25	19	19	0.760	37.211	2.332	1.474	0.016	1.000	0.825
whoami	12	7	7	0.583	29.714	5.875	2.143	0.018	1.000	0.667
yes	12	7	7	0.583	29.714	5.875	2.143	0.018	1.000	0.667

Table 42: Array recovery (compilation = debug)

Cround	Altulhaltay A	arnodes compaisons	valnodes infer	red as array	red as alray fr	action average of Array.	rot instanciale et site loytestan	garatio gage error site to yes and	zrage error rai	do core 10.11 ch score alement of
[15	16	15	1.000	0.000	0.000	0.000	0.000	1.000	1.000
b2sum	24	25	24	1.000	0.000	0.000	0.000	0.000	1.000	1.000
base32	12	13	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
base64	12	12	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
basename	10	10	10	1.000	0.000	0.000	0.000	0.000	1.000	1.000
basenc	20	21	20	1.000	0.000	0.000	0.000	0.000	1.000	1.000
cat	11	12	11	1.000	0.000	0.000	0.000	0.000	1.000	1.000
chcon	18	18	18	1.000	0.000	0.000	0.000	0.000	1.000	1.000
chgrp	15	15	15	1.000	0.000	0.000	0.000	0.000	1.000	1.000
chmod	19	20	19	1.000	0.000	0.000	0.000	0.000	1.000	1.000
chown	16	16	16	1.000	0.000	0.000	0.000	0.000	1.000	1.000
chroot	11	11	11	1.000	0.000	0.000	0.000	0.000	1.000	1.000
cksum	66	67	66	1.000	0.000	0.000	0.000	0.000	1.000	1.000
comm	22	22	22	1.000	0.000	0.000	0.000	0.000	1.000	1.000
cp	40	44	39	0.975	0.000	0.000	0.000	0.000	1.000	1.000
csplit	35	36	35	1.000	6.667	0.026	6.667	0.026	1.000	1.000
cut	12	12	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000

Table 42: Array recovery (compilation = debug)

				erted as array	redas atray f	action	hid and ase of the said	rotratio	×.¢	dio (0,1)
		A variode's Arr	<u>.</u> 6	Jerred as array	ried as arrive	nts average	ind internations of site loyles and Artist	erage erro	Wetage error fo	dio die de la
	. Luth atra	Angaitson	s attodes in	athodes inte	ngh cleni	mgh eleni	ine layles).	:18 (byles).	inensionit	istas gent
Citolic	Atr'	A vatir	N No. Will	N No. William	Array	Arian	Array Array	Arian	Artial Artial	
date	63	70	63	1.000	31.071	0.100	31.071	0.100	1.000	1.000
dd	34	37	34	1.000	0.000	0.000	0.000	0.000	1.000	1.000
df	25	26	25	1.000	24.269	1.156	24.269	1.156	1.000	1.000
dir	71	75	71	1.000	47.200	0.840	47.200	0.840	1.000	1.000
dircolors	13	13	13	1.000	0.000	0.000	0.000	0.000	1.000	1.000
dirname	10	10	10	1.000	0.000	0.000	0.000	0.000	1.000	1.000
du	51	54	51	1.000	23.259	0.036	23.259	0.036	1.000	1.000
echo	9	9	9	1.000	0.000	0.000	0.000	0.000	1.000	1.000
env	18	19	18	1.000	0.000	0.000	0.000	0.000	1.000	1.000
expand	13	13	13	1.000	0.000	0.000	0.000	0.000	1.000	1.000
expr	33	33	33	1.000	7.273	0.028	7.273	0.028	1.000	1.000
factor	37	32	32	0.865	0.000	0.000	0.000	0.000	1.000	1.000
false	9	9	9	1.000	0.000	0.000	0.000	0.000	1.000	1.000
fmt	12	12	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
fold	12	12	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
groups	11	12	11	1.000	0.000	0.000	0.000	0.000	1.000	1.000
head	18	19	18	1.000	0.000	0.000	0.000	0.000	1.000	1.000
hostid	12	12	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000

Table 42: Array recovery (compilation = debug)

						tion	4	ratio		
				Par	ray st	ge.	ition age et	ior	ist in	itio (0)
		modes		्वे वह वरि	ad as air	, डो व्यक्तियः इ	re) averious	Tage ett.	rage esti-	in score
	25.0	y war.	, <u> </u>	jerie sinfe	ite cleme	aleme	ज़ार रहा जे	er (er	iger . On the	alch
	A truth a	compari	s/atmodes	annode	length (engin	iste logic	ite Ogl	Aimensie	average
Circuir	Pit,	N variodes	ATT'	Refedas afroy	redasaray fi Length clemen	Atian	Jidi average of Jide average of	Array	y Array)
id	14	17	14	1.000	0.000	0.000	0.000	0.000	1.000	1.000
join	18	18	18	1.000	0.000	0.000	0.000	0.000	1.000	1.000
kill	14	14	14	1.000	0.000	0.000	0.000	0.000	1.000	1.000
link	12	12	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
ln	22	23	22	1.000	0.000	0.000	0.000	0.000	1.000	1.000
logname	12	12	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
ls	71	75	71	1.000	47.200	0.840	47.200	0.840	1.000	1.000
md5sum	16	17	16	1.000	0.000	0.000	0.000	0.000	1.000	1.000
mkdir	19	20	18	0.947	0.000	0.000	0.000	0.000	1.000	1.000
mkfifo	12	13	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
mknod	12	13	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
mktemp	12	13	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
mv	34	36	33	0.971	0.000	0.000	0.000	0.000	1.000	1.000
nice	10	10	10	1.000	0.000	0.000	0.000	0.000	1.000	1.000
nl	36	36	36	1.000	6.667	0.026	6.667	0.026	1.000	1.000
nohup	13	13	13	1.000	0.000	0.000	0.000	0.000	1.000	1.000
nproc	10	10	10	1.000	0.000	0.000	0.000	0.000	1.000	1.000
numfmt	20	20	20	1.000	0.000	0.000	0.000	0.000	1.000	1.000

Table 42: Array recovery (compilation = debug)

						ion		ratio		
				to.	and the	ger,	ioi geei	ia	A 18	io (0)
		nodes		. A as affice	A 25 affic	average	averate	age etil	inge etito	n score l
	, S	Wall Cons	in	jeried infer	ied	its,	गुर्दे ।	હોં.	ele an ma	ici.
	Tulh ai.	MRATIS	athodes	arnoles	angth (ex	angh ler	:16 QAG	:18 (Dyle)	inensio	Netage C
Cround	s Diti	Avamodes	Vi. Viis	defed as attay	ted as atray french	Dr. Array	ior his average et site to hes av	rortatio rortatio rortatio rortatio Array Array Array	erage error ra	idascore le la suria de la companya
od	40	42	40	1.000	0.000	0.000	0.000	0.000	1.000	1.000
paste	10	10	10	1.000	0.000	0.000	0.000	0.000	1.000	1.000
pathchk	10	10	10	1.000	0.000	0.000	0.000	0.000	1.000	1.000
pinky	17	19	17	1.000	11.789	0.046	11.789	0.046	1.000	1.000
pr	20	21	20	1.000	48.381	0.047	48.381	0.047	1.000	1.000
printenv	10	10	10	1.000	0.000	0.000	0.000	0.000	1.000	1.000
printf	17	18	17	1.000	0.000	0.000	0.000	0.000	1.000	1.000
ptx	39	39	39	1.000	6.154	0.024	6.154	0.024	1.000	1.000
pwd	10	10	10	1.000	0.000	0.000	0.000	0.000	1.000	1.000
readlink	12	12	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
realpath	11	11	11	1.000	0.000	0.000	0.000	0.000	1.000	1.000
rm	15	15	15	1.000	0.000	0.000	0.000	0.000	1.000	1.000
rmdir	14	15	14	1.000	0.000	0.000	0.000	0.000	1.000	1.000
runcon	10	10	10	1.000	0.000	0.000	0.000	0.000	1.000	1.000
seq	15	17	15	1.000	0.000	0.000	0.000	0.000	1.000	1.000
sha1sum	16	17	16	1.000	0.000	0.000	0.000	0.000	1.000	1.000
sha224sum	17	18	17	1.000	0.000	0.000	0.000	0.000	1.000	1.000
sha256sum	17	18	17	1.000	0.000	0.000	0.000	0.000	1.000	1.000

Table 42: Array recovery (compilation = debug)

				ed as atray	દ્યસ્	jion	of Saverage error Le loyes aver Array si	r ratio	منح)
		gde ⁵	varnode ^s infer	1 as atray	ed as array fras	average ex	ot Saverage ettic Je Oyles avet Je Oyles avet	ge etior	rage error ratio	score 10.
	Aray c	ine isons	Sinfer	ied sinferi	ed Glement	s) Glement	is) responer	igh Tes) grie	rage ento Inersion match	n elen
ω ^γ ,	Tuth at	ongaisons Aria ⁹	varnode	athode 18	ingth (C)	ngin (C	ie (1991)	is all is	Mensie av	हां वर्ष्ट
Chair	Atray	Atran	Atray	Array	ATTOM	Attay	ATTOM	ATTOM	ATTON	
sha384sum	17	18	17	1.000	0.000	0.000	0.000	0.000	1.000	1.000
sha512sum	17	18	17	1.000	0.000	0.000	0.000	0.000	1.000	1.000
shred	27	27	27	1.000	23.370	0.036	23.370	0.036	1.000	1.000
shuf	12	12	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
sleep	12	12	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
sort	46	50	46	1.000	0.320	0.010	0.320	0.010	1.000	1.000
split	18	18	17	0.944	0.000	0.000	0.000	0.000	1.000	1.000
stat	32	37	32	1.000	27.459	0.027	27.459	0.027	1.000	1.000
stdbuf	16	17	16	1.000	0.000	0.000	0.000	0.000	1.000	1.000
stty	19	21	19	1.000	0.000	0.000	0.000	0.000	1.000	1.000
sum	22	23	22	1.000	0.000	0.000	0.000	0.000	1.000	1.000
sync	11	11	11	1.000	0.000	0.000	0.000	0.000	1.000	1.000
tac	33	35	33	1.000	6.857	0.027	6.857	0.027	1.000	1.000
tail	20	19	19	0.950	0.000	0.000	0.000	0.000	1.000	1.000
tee	14	14	14	1.000	0.000	0.000	0.000	0.000	1.000	1.000
test	12	13	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
timeout	13	13	13	1.000	0.000	0.000	0.000	0.000	1.000	1.000
touch	56	60	56	1.000	19.317	0.100	19.317	0.100	1.000	0.983

Table 42: Array recovery (compilation = debug)

Grand	Ruth atray vatr	ndes Inpaisons Artay va	Array wat	Jasaray Jasaray Jades inferei	dasahay frac	ion average error	s average error	Artay dir	age effort ratio	rscore (0,1) rscore (0,1) rscore (0,1) rscore (0,1) rscore (0,1)
tr	17	17	17	1.000	0.000	0.000	0.000	0.000	1.000	1.000
true	9	9	9	1.000	0.000	0.000	0.000	0.000	1.000	1.000
truncate	10	10	10	1.000	0.000	0.000	0.000	0.000	1.000	1.000
tsort	13	13	13	1.000	0.000	0.000	0.000	0.000	1.000	1.000
tty	10	10	10	1.000	0.000	0.000	0.000	0.000	1.000	1.000
uname	12	13	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
unexpand	11	11	11	1.000	0.000	0.000	0.000	0.000	1.000	1.000
uniq	15	15	15	1.000	0.000	0.000	0.000	0.000	1.000	1.000
unlink	12	12	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
uptime	18	19	18	1.000	53.474	0.052	53.474	0.052	1.000	1.000
users	12	12	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
vdir	71	75	71	1.000	47.200	0.840	47.200	0.840	1.000	1.000
wc	16	18	16	1.000	0.000	0.000	0.000	0.000	1.000	1.000
who	25	29	25	1.000	0.000	0.000	0.000	0.000	1.000	1.000
whoami	12	12	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000
yes	12	12	12	1.000	0.000	0.000	0.000	0.000	1.000	1.000