GNATcheck Reference Manual

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CONTENTS

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GNAT, The GNU Ada Development Environment

The GNAT Ada Compiler
Version 2016

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CHAPTER
ONE

ABOUT THIS MANUAL

The *gnatcheck* tool in GNAT can be used to enforce coding conventions by analyzing Ada source programs with respect to a set of *rules* supplied at tool invocation. This manual describes the complete set of predefined rules that *gnatcheck* can take as input.

What This Manual Contains

This manual contains a description of *gnatcheck*, an ASIS-based utility that checks properties of Ada source files according to a given set of semantic rules

- *Introduction*, gives the general overview of the *gnatcheck* tool

   Format of the Report File, describes the structure of the report file generated by *gnatcheck*

   General gnatcheck Switches, describes switches that control the general behavior of *gnatcheck*

   gnatcheck Rule Options, describes options used to control a set of rules to be checked by *gnatcheck*

   Adding the Results of Compiler Checks to gnatcheck Output, explains how the results of the check performed by the GNAT compiler can be added to the report generated by *gnatcheck*

   Rule exemption, explains how to turn off a rule check for a specified fragment of a source file

   Predefined Rules, contains a description of each predefined *gnatcheck* rule, organized into categories.

   Example of gnatcheck Usage, contains a full example of *gnatcheck* usage

   List of Rules, gives an alphabetized list of all predefined rules, for ease of reference.

The name of each rule (the 'rule identifier') denotes the condition that is detected and flagged by *gnatcheck*. The rule identifier is used as a parameter of the +R or −R switch to *gnatcheck*.

What You Should Know Before Reading This Manual

You should be familiar with the Ada language and with the usage of GNAT in general; please refer to the GNAT User's Guide.

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CHAPTER

TWO

INTRODUCTION

The *gnatcheck* tool is an ASIS-based utility that checks properties of Ada source files according to a given set of semantic rules.

In order to check compliance with a given rule, *gnatcheck* has to semantically analyze the Ada sources. Therefore, checks can only be performed on legal Ada units. Moreover, when a unit depends semantically upon units located outside the current directory, the source search path has to be provided when calling *gnatcheck*, either through a specified project file or through *gnatcheck* switches as described below.

If the set of sources to be processed by gnatcheck contains sources with preprocessing directives then the needed options should be provided to run preprocessor as a part of the *gnatcheck* call, and detected rule violations will correspond to preprocessed sources.

A number of rules are predefined in *gnatcheck* and are described later in this chapter. You can also add new rules, by modifying the *gnatcheck* code and rebuilding the tool. In order to add a simple rule making some local checks, a small amount of straightforward ASIS-based programming is usually needed.

Invoking *gnatcheck* on the command line has the form:

```
$ gnatcheck [switches]  {filename}
      [-files={arg_list_filename}]
      [-cargs gcc_switches] -rules rule_options
```

where

- *switches* specify the general tool options

- Each *filename* is the name (including the extension) of a source file to process. 'Wildcards' are allowed, and the file name may contain path information.

- Each *arg_list_filename* is the name (including the extension) of a text file containing the names of the source files to process, separated by spaces or line breaks.

- *gcc_switches* is a list of switches for *gcc*. They will be passed on to all compiler invocations made by *gnatcheck* to generate the ASIS trees. Here you can provide -I switches to form the source search path, and use the -gnatec switch to set the configuration file, etc.

- *rule_options* is a list of options for controlling a set of rules to be checked by *gnatcheck* (*gnatcheck Rule Options*).

Either a filename or an arg_list_filename must be supplied.

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CHAPTER

THREE

FORMAT OF THE REPORT FILE

The *gnatcheck* tool outputs on `stderr` all messages concerning rule violations except if running in quiet mode. By default it also creates a text file that contains the complete report of the last gnatcheck run, this file is named `gnatcheck.out`. A user can specify generation of the XML version of the report file (its default name is `gnatcheck.xml`) If *gnatcheck* is called with a project file, the report file is located in the object directory defined by the project file (or in the directory where the argument project file is located if no object directory is defined), if `--subdirs` option is specified, the file is placed in the subrirectory of this directory specified by this option. Otherwise it is located in the current directory; the `-o` or `-ox` option can be used to change the name and/or location of the text or XML report file. This text report contains:

- general details of the *gnatcheck* run: date and time of the run, the version of the tool that has generated this report, full parameters of the *gnatcheck* invocation, reference to the list of checked sources and applied rules (coding standard);

- summary of the run (number of checked sources and detected violations);

- list of exempted coding standard violations;

- list of non-exempted coding standard violations;

- list of problems in the definition of exemption sections;

- list of language violations (compile-time errors) detected in processed sources;

The references to the list of checked sources and applied rules are references to the text files that contain the corresponding information. These files could be either files supplied as *gnatcheck* parameters or files created by *gnatcheck*; in the latter case these files are located in the same directory as the report file.

The content of the XML report is similar to the text report except that it explores the set of files processed by gnatcheck and the coding standard used for checking these files.

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CHAPTER

FOUR

GENERAL *GNATCHECK* SWITCHES

The following switches control the general *gnatcheck* behavior

--version Display Copyright and version, then exit disregarding all other options.

--help Display usage, then exit disregarding all other options.

-P file Indicates the name of the project file that describes the set of sources to be processed. The exact set of argument sources depends on other options specified, see below.

-U If a project file is specified and no argument source is explicitly specified (either directly or by means of -files option), process all the units of the closure of the argument project. Otherwise this option has no effect.

-U main_unit If a project file is specified and no argument source is explicitly specified (either directly or by means of -files option), process the closure of units rooted at *main_unit*. Otherwise this option has no effect.

-Xname=value Indicates that external variable *name* in the argument project has the *value* value. Has no effect if no project is specified as tool argument.

--subdirs=dir Use the specified subdirectory of the project objects file (or of the project file directory if the project does not specify an object directory) for tool output files. Has no effect if no project is specified as tool argument or if --no_objects_dir is specified.

--no_objects_dir Place all the result files into the current directory instead of project objects directory.

--RTS=rts-path Specifies the default location of the runtime library. Same meaning as the equivalent *gnatmake* flag (see GNAT User's Guide).

-a Process all units including those with read-only ALI files such as those from the GNAT Run-Time library.

--incremental Incremental processing on a per-file basis. Source files are only processed if they have been modified, or if files they depend on have been modified. This is similar to the way gnatmake/gprbuild only compiles files that need to be recompiled. A project file is required in this mode, and the gnat driver (as in *gnat check*) is not supported. Note that rules requiring a global analysis (Recursive_Subprograms, Deeply_Nested_Inlining) are not supported in –incremental mode.

-h List all the rules checked by the given *gnatcheck* version.

-jnnnn Use *nnnn* processes to carry out the tree creations (internal representations of the argument sources). On a multiprocessor machine this speeds up processing of big sets of argument sources. If *n* is 0, then the maximum number of parallel tree creations is the number of core processors on the platform.

-l Use full source locations references in the report file. For a construct from a generic instantiation a full source location is a chain from the location of this construct in the generic unit to the place where this unit is instantiated.

-log Duplicate all the output sent to stderr into a log file. The log file is named gnatcheck.log. If a project file is specified as *gnatcheck* parameter then it is located in the project objects directory (or in the project file directory if no object directory is specified). Otherwise it is located in the current directory.

–mnnnn Maximum number of diagnostics to be sent to `stdout`, where *nnnn* is in the range 0...1000; the default value is 500. Zero means that there is no limitation on the number of diagnostic messages to be output.

–q Quiet mode. All the diagnostics about rule violations are placed in the *gnatcheck* report file only, without duplication on `stdout`.

–s Short format of the report file (no version information, no list of applied rules, no list of checked sources is included)

–xml Generate the report file in XML format. Is not allowed in incremental mode.

–nt Do not generate the report file in text format. Enforces `-xml`, is not allowed in incremental mode.

--show-rule Add the corresponding rule name to the diagnosis generated for its violation.

--include-file=file Append the content of the specified text file to the report file

–t Print out execution time.

–v Verbose mode; *gnatcheck* generates version information and then a trace of sources being processed.

–o report_file Set name of the text report file to *report_file*.

–ox report_file Set name of the XML report file to *report_file*. Enforces `-xml`, is not allowed in incremental mode.

--write-rules=template_file Write to *template_file* the template rule file that contains all the rules currently implemented in *gnatcheck* turned off. A user may edit this template file manually to get his own coding standard file.

If a project file is specified and no argument source is explicitly specified (either directly or by means of `-files` option), and no `-U` is specified, then the set of processed sources is all the immediate units of the argument project.

CHAPTER

FIVE

GNATCHECK RULE OPTIONS

The following options control the processing performed by *gnatcheck*.

+Rrule_id[:param] Turn on the check for a specified rule with the specified parameter, if any. *rule_id* must be the identifier of one of the currently implemented rules (use -h for the list of implemented rules). Rule identifiers are not case-sensitive. The *param* item must be a string representing a valid parameter(s) for the specified rule. If it contains any space characters then this string must be enclosed in quotation marks.

-Rrule_id[:param] Turn off the check for a specified rule with the specified parameter, if any.

-from=rule_option_filename Read the rule options from the text file *rule_option_filename*, referred to as a 'coding standard file' below.

The default behavior is that all the rule checks are disabled.

If more than one rule option is specified for the same rule, these options are summed together. If a new option contradicts the rule settings specified by previous options for this rule, the new option overrides the previous settings.

A coding standard file is a text file that contains a set of rule options described above.

The file may contain empty lines and Ada-style comments (comment lines and end-of-line comments). There can be several rule options on a single line (separated by a space).

A coding standard file may reference other coding standard files by including more -from=rule_option_filename options, each such option being replaced with the content of the corresponding coding standard file during processing. In case a cycle is detected (that is, rule_file_1 reads rule options from rule_file_2, and rule_file_2 reads (directly or indirectly) rule options from rule_file_1), processing fails with an error message.

If the name of the coding standard file does not contain a path information in absolute form, then it is treated as being relative to the current directory if gnatcheck is called without a project file or as being relative to the project file directory if gnatcheck is called with a project file as an argument.

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CHAPTER

SIX

ADDING THE RESULTS OF COMPILER CHECKS TO *GNATCHECK* OUTPUT

The *gnatcheck* tool can include in the generated diagnostic messages and in the report file the results of the checks performed by the compiler. Though disabled by default, this effect may be obtained by using +R with the following rule identifiers and parameters:

Restrictions To record restrictions violations (which are performed by the compiler if the pragma `Restrictions` or `Restriction_Warnings` are given), use the `Restrictions` rule with the same parameters as pragma `Restrictions` or `Restriction_Warnings`.

> This rule allows parametric rule exemptions, the parameters that are allowed in the definition of exemption sections are the names of the restrictions except for the case when a restriction requires a non-numeric parameter, in this case the parameter should be the name of the restriction with the parameter, as it is given for the rule.

Style_Checks To record compiler style checks (see Style Checking section in GNAT User's Guide), use the `Style_Checks` rule.

> This rule takes a parameter in one of the following forms:
>
> - ***All_Checks***, which enables the standard style checks corresponding to the `-gnatyy` GNAT style check option, or
>
> - a string with the same structure and semantics as the `string_LITERAL` parameter of the GNAT pragma `Style_Checks` (see "Pragma Style_Checks" in the GNAT Reference Manual).
>
> For example, the `+RStyle_Checks:O` rule option activates the compiler style check that corresponds to `-gnatyO` style check option.

Warnings To record compiler warnings (see Warning Message Control section in GNAT User's Guide), use the `Warnings` rule with a parameter that is a valid *static_string_expression* argument of the GNAT pragma `Warnings` (see "Pragma Warnings" in the GNAT Reference Manual). Note that in case of gnatcheck 's' parameter, that corresponds to the GNAT `-gnatws` option, disables all the specific warnings, but not suppresses the warning mode, and 'e' parameter, corresponding to `-gnatwe` that means "treat warnings as errors", does not have any effect.

To disable a specific restriction check, use `-RRestrictions` gnatcheck option with the corresponding restriction name as a parameter. `-R` is not available for `Style_Checks` and `Warnings` options, to disable warnings and style checks, use the corresponding warning and style options.

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CHAPTER

SEVEN

RULE EXEMPTION

One of the most useful applications of *gnatcheck* is to automate the enforcement of project-specific coding standards, for example in safety-critical systems where particular features must be restricted in order to simplify the certification effort. However, it may sometimes be appropriate to violate a coding standard rule, and in such cases the rationale for the violation should be provided in the source program itself so that the individuals reviewing or maintaining the program can immediately understand the intent.

The *gnatcheck* tool supports this practice with the notion of a 'rule exemption' covering a specific source code section. Normally rule violation messages are issued both on `stderr` and in a report file. In contrast, exempted violations are not listed on `stderr`; thus users invoking *gnatcheck* interactively (e.g. in its GPS interface) do not need to pay attention to known and justified violations. However, exempted violations along with their justification are documented in a special section of the report file that *gnatcheck* generates.

7.1 Using pragma `Annotate` to Control Rule Exemption

Rule exemption is controlled by pragma `Annotate` when its first argument is 'gnatcheck'. The syntax of *gnatcheck*'s exemption control annotations is as follows:

```
pragma Annotate (gnatcheck, exemption_control, Rule_Name [, justification]);

exemption_control ::= Exempt_On | Exempt_Off

Rule_Name         ::= string_literal

justification     ::= string_literal
```

When a *gnatcheck* annotation has more than four arguments, *gnatcheck* issues a warning and ignores the additional arguments. If the arguments do not follow the syntax above, *gnatcheck* emits a warning and ignores the annotation.

The `Rule_Name` argument should be the name of some existing *gnatcheck* rule. Otherwise a warning message is generated and the pragma is ignored. If `Rule_Name` denotes a rule that is not activated by the given *gnatcheck* call, the pragma is ignored and no warning is issued. The exception from this rule is that exemption sections for `Warnings` rule are fully processed when `Restrictions` rule is activated.

A source code section where an exemption is active for a given rule is delimited by an `exempt_on` and `exempt_off` annotation pair:

```
pragma Annotate (gnatcheck, Exempt_On, "Rule_Name", "justification");
-- source code section
pragma Annotate (gnatcheck, Exempt_Off, "Rule_Name");
```

For some rules it is possible specify rule parameter(s) when defining an exemption section for a rule. This means that only the checks corresponding to the given rule parameter(s) are exempted in this section:

```
pragma Annotate (gnatcheck, Exempt_On, "Rule_Name: Par1, Par2", "justification");
-- source code section
pragma Annotate (gnatcheck, Exempt_Off, "Rule_Name: Par1, Par2");
```

A parametric exemption section can be defined for a rule if a rule has parameters and these parameters change the scope of the checks performed by a rule. For example, if you define an exemption section for 'Restriction' rule with the parameter 'No_Allocators', then in this section only the checks for `No_Allocators` will be exempted, and the checks for all the other restrictions from your coding standard will be performed as usial.

See the description of individual rules to check if parametric exemptions are available for them and what is the format of the rule parameters to be used in the corresponding parameters of the `Annotate` pragmas.

7.2 *gnatcheck* Annotations Rules

- An 'Exempt_Off' annotation can only appear after a corresponding 'Exempt_On' annotation.

- Exempted source code sections are only based on the source location of the annotations. Any source construct between the two annotations is part of the exempted source code section.

- Exempted source code sections for different rules are independent. They can be nested or intersect with one another without limitation. Creating nested or intersecting source code sections for the same rule is not allowed.

- A matching 'Exempt_Off' annotation pragma for an 'Exempt_On' pragma that defines a parametric exemption section is the pragma that contains exactly the same set of rule parameters for the same rule.

- Parametric exemption sections for the same rule with different parameters can intersect or overlap in case if the parameter sets for such sections have an empty intersection.

- Malformed exempted source code sections are reported by a warning, and the corresponding rule exemptions are ignored.

- When an exempted source code section does not contain at least one violation of the exempted rule, a warning is emitted on `stderr`.

- If an 'Exempt_On' annotation pragma does not have a matching 'Exempt_Off' annotation pragma in the same compilation unit, a warning is issued and the exemption section is considered to last until the end of the compilation unit source.

PREDEFINED RULES

The description of the rules currently implemented in *gnatcheck* is given in this chapter. The rule identifier is used as a parameter of *gnatcheck*'s +R or -R switches.

Be aware that most of these rules apply to specialized coding requirements developed by individual users and may well not make sense in other environments. In particular, there are many rules that conflict with one another. Proper usage of gnatcheck involves selecting the rules you wish to apply by looking at your independently developed coding standards and finding the corresponding gnatcheck rules.

If not otherwise specified, a rule does not do any check for the results of generic instantiations.

8.1 Style-Related Rules

The rules in this section may be used to enforce various feature usages consistent with good software engineering, for example as described in Ada 95 Quality and Style.

8.1.1 Tasking

The rules in this subsection may be used to enforce various feature usages related to concurrency.

Multiple_Entries_In_Protected_Definitions

Flag each protected definition (i.e., each protected object/type declaration) that declares more than one entry. Diagnostic messages are generated for all the entry declarations except the first one. An entry family is counted as one entry. Entries from the private part of the protected definition are also checked.

This rule has no parameters.

Volatile_Objects_Without_Address_Clauses

Flag each volatile object that does not have an address clause.

The following check is made: if the pragma `Volatile` is applied to a data object or to its type, then an address clause must be supplied for this object.

This rule does not check the components of data objects, array components that are volatile as a result of the pragma `Volatile_Components`, or objects that are volatile because they are atomic as a result of pragmas `Atomic` or `Atomic_Components`.

Only variable declarations, and not constant declarations, are checked.

This rule has no parameters.

8.1.2 Object Orientation

The rules in this subsection may be used to enforce various feature usages related to Object-Oriented Programming.

Deep_Inheritance_Hierarchies

Flags a tagged derived type declaration or an interface type declaration if its depth (in its inheritance hierarchy) exceeds the value specified by the *N* rule parameter. Types in generic instantiations which violate this rule are also flagged; generic formal types are not flagged. This rule also does not flag private extension declarations. In the case of a private extension, the corresponding full declaration is checked.

In most cases, the inheritance depth of a tagged type or interface type is defined as 0 for a type with no parent and no progenitor, and otherwise as 1 + max of the depths of the immediate parent and immediate progenitors. If the declaration of a formal derived type has no progenitor, or if the declaration of a formal interface type has exactly one progenitor, then the inheritance depth of such a formal derived/interface type is equal to the inheritance depth of its parent/progenitor type, otherwise the general rule is applied.

If the rule flags a type declaration inside the generic unit, this means that this type declaration will be flagged in any instantiation of the generic unit. But if a type is derived from a format type or has a formal progenitor and it is not flagged at the place where it is defined in a generic unit, it may or may not be flagged in instantiation, this depends of the inheritance depth of the actual parameters.

This rule has the following (mandatory) parameter for the +R option:

N Integer not less than -1 specifying the maximal allowed depth of any inheritance hierarchy. If the rule parameter is set to -1, the rule flags all the declarations of tagged and interface types.

Direct_Calls_To_Primitives

Flag any nondispatching call to a dispatching primitive operation, except for:

  • a call to the corresponding primitive of the parent type. (This occurs in the common idiom where a primitive subprogram for a tagged type directly calls the same primitive subprogram of the parent type.)

  • a call to a primitive of an untagged private type, even though the full type may be tagged, when the call is made at a place where the view of the type is untagged.

This rule has the following (optional) parameters for the +R option:

Except_Constructors Do not flag nondispatching calls to functions if the function has a controlling result and no controlling parameters (in a traditional OO sense such functions may be considered as constructors).

Too_Many_Parents

Flag any tagged type declaration, interface type declaration, single task declaration or single protected declaration that has more than *N* parents, where *N* is a parameter of the rule. A *parent* here is either a (sub)type denoted by the subtype mark from the parent_subtype_indication (in case of a derived type declaration), or any of the progenitors from the interface list (if any).

This rule has the following (mandatory) parameters for the +R option:

N Positive integer specifying the maximal allowed number of parents/progenitors.

Visible_Components

Flag all the type declarations located in the visible part of a library package or a library generic package that can declare a visible component. A visible component can be declared in a *record definition* which appears on its own or as part of a record extension. The *record definition* is flagged even if it contains no components.

Record definitions located in private parts of library (generic) packages or in local (generic) packages are not flagged. *Record definitions* in private packages, in package bodies, and in the main subprogram body are not flagged.

This rule has no parameters.

8.1.3 Portability

The rules in this subsection may be used to enforce various feature usages that support program portability.

Forbidden_Attributes

Flag each use of the specified attributes. The attributes to be detected are named in the rule's parameters.

This rule has the following parameters:

- For the +R option

Attribute_Designator Adds the specified attribute to the set of attributes to be detected and sets the detection checks for all the specified attributes ON. If *Attribute_Designator* does not denote any attribute defined in the Ada standard or in the GNAT Reference Manual, it is treated as the name of unknown attribute.

GNAT All the GNAT-specific attributes are detected; this sets the detection checks for all the specified attributes ON.

ALL All attributes are detected; this sets the rule ON.

- For the −R option

Attribute_Designator Removes the specified attribute from the set of attributes to be detected without affecting detection checks for other attributes. If *Attribute_Designator* does not correspond to any attribute defined in the Ada standard or in the GNAT Reference Manual, this option is treated as turning OFF detection of all unknown attributes.

GNAT Turn OFF detection of all GNAT-specific attributes

ALL Clear the list of the attributes to be detected and turn the rule OFF.

Parameters are not case sensitive. If *Attribute_Designator* does not have the syntax of an Ada identifier and therefore can not be considered as a (part of an) attribute designator, a diagnostic message is generated and the corresponding parameter is ignored. (If an attribute allows a static expression to be a part of the attribute designator, this expression is ignored by this rule.)

When more than one parameter is given in the same rule option, the parameters must be separated by commas.

If more than one option for this rule is specified for the gnatcheck call, a new option overrides the previous one(s).

The +R option with no parameters turns the rule ON, with the set of attributes to be detected defined by the previous rule options. (By default this set is empty, so if the only option specified for the rule is +RForbidden_Attributes (with no parameter), then the rule is enabled, but it does not detect anything). The −R option with no parameter turns the rule OFF, but it does not affect the set of attributes to be detected.

The rule allows parametric exemption, the parameters that are allowed in the definition of exemption sections are *Attribute_Designators*. Each *Attribute_Designator* used as a rule exemption parameter should denote a predefined or GNAT-specific attribute.

Forbidden_Pragmas

Flag each use of the specified pragmas. The pragmas to be detected are named in the rule's parameters.

This rule has the following parameters:

- For the +R option

Pragma_Name Adds the specified pragma to the set of pragmas to be checked and sets the checks for all the specified pragmas ON. *Pragma_Name* is treated as a name of a pragma. If it does not correspond to any pragma name defined in the Ada standard or to the name of a GNAT-specific pragma defined in the GNAT Reference Manual, it is treated as the name of unknown pragma.

GNAT All the GNAT-specific pragmas are detected; this sets the checks for all the specified pragmas ON.

ALL All pragmas are detected; this sets the rule ON.

- For the −R option

Pragma_Name Removes the specified pragma from the set of pragmas to be checked without affecting checks for other pragmas. *Pragma_Name* is treated as a name of a pragma. If it does not correspond to any pragma defined in the Ada standard or to any name defined in the GNAT Reference Manual, this option is treated as turning OFF detection of all unknown pragmas.

GNAT Turn OFF detection of all GNAT-specific pragmas

ALL Clear the list of the pragmas to be detected and turn the rule OFF.

Parameters are not case sensitive. If *Pragma_Name* does not have the syntax of an Ada identifier and therefore can not be considered as a pragma name, a diagnostic message is generated and the corresponding parameter is ignored.

When more than one parameter is given in the same rule option, the parameters must be separated by a comma.

If more than one option for this rule is specified for the *gnatcheck* call, a new option overrides the previous one(s).

The +R option with no parameters turns the rule ON with the set of pragmas to be detected defined by the previous rule options. (By default this set is empty, so if the only option specified for the rule is +RForbidden_Pragmas (with no parameter), then the rule is enabled, but it does not detect anything). The −R option with no parameter turns the rule OFF, but it does not affect the set of pragmas to be detected.

Note that in case when the rule is enabled with *ALL* parameter, then the rule will flag also pragmas Annotate used to exempt rules, see *Rule exemption*. Even if you exempt this *Forbidden_Pragmas* rule then the pragma Annotate that closes the exemption section will be flagged as non-exempted. To avoid this, turn off the check for pragma Annotate by using −RForbidden_Pragmas:Annotate rule option.

The rule allows parametric exemption, the parameters that are allowed in the definition of exemption sections are pragma names. Each name used as a rule exemption parameter should denote a predefined or GNAT-specific pragma.

Implicit_SMALL_For_Fixed_Point_Types

Flag each fixed point type declaration that lacks an explicit representation clause to define its ′Small value. Since ′Small can be defined only for ordinary fixed point types, decimal fixed point type declarations are not checked.

This rule has no parameters.

No_Scalar_Storage_Order_Specified

Flag each record type declaration, record extension declaration, and untagged derived record type declaration if a record_representation_clause that has at least one component clause applies to it (or an ancestor), but neither the type nor any of its ancestors has an explicitly specified Scalar_Storage_Order attribute.

This rule has no parameters.

Predefined_Numeric_Types

Flag each explicit use of the name of any numeric type or subtype declared in package `Standard`.

The rationale for this rule is to detect when the program may depend on platform-specific characteristics of the implementation of the predefined numeric types. Note that this rule is overly pessimistic; for example, a program that uses `String` indexing likely needs a variable of type `Integer`. Another example is the flagging of predefined numeric types with explicit constraints:

```
subtype My_Integer is Integer range Left .. Right;
Vy_Var : My_Integer;
```

This rule detects only numeric types and subtypes declared in package `Standard`. The use of numeric types and subtypes declared in other predefined packages (such as `System.Any_Priority` or `Ada.Text_IO.Count`) is not flagged

This rule has no parameters.

Separate_Numeric_Error_Handlers

Flags each exception handler that contains a choice for the predefined `Constraint_Error` exception, but does not contain the choice for the predefined `Numeric_Error` exception, or that contains the choice for `Numeric_Error`, but does not contain the choice for `Constraint_Error`.

This rule has no parameters.

8.1.4 Program Structure

The rules in this subsection may be used to enforce feature usages related to program structure.

Deeply_Nested_Generics

Flag a generic declaration nested in another generic declaration if the nesting level of the inner generic exceeds the value specified by the *N* rule parameter. The nesting level is the number of generic declarations that enclose the given (generic) declaration. Formal packages are not flagged by this rule.

This rule has the following (mandatory) parameters for the +R option:

N Positive integer specifying the maximum nesting level for a generic declaration.

Local_Packages

Flag all local packages declared in package and generic package specs. Local packages in bodies are not flagged.

This rule has no parameters.

Non_Visible_Exceptions

Flag constructs leading to the possibility of propagating an exception out of the scope in which the exception is declared. Two cases are detected:

- An exception declaration in a subprogram body, task body or block statement is flagged if the body or statement does not contain a handler for that exception or a handler with an `others` choice.

- A `raise` statement in an exception handler of a subprogram body, task body or block statement is flagged if it (re)raises a locally declared exception. This may occur under the following circumstances:

  - it explicitly raises a locally declared exception, or

  - it does not specify an exception name (i.e., it is simply `raise;`) and the enclosing handler contains a locally declared exception in its exception choices.

Renamings of local exceptions are not flagged.

This rule has no parameters.

Raising_External_Exceptions

Flag any `raise` statement, in a program unit declared in a library package or in a generic library package, for an exception that is neither a predefined exception nor an exception that is also declared (or renamed) in the visible part of the package.

This rule has no parameters.

8.1.5 Programming Practice

The rules in this subsection may be used to enforce feature usages that relate to program maintainability.

Anonymous_Arrays

Flag all anonymous array type definitions (by Ada semantics these can only occur in object declarations).

This rule has no parameters.

Enumeration_Ranges_In_CASE_Statements

Flag each use of a range of enumeration literals as a choice in a `case` statement. All forms for specifying a range (explicit ranges such as A .. B, subtype marks and ′Range attributes) are flagged. An enumeration range is flagged even if contains exactly one enumeration value or no values at all. A type derived from an enumeration type is considered as an enumeration type.

This rule helps prevent maintenance problems arising from adding an enumeration value to a type and having it implicitly handled by an existing `case` statement with an enumeration range that includes the new literal.

This rule has no parameters.

Exceptions_As_Control_Flow

Flag each place where an exception is explicitly raised and handled in the same subprogram body. A `raise` statement in an exception handler, package body, task body or entry body is not flagged.

The rule has no parameters.

Exits_From_Conditional_Loops

Flag any exit statement if it transfers the control out of a `for` loop or a `while` loop. This includes cases when the `exit` statement applies to a `FOR` or `while` loop, and cases when it is enclosed in some `for` or `while` loop, but transfers the control from some outer (unconditional) `loop` statement.

The rule has no parameters.

EXIT_Statements_With_No_Loop_Name

Flag each `exit` statement that does not specify the name of the loop being exited.

The rule has no parameters.

Global_Variables

Flag any variable declaration that appears immediately within the specification of a library package or library generic package. Variable declarations in nested packages and inside package instantiations are not flagged.

This rule has the following (optional) parameters for the +R option:

Only_Public Do not flag variable declarations in private library (generic) packages and in package privat parts.

GOTO_Statements

Flag each occurrence of a `goto` statement.

This rule has no parameters.

Improper_Returns

Flag each explicit `return` statement in procedures, and multiple `return` statements in functions. Diagnostic messages are generated for all `return` statements in a procedure (thus each procedure must be written so that it returns implicitly at the end of its statement part), and for all `return` statements in a function after the first one. This rule supports the stylistic convention that each subprogram should have no more than one point of normal return.

This rule has no parameters.

Maximum_Parameters

Flag any subprogram declaration, subprogram body declaration, expression function declaration, null procedure declaration, subprogram body stub or generic subprogram declaration if the corresponding subprogram has more than *N* formal parameters, where *N* is a parameter of the rule.

A subprogram body, an expression function, a null procedure or a subprogram body stub is flagged only if there is no separate declaration for this subprogram. Subprogram renaming declarations and subprogram instantiations, as well as declarations inside expanded generic instantiations are never flagged.

This rule has the following (mandatory) parameters for the +R option:

N Positive integer specifying the maximum allowed total number of subprogram formal parameters.

Non_Short_Circuit_Operators

Flag all calls to predefined `and` and `or` operators for any boolean type. Calls to user-defined `and` and `or` and to operators defined by renaming declarations are not flagged. Calls to predefined `and` and `or` operators for modular types or boolean array types are not flagged.

This rule has no parameters.

OTHERS_In_Aggregates

Flag each use of an `others` choice in extension aggregates. In record and array aggregates, an `others` choice is flagged unless it is used to refer to all components, or to all but one component.

If, in case of a named array aggregate, there are two associations, one with an `others` choice and another with a discrete range, the `others` choice is flagged even if the discrete range specifies exactly one component; for example, `(1..1 => 0, others => 1)`.

This rule has no parameters.

OTHERS_In_CASE_Statements

Flag any use of an `others` choice in a `case` statement.

This rule has no parameters.

OTHERS_In_Exception_Handlers

Flag any use of an `others` choice in an exception handler.

This rule has no parameters.

Overly_Nested_Control_Structures

Flag each control structure whose nesting level exceeds the value provided in the rule parameter.

The control structures checked are the following:

- `if` statement
- `case` statement
- `loop` statement
- selective accept statement
- timed entry call statement
- conditional entry call statement
- asynchronous select statement

The rule has the following parameter for the +R option:

N Positive integer specifying the maximal control structure nesting level that is not flagged

If the parameter for the +R option is not specified or if it is not a positive integer, +R option is ignored.

If more than one option is specified for the gnatcheck call, the later option and new parameter override the previous one(s).

Positional_Actuals_For_Defaulted_Generic_Parameters

Flag each generic actual parameter corresponding to a generic formal parameter with a default initialization, if positional notation is used.

This rule has no parameters.

Positional_Actuals_For_Defaulted_Parameters

Flag each actual parameter to a subprogram or entry call where the corresponding formal parameter has a default expression, if positional notation is used.

This rule has no parameters.

Positional_Components

Flag each array, record and extension aggregate that includes positional notation.

This rule has no parameters.

Positional_Generic_Parameters

Flag each positional actual generic parameter except for the case when the generic unit being instantiated has exactly one generic formal parameter.

This rule has no parameters.

Positional_Parameters

Flag each positional parameter notation in a subprogram or entry call, except for the following:

- Parameters of calls to attribute subprograms are not flagged;

- Parameters of prefix or infix calls to operator functions are not flagged;

- If the called subprogram or entry has only one formal parameter, the parameter of the call is not flagged;

- If a subprogram call uses the *Object.Operation* notation, then

  - the first parameter (that is, *Object*) is not flagged;

  - if the called subprogram has only two parameters, the second parameter of the call is not flagged;

This rule has the following (optional) parameters for the +R option:

All if this parameter is specified, all the positional parameter associations that can be replaced with named associations according to language rules are flagged

This rule has no parameters.

Recursive_Subprograms

Flags specs (and bodies that act as specs) of recursive subprograms. A subprogram is considered as recursive in a given context if there exists a chain of direct calls starting from the body of, and ending at this subprogram within this context. A context is provided by the set of Ada sources specified as arguments of a given gnatcheck call. Neither dispatching calls nor calls through access-to-subprograms are considered as direct calls by this rule.

Generic subprograms and subprograms detected in generic units are not flagged. Recursive subprograms in expanded generic instantiations are flagged.

This rule has no parameters.

Unconditional_Exits

Flag unconditional `exit` statements.

This rule has no parameters.

Unnamed_Blocks_And_Loops

Flag each unnamed block statement and loop statement.

The rule has no parameters.

USE_PACKAGE_Clauses

Flag all `use` clauses for packages; `use type` clauses are not flagged.

This rule has no parameters.

8.1.6 Readability

The rules described in this subsection may be used to enforce feature usages that contribute towards readability.

Identifier_Casing

Flag each defining identifier that does not have a casing corresponding to the kind of entity being declared. All defining names are checked. For the defining names from the following kinds of declarations a special casing scheme can be defined:

- type and subtype declarations;

- enumeration literal specifications (not including character literals) and function renaming declarations if the renaming entity is an enumeration literal;

- constant and number declarations (including object renaming declarations if the renamed object is a constant);

- exception declarations and exception renaming declarations.

The rule may have the following parameters for +R:

- Type=*casing_scheme*

  Specifies casing for names from type and subtype declarations.

- Enum=*casing_scheme*

  Specifies the casing of defining enumeration literals and for the defining names in a function renaming declarations if the renamed entity is an enumeration literal.

- Constant=*casing_scheme*

  Specifies the casing for defining names from constants and named number declarations, including the object renaming declaration if the renamed object is a constant

- Exception=*casing_scheme*

  Specifies the casing for names from exception declarations and exception renaming declarations.

- Others=*casing_scheme*

  Specifies the casing for all defining names for which no special casing scheme is specified. If this parameter is not set, the casing for the entities that do not correspond to the specified parameters is not checked.

- Exclude=*dictionary_file*

  Specifies casing exceptions.

Where:

```
casing_scheme ::= upper|lower|mixed
```

upper means that the defining identifier should be upper-case. *lower* means that the defining identifier should be lower-case *mixed* means that the first defining identifier letter and the first letter after each underscore should be upper-case, and all the other letters should be lower-case

If a defining identifier is from a declaration for which a specific casing scheme can be set, but the corresponding parameter is not specified for the rule, then the casing scheme defined by `Others` parameter is used to check this identifier. If `Others` parameter also is not set, the identifier is not checked.

dictionary_file is the name of the text file that contains casing exceptions. The way how this rule is using the casing exception dictionary file is consistent with using the casing exception dictionary in the GNAT pretty-printer *gnatpp*, see GNAT User's Guide.

There are two kinds of exceptions:

identifier If a dictionary file contains an identifier, then each occurrence of that (defining) identifier in the checked source should use the casing specified included in *dictionary_file*

wildcard A wildcard has the following syntax

```
wildcard ::= *simple_identifier* |
              *simple_identifier |
              simple_identifier*
simple_identifier ::= letter{letter_or_digit}
```

`simple_identifier` specifies the casing of subwords (the term 'subword' is used below to denote the part of a name which is delimited by '_' or by the beginning or end of the word and which does not contain any '_' inside). A wildcard of the form `simple_identifier*` defines the casing of the first subword of a defining name to check, the wildcard of the form `*simple_identifier` specifies the casing of the last subword, and the wildcard of the form `*simple_identifier*` specifies the casing of any subword.

If for a defining identifier some of its subwords can be mapped onto wildcards, but some other cannot, the casing of the identifier subwords that are not mapped onto wildcards from casing exception dictionary is checked against the casing scheme defined for the corresponding entity.

If some identifier is included in the exception dictionary both as a whole identifier and can be mapped onto some wildcard from the dictionary, then it is the identifier and not the wildcard that is used to check the identifier casing.

If more than one dictionary file is specified, or a dictionary file contains more than one exception variant for the same identifier, the new casing exception overrides the previous one.

Casing check against dictionary file(s) has a higher priority than checks against the casing scheme specified for a given entity/declaration kind.

+R option should contain at least one parameter.

There is no parameter for `-R` option, it just turns the rule off.

The rule allows parametric exemption, the parameters that are allowed in the definition of exemption sections are:

Type Exempts check for type and subtype name casing

Enum Exempts check for enumeration literal name casing

Constant Exempts check for constant name casing

Exception Exempts check for exception name casing

Others Exempts check for defining names for which no special casing scheme is specified.

Exclude Exempts check for defining names for which casing schemes are specified in exception dictionaries

Identifier_Prefixes

Flag each defining identifier that does not have a prefix corresponding to the kind of declaration it is defined by. The defining names in the following kinds of declarations are checked:

- type and subtype declarations (task, protected and access types are treated separately);

- enumeration literal specifications (not including character literals) and function renaming declarations if the renaming entity is an enumeration literal;

- exception declarations and exception renaming declarations;

- constant and number declarations (including object renaming declarations if the renamed object is a constant).

Defining names declared by single task declarations or single protected declarations are not checked by this rule.

The defining name from the full type declaration corresponding to a private type declaration or a private extension declaration is never flagged. A defining name from an incomplete type declaration is never flagged.

The defining name from a subprogram renaming-as-body declaration is never flagged.

For a deferred constant, the defining name in the corresponding full constant declaration is never flagged.

The defining name from a body that is a completion of a program unit declaration or a proper body of a subunit is never flagged.

The defining name from a body stub that is a completion of a program unit declaration is never flagged.

Note that the rule checks only defining names. Usage name occurrence are not checked and are never flagged.

The rule may have the following parameters:

- For the +R option:

- Type=*string*

    Specifies the prefix for a type or subtype name.

- Concurrent=*string*

    Specifies the prefix for a task and protected type/subtype name. If this parameter is set, it overrides for task and protected types the prefix set by the Type parameter.

- Access=*string*

    Specifies the prefix for an access type/subtype name. If this parameter is set, it overrides for access types the prefix set by the `Type` parameter.

- Class_Access=*string*

Specifies the prefix for the name of an access type/subtype that points to some class-wide type. If this parameter is set, it overrides for such access types and subtypes the prefix set by the `Type` or `Access` parameter.

- Subprogram_Access=*string*

    Specifies the prefix for the name of an access type/subtype that points to a subprogram. If this parameter is set, it overrides for such access types/subtypes the prefix set by the `Type` or `Access` parameter.

- Derived=*string1:string2*

    Specifies the prefix for a type that is directly derived from a given type or from a subtype thereof. *string1* should be a full expanded Ada name of the ancestor type (starting from the full expanded compilation unit name), *string2* defines the prefix to check. If this parameter is set, it overrides for types that are directly derived from the given type the prefix set by the `Type` parameter.

- Constant=*string*

    Specifies the prefix for defining names from constants and named number declarations, including the object renaming declaration if the renamed object is a constant

- Enum=*string*

    Specifies the prefix for defining enumeration literals and for the defining names in a function renaming declarations if the renamed entity is an enumeration literal.

- Exception=*string*

    Specifies the prefix for defining names from exception declarations and exception renaming declarations.

Exclusive

Check that only those kinds of names for which specific prefix is defined have that prefix (e.g., only type/subtype names have prefix *T_*, but not variable or package names), and flag all defining names that have any of the specified prefixes but do not belong to the kind of entities this prefix is defined for. By default the exclusive check mode is ON.

For the `-R` option:

All_Prefixes Removes all the prefixes specified for the identifier prefix checks, whether by default or as specified by other rule parameters and disables the rule.

Type Removes the prefix specified for type/subtype names. This does not remove prefixes specified for specific type kinds and does not disable checks for these specific kinds.

Concurrent Removes the prefix specified for task and protected types.

Access Removes the prefix specified for access types. This does not remove prefixes specified for specific access types (access to subprograms and class-wide access)

Class_Access Removes the prefix specified for access types pointing to class-wide types.

Subprogram_Access Removes the prefix specified for access types pointing to subprograms.

Derived Removes prefixes specified for derived types that are directly derived from specific types.

Constant Removes the prefix specified for constant and number names and turns off the check for these names.

Exception Removes the prefix specified for exception names and turns off the check for exception names.

Enum Removes the prefix specified for enumeration literal names and turns off the check for them.

Exclusive Turns of the check that only names of specific kinds of entities have prefixes specified for these kinds.

If more than one parameter is used, parameters must be separated by commas.

If more than one option is specified for the gnatcheck invocation, a new option overrides the previous one(s).

The `+RIdentifier_Prefixes` option (with no parameter) enables checks for all the name prefixes specified by previous options used for this rule. If no prefix is specified, the rule is not enabled.

The `-RIdentifier_Prefixes` option (with no parameter) disables all the checks but keeps all the prefixes specified by previous options used for this rule.

There is no default prefix setting for this rule. All checks for name prefixes are case-sensitive

If any error is detected in a rule parameter, that parameter is ignored. In such a case the options that are set for the rule are not specified.

The rule allows parametric exemption, the parameters that are allowed in the definition of exemption sections are:

Type Exempts check for type and subtype name prefixes

Concurrent Exempts check for task and protected type/subtype name prefixes

Access Exempts check for access type/subtype name prefixes

Class_Access Exempts check for names of access types/subtypes that point to some class-wide types

Subprogram_Access Exempts check for names of access types/subtypes that point to subprograms

Derived Exempts check for derived type name prefixes

Constant Exempts check for constant and number name prefixes

Exception Exempts check for exception name prefixes

Enum Exempts check for enumeration literal name prefixes

Exclusive Exempts check that only names of specific kinds of entities have prefixes specified for these kinds

Identifier_Suffixes

Flag the declaration of each identifier that does not have a suffix corresponding to the kind of entity being declared. The following declarations are checked:

- type declarations

- subtype declarations

- constant declarations (but not number declarations)

- package renaming declarations (but not generic package renaming declarations)

The default checks (enforced by the *Default* rule parameter) are:

- type-defining names end with _T, unless the type is an access type, in which case the suffix must be _A

- constant names end with _C

- names defining package renamings end with _R

Defining identifiers from incomplete type declarations are never flagged.

For a private type declaration (including private extensions), the defining identifier from the private type declaration is checked against the type suffix (even if the corresponding full declaration is an access type declaration), and the defining identifier from the corresponding full type declaration is not checked.

For a deferred constant, the defining name in the corresponding full constant declaration is not checked.

Defining names of formal types are not checked.

The rule may have the following parameters:

- For the +R option: unless the parameter is `Default`, then only the explicitly specified suffix is checked, and no defaults are used.

Default Sets the default listed above for all the names to be checked.

- Type_Suffix=*string*

    Specifies the suffix for a type name.

- Access_Suffix=*string*

    Specifies the suffix for an access type name. If this parameter is set, it overrides for access types the suffix set by the `Type_Suffix` parameter. For access types, *string* may have the following format: *suffix1(suffix2)*. That means that an access type name should have the *suffix1* suffix except for the case when the designated type is also an access type, in this case the type name should have the *suffix1 & suffix2* suffix.

- Class_Access_Suffix=*string*

    Specifies the suffix for the name of an access type that points to some class-wide type. If this parameter is set, it overrides for such access types the suffix set by the `Type_Suffix` or `Access_Suffix` parameter.

- Class_Subtype_Suffix=*string*

    Specifies the suffix for the name of a subtype that denotes a class-wide type.

- Constant_Suffix=*string*

    Specifies the suffix for a constant name.

- Renaming_Suffix=*string*

    Specifies the suffix for a package renaming name.

- For the −R option:

All_Suffixes Remove all the suffixes specified for the identifier suffix checks, whether by default or as specified by other rule parameters. All the checks for this rule are disabled as a result.

Type_Suffix Removes the suffix specified for types. This disables checks for types but does not disable any other checks for this rule (including the check for access type names if `Access_Suffix` is set).

Access_Suffix Removes the suffix specified for access types. This disables checks for access type names but does not disable any other checks for this rule. If `Type_Suffix` is set, access type names are checked as ordinary type names.

Class_Access_Suffix Removes the suffix specified for access types pointing to class-wide type. This disables specific checks for names of access types pointing to class-wide types but does not disable any other checks for this rule. If `Type_Suffix` is set, access type names are checked as ordinary type names. If `Access_Suffix` is set, these access types are checked as any other access type name.

- Class_Subtype_Suffix=*string*

    Removes the suffix specified for subtype names. This disables checks for subtype names but does not disable any other checks for this rule.

Constant_Suffix Removes the suffix specified for constants. This disables checks for constant names but does not disable any other checks for this rule.

Renaming_Suffix Removes the suffix specified for package renamings. This disables checks for package renamings but does not disable any other checks for this rule.

If more than one parameter is used, parameters must be separated by commas.

If more than one option is specified for the *gnatcheck* invocation, a new option overrides the previous one(s).

The `+RIdentifier_Suffixes` option (with no parameter) enables checks for all the name suffixes specified by previous options used for this rule.

The `-RIdentifier_Suffixes` option (with no parameter) disables all the checks but keeps all the suffixes specified by previous options used for this rule.

The *string* value must be a valid suffix for an Ada identifier (after trimming all the leading and trailing space characters, if any). Parameters are not case sensitive, except the *string* part.

If any error is detected in a rule parameter, the parameter is ignored. In such a case the options that are set for the rule are not specified.

Misnamed_Controlling_Parameters

Flag a declaration of a dispatching operation, if the first parameter is not a controlling one and its name is not `This` (the check for parameter name is not case-sensitive). Declarations of dispatching functions with a controlling result and no controlling parameter are never flagged.

A subprogram body declaration, subprogram renaming declaration, or subprogram body stub is flagged only if it is not a completion of a prior subprogram declaration.

This rule has no parameters.

Name_Clashes

Check that certain names are not used as defining identifiers. The names that should not be used as identifiers must be listed in a dictionary file that is a rule parameter. A defining identifier is flagged if it is included in a dictionary file specified as a rule parameter, the check is not case-sensitive. More than one dictionary file can be specified as the rule parameter, in this case the rule checks defining identifiers against the union of all the identifiers from all the dictionary files provided as the rule parameters.

This rule has the following (mandatory) parameters for the `+R` option:

dictionary_file The name of a dictionary file.

This rule is enabled by default, but without setting any corresponding dictionary file(s); thus the default effect is to do no checks.

A dictionary file is a plain text file. The maximum line length for this file is 1024 characters. If the line is longer than this limit, extra characters are ignored.

Each line can be either an empty line, a comment line, or a line containing a list of identifiers separated by space or HT characters. A comment is an Ada-style comment (from `--` to end-of-line). Identifiers must follow the Ada syntax for identifiers. A line containing one or more identifiers may end with a comment.

Uncommented_BEGIN_In_Package_Bodies

Flags each package body with declarations and a statement part that does not include a trailing comment on the line containing the `begin` keyword; this trailing comment needs to specify the package name and nothing else. The `begin` is not flagged if the package body does not contain any declarations.

If the `begin` keyword is placed on the same line as the last declaration or the first statement, it is flagged independently of whether the line contains a trailing comment. The diagnostic message is attached to the line containing the first statement.

This rule has no parameters.

8.1.7 Source Code Presentation

This subsection is a placeholder; there are currently no rules in this category.

8.2 Feature Usage Rules

The rules in this section can be used to enforce specific usage patterns for a variety of language features.

8.2.1 `Abstract_Type_Declarations`

Flag all declarations of abstract types. For an abstract private type, both the private and full type declarations are flagged.

This rule has no parameters.

8.2.2 `Anonymous_Subtypes`

Flag all uses of anonymous subtypes (except cases when subtype indication is a part of a record component definition, and this subtype indication depends on a discriminant). A use of an anonymous subtype is any instance of a subtype indication with a constraint, other than one that occurs immediately within a subtype declaration. Any use of a range other than as a constraint used immediately within a subtype declaration is considered as an anonymous subtype.

The rule does not flag ranges in the component clauses from a record representation clause, because the language rules do not allow to use subtype names there.

An effect of this rule is that `for` loops such as the following are flagged (since `1..N` is formally a 'range'):

```
for I in 1 .. N loop
   ...
end loop;
```

Declaring an explicit subtype solves the problem:

```
subtype S is Integer range 1..N;
...
for I in S loop
   ...
end loop;
```

This rule has no parameters.

8.2.3 `Blocks`

Flag each block statement.

This rule has no parameters.

8.2.4 `Complex_Inlined_Subprograms`

Flag a subprogram (or generic subprogram, or instantiation of a subprogram) if pragma Inline is applied to it and at least one of the following conditions is met:

- it contains at least one complex declaration such as a subprogram body, package, task, protected declaration, or a generic instantiation (except instantiation of `Ada.Unchecked_Conversion`);

- it contains at least one complex statement such as a loop, a case or an if statement;

- the number of statements exceeds a value specified by the *N* rule parameter;

Subprogram renamings are also considered.

This rule has the following (mandatory) parameter for the +R option:

N Positive integer specifying the maximum allowed total number of statements in the subprogram body.

8.2.5 `Conditional_Expressions`

Flag use of conditional expression.

This rule has the following (optional) parameters for the +R option:

Except_Assertions Do not flag a conditional expression if it is a subcomponent of the following constructs:

argument of the following pragmas

Language-defined

- `Assert`

GNAT-specific

- `Assert_And_Cut`

- `Assume`

- `Contract_Cases`

- `Debug`

- `Invariant`

- `Loop_Invariant`

- `Loop_Variant`

- `Postcondition`

- `Precondition`

- `Predicate`

- `Refined_Post`

definition of the following aspects

Language-defined

- `Static_Predicate`

- `Dynamic_Predicate`

- `Pre`

- `Pre'Class`

- `Post`
- `Post'Class`
- `Type_Invariant`
- `Type_Invariant'Class`

GNAT-specific

- `Contract_Cases`
- `Invariant`
- `Invariant'Class`
- `Predicate`
- `Refined_Post`

8.2.6 `Controlled_Type_Declarations`

Flag all declarations of controlled types. A declaration of a private type is flagged if its full declaration declares a controlled type. A declaration of a derived type is flagged if its ancestor type is controlled. Subtype declarations are not checked. A declaration of a type that itself is not a descendant of a type declared in `Ada.Finalization` but has a controlled component is not checked.

This rule has no parameters.

8.2.7 `Declarations_In_Blocks`

Flag all block statements containing local declarations. A `declare` block with an empty *declarative_part* or with a *declarative part* containing only pragmas and/or `use` clauses is not flagged.

This rule has no parameters.

8.2.8 `Deeply_Nested_Inlining`

Flag a subprogram (or generic subprogram) if pragma Inline has been applied to it, and it calls another subprogram to which pragma Inline applies, resulting in potential nested inlining, with a nesting depth exceeding the value specified by the *N* rule parameter.

This rule requires the global analysis of all the compilation units that are *gnatcheck* arguments; such analysis may affect the tool's performance.

This rule has the following (mandatory) parameter for the +R option:

N Positive integer specifying the maximum level of nested calls to subprograms to which pragma Inline has been applied.

8.2.9 `Default_Parameters`

Flag all default expressions in parameters specifications. All parameter specifications are checked: in subprograms (including formal, generic and protected subprograms) and in task and protected entries (including accept statements and entry bodies).

This rule has no parameters.

8.2.10 `Discriminated_Records`

Flag all declarations of record types with discriminants. Only the declarations of record and record extension types are checked. Incomplete, formal, private, derived and private extension type declarations are not checked. Task and protected type declarations also are not checked.

This rule has no parameters.

8.2.11 `Explicit_Full_Discrete_Ranges`

Flag each discrete range that has the form `A'First .. A'Last`.

This rule has no parameters.

8.2.12 `Float_Equality_Checks`

Flag all calls to the predefined equality operations for floating-point types. Both '=' and '/=' operations are checked. User-defined equality operations are not flagged, nor are uses of operators that are renamings of the predefined equality operations. Also, the '=' and '/=' operations for fixed-point types are not flagged.

This rule has no parameters.

8.2.13 `Function_Style_Procedures`

Flag each procedure that can be rewritten as a function. A procedure can be converted into a function if it has exactly one parameter of mode `out` and no parameters of mode `in out`. Procedure declarations, formal procedure declarations, and generic procedure declarations are always checked. Procedure bodies and body stubs are flagged only if they do not have corresponding separate declarations. Procedure renamings and procedure instantiations are not flagged.

If a procedure can be rewritten as a function, but its `out` parameter is of a limited type, it is not flagged.

Protected procedures are not flagged. Null procedures also are not flagged.

This rule has no parameters.

8.2.14 `Generics_In_Subprograms`

Flag each declaration of a generic unit in a subprogram. Generic declarations in the bodies of generic subprograms are also flagged. A generic unit nested in another generic unit is not flagged. If a generic unit is declared in a local package that is declared in a subprogram body, the generic unit is flagged.

This rule has no parameters.

8.2.15 `Implicit_IN_Mode_Parameters`

Flag each occurrence of a formal parameter with an implicit `in` mode. Note that `access` parameters, although they technically behave like `in` parameters, are not flagged.

This rule has no parameters.

8.2.16 `Improperly_Located_Instantiations`

Flag all generic instantiations in library-level package specs (including library generic packages) and in all subprogram bodies.

Instantiations in task and entry bodies are not flagged. Instantiations in the bodies of protected subprograms are flagged.

This rule has no parameters.

8.2.17 `Library_Level_Subprograms`

Flag all library-level subprograms (including generic subprogram instantiations).

This rule has no parameters.

8.2.18 `Non_Qualified_Aggregates`

Flag each non-qualified aggregate. A non-qualified aggregate is an aggregate that is not the expression of a qualified expression. A string literal is not considered an aggregate, but an array aggregate of a string type is considered as a normal aggregate. Aggregates of anonymous array types are not flagged.

This rule has no parameters.

8.2.19 `Numeric_Literals`

Flag each use of a numeric literal in an index expression, and in any circumstance except for the following:

- a literal occurring in the initialization expression for a constant declaration or a named number declaration, or
- a literal occurring in an aspect definition or in an aspect clause, or
- an integer literal that is less than or equal to a value specified by the *N* rule parameter.
- a literal occurring in a declaration in case the *Statements_Only* rule parameter is given

This rule may have the following parameters for the +R option:

N N is an integer literal used as the maximal value that is not flagged (i.e., integer literals not exceeding this value are allowed)

ALL All integer literals are flagged

Statements_Only Numeric literals are flagged only when used in statements

If no parameters are set, the maximum unflagged value is 1, and the check for literals is not limited by statements only.

The last specified check limit (or the fact that there is no limit at all) is used when multiple +R options appear.

The −R option for this rule has no parameters. It disables the rule and restores its default operation mode. If the +R option subsequently appears, will be 1, and the check will not be limited by statements only.

8.2.20 `Parameters_Out_Of_Order`

Flag each subprogram and entry declaration whose formal parameters are not ordered according to the following scheme:

- `in` and `access` parameters first, then `in out` parameters, and then `out` parameters;

- for `in` mode, parameters with default initialization expressions occur last

Only the first violation of the described order is flagged.

The following constructs are checked:

- subprogram declarations (including null procedures);

- generic subprogram declarations;

- formal subprogram declarations;

- entry declarations;

- subprogram bodies and subprogram body stubs that do not have separate specifications

Subprogram renamings are not checked.

This rule has no parameters.

8.2.21 `Quantified_Expressions`

Flag use of quantified expression.

This rule has the following (optional) parameters for the `+R` option:

Except_Assertions Do not flag a conditional expression if it is a subcomponent of the following constructs:

argument of the following pragmas

Language-defined

- `Assert`

GNAT-specific

- `Assert_And_Cut`

- `Assume`

- `Contract_Cases`

- `Debug`

- `Invariant`

- `Loop_Invariant`

- `Loop_Variant`

- `Postcondition`

- `Precondition`

- `Predicate`

- `Refined_Post`

definition of the following aspects

Language-defined

- `Static_Predicate`

- `Dynamic_Predicate`

- `Pre`

- `Pre'Class`

- `Post`

- `Post'Class`

- `Type_Invariant`

- `Type_Invariant'Class`

GNAT-specific

- `Contract_Cases`

- `Invariant`

- `Invariant'Class`

- `Predicate`

- `Refined_Post`

8.2.22 `Raising_Predefined_Exceptions`

Flag each `raise` statement that raises a predefined exception (i.e., one of the exceptions `Constraint_Error`, `Numeric_Error`, `Program_Error`, `Storage_Error`, or `Tasking_Error`).

This rule has no parameters.

8.2.23 `Unassigned_OUT_Parameters`

Flag procedures' `out` parameters that are not assigned.

An `out` parameter is flagged if the *sequence of statements* of the procedure body (before the procedure body's exception part, if any) contains no assignment to the parameter.

An `out` parameter is flagged in an *exception handler* in the exception part of the procedure body, if the *exception handler* contains neither an assignment to the parameter nor a raise statement.

Bodies of generic procedures are also considered.

The following are treated as assignments to an `out` parameter:

- an assignment statement, with the parameter or some component as the target

- passing the parameter (or one of its components) as an `out` or `in out` parameter, except for the case when it is passed to the call of an attribute subprogram.

This rule has no parameters.

> **Warning:** This rule only detects a trivial case of an unassigned variable and doesn't provide a guarantee that there is no uninitialized access. It is not a replacement for rigorous check for uninitialized access provided by advanced static analysis tools.

8.2.24 `Unconstrained_Array_Returns`

Flag each function returning an unconstrained array. Function declarations, function bodies (and body stubs) having no separate specifications, and generic function instantiations are flagged. Function calls and function renamings are not flagged.

Generic function declarations, and function declarations in generic packages, are not flagged. Instead, this rule flags the results of generic instantiations (that is, expanded specification and expanded body corresponding to an instantiation).

This rule has the following (optional) parameters for the `+R` option:

Except_String Do not flag functions that return the predefined `String` type or a type derived from it, directly or indirectly.

8.3 Metrics-Related Rules

The rules in this section can be used to enforce compliance with specific code metrics, by checking that the metrics computed for a program lie within user-specifiable bounds. Depending on the metric, there may be a lower bound, an upper bound, or both. A construct is flagged if the value of the metric exceeds the upper bound or is less than the lower bound.

The name of any metrics rule consists of the prefix `Metrics_` followed by the name of the corresponding metric: `Essential_Complexity`, `Cyclomatic_Complexity`, or `LSLOC`. (The 'LSLOC' acronym stands for 'Logical Source Lines Of Code'.) The meaning and the computed values of the metrics are the same as in *gnatmetric*.

For the `+R` option, each metrics rule has a numeric parameter specifying the bound (integer or real, depending on a metric). The `-R` option for the metrics rules does not have a parameter.

Example: the rule

```
+RMetrics_Cyclomatic_Complexity : 7
```

means that all bodies with cyclomatic complexity exceeding 7 will be flagged.

To turn OFF the check for cyclomatic complexity metric, use the following option:

```
-RMetrics_Cyclomatic_Complexity
```

8.3.1 `Metrics_Essential_Complexity`

The `Metrics_Essential_Complexity` rule takes a positive integer as upper bound. A program unit that is an executable body exceeding this limit will be flagged.

The Ada essential complexity metric is a McCabe cyclomatic complexity metric counted for the code that is reduced by excluding all the pure structural Ada control statements.

8.3.2 `Metrics_Cyclomatic_Complexity`

The `Metrics_Cyclomatic_Complexity` rule takes a positive integer as upper bound. A program unit that is an executable body exceeding this limit will be flagged.

The McCabe cyclomatic complexity metric is defined in http://www.mccabe.com/pdf/mccabe-nist235r.pdf The goal of cyclomatic complexity metric is to estimate the number of independent paths in the control flow graph that in turn gives the number of tests needed to satisfy paths coverage testing completeness criterion.

8.3.3 `Metrics_LSLOC`

The `Metrics_LSLOC` rule takes a positive integer as upper bound. A program unit declaration or a program unit body exceeding this limit will be flagged.

The metric counts the total number of declarations and the total number of statements.

8.4 SPARK Ada Rules

The rules in this section can be used to enforce compliance with the Ada subset allowed by the SPARK tools.

8.4.1 `Annotated_Comments`

Flags comments that are used as annotations or as special sentinels/markers. Such comments have the following structure

```
--<special_character> <comment_marker>
```

where

<special_character> character (such as '#', '$', '|' etc.) indicating that the comment is used for a specific purpose

<comment_marker> a word identifying the annotation or special usage (word here is any sequence of characters except white space)

There may be any amount of white space (including none at all) between `<special_character>` and `<comment_marker>`, but no white space is permitted between `'--'` and `<special_character>`. (A white space here is either a space character or horizontal tabulation)

`<comment_marker>` must not contain any white space.

`<comment_marker>` may be empty, in which case the rule flags each comment that starts with `--<special_character>` and that does not contain any other character except white space

The rule has the following (mandatory) parameter for the +R option:

S String with the following interpretation: the first character is the special comment character, and the rest is the comment marker. S must not contain white space.

The `-R` option erases all definitions of special comment annotations specified by the previous +R options.

The rule is case-sensitive.

Example:

The rule

```
+RAnnotated_Comments:#hide
```

will flag the following comment lines

```
--#hide
--# hide
--#           hide

   I := I + 1; --# hide
```

But the line

```
-- # hide
```

will not be flagged, because of the space between '–' and '#'.

The line

```
--#Hide
```

will not be flagged, because the string parameter is case sensitive.

8.4.2 `Boolean_Relational_Operators`

Flag each call to a predefined relational operator ('<', '>', '<=', '>=', '=' and '/=') for the predefined Boolean type. (This rule is useful in enforcing the SPARK language restrictions.)

Calls to predefined relational operators of any type derived from `Standard.Boolean` are not detected. Calls to user-defined functions with these designators, and uses of operators that are renamings of the predefined relational operators for `Standard.Boolean`, are likewise not detected.

This rule has no parameters.

8.4.3 `Expanded_Loop_Exit_Names`

Flag all expanded loop names in `exit` statements.

This rule has no parameters.

8.4.4 `Non_SPARK_Attributes`

The SPARK language defines the following subset of Ada 95 attribute designators as those that can be used in SPARK programs. The use of any other attribute is flagged.

- `'Adjacent`
- `'Aft`
- `'Base`
- `'Ceiling`
- `'Component_Size`
- `'Compose`
- `'Copy_Sign`
- `'Delta`
- `'Denorm`
- `'Digits`
- `'Exponent`
- `'First`
- `'Floor`
- `'Fore`
- `'Fraction`
- `'Last`
- `'Leading_Part`
- `'Length`

- `'Machine`

- `'Machine_Emax`

- `'Machine_Emin`

- `'Machine_Mantissa`

- `'Machine_Overflows`

- `'Machine_Radix`

- `'Machine_Rounds`

- `'Max`

- `'Min`

- `'Model`

- `'Model_Emin`

- `'Model_Epsilon`

- `'Model_Mantissa`

- `'Model_Small`

- `'Modulus`

- `'Pos`

- `'Pred`

- `'Range`

- `'Remainder`

- `'Rounding`

- `'Safe_First`

- `'Safe_Last`

- `'Scaling`

- `'Signed_Zeros`

- `'Size`

- `'Small`

- `'Succ`

- `'Truncation`

- `'Unbiased_Rounding`

- `'Val`

- `'Valid`

This rule has no parameters.

8.4.5 `Non_Tagged_Derived_Types`

Flag all derived type declarations that do not have a record extension part.

This rule has no parameters.

8.4.6 `Outer_Loop_Exits`

Flag each `exit` statement containing a loop name that is not the name of the immediately enclosing `loop` statement.

This rule has no parameters.

8.4.7 `Overloaded_Operators`

Flag each function declaration that overloads an operator symbol. A function body is checked only if the body does not have a separate spec. Formal functions are also checked. For a renaming declaration, only renaming-as-declaration is checked

This rule has no parameters.

8.4.8 `Slices`

Flag all uses of array slicing

This rule has no parameters.

8.4.9 `Universal_Ranges`

Flag discrete ranges that are a part of an index constraint, constrained array definition, or `for`-loop parameter specification, and whose bounds are both of type *universal_integer*. Ranges that have at least one bound of a specific type (such as `1 .. N`, where `N` is a variable or an expression of non-universal type) are not flagged.

This rule has no parameters.

CHAPTER

NINE

EXAMPLE OF *GNATCHECK* USAGE

Here is a simple example. Suppose that in the current directory we have a project file named `gnatcheck_example.gpr` with the following content:

```
project Gnatcheck_Example is

   for Source_Dirs use ("src");
   for Object_Dir use "obj";
   for Main use ("main.adb");

   package Check is
      for Default_Switches ("ada") use ("-rules", "-from=coding_standard");
   end Check;

end Gnatcheck_Example;
```

And the file named `coding_standard` is also located in the current directory and has the following content:

```
---------------------------------------------------
-- This is a sample gnatcheck coding standard file --
---------------------------------------------------

--  First, turning on rules, that are directly implemented in gnatcheck
+RAbstract_Type_Declarations
+RAnonymous_Arrays
+RLocal_Packages
+RFloat_Equality_Checks
+REXIT_Statements_With_No_Loop_Name

--  Then, activating compiler checks of interest:
+RStyle_Checks:e
--  This style check checks if a unit name is present on END keyword that
--  is the end of the unit declaration
```

And the subdirectory `src` contains the following Ada sources:

`pack.ads`:

```
package Pack is
   type T is abstract tagged private;
   procedure P (X : T) is abstract;

   package Inner is
      type My_Float is digits 8;
```

```
      function Is_Equal (L, R : My_Float) return Boolean;
   end Inner;
private
   type T is abstract tagged null record;
end;
```

`pack.adb`:

```
package body Pack is
   package body Inner is
      function Is_Equal (L, R : My_Float) return Boolean is
      begin
         return L = R;
      end;
   end Inner;
end Pack;
```

and `main.adb`

```
with Pack; use Pack;
procedure Main is

   pragma Annotate
     (gnatcheck, Exempt_On, "Anonymous_Arrays", "this one is fine");
   Float_Array : array (1 .. 10) of Inner.My_Float;
   pragma Annotate (gnatcheck, Exempt_Off, "Anonymous_Arrays");

   Another_Float_Array : array (1 .. 10) of Inner.My_Float;

   use Inner;

   B : Boolean := False;

begin
   for J in Float_Array'Range loop
      if Is_Equal (Float_Array (J), Another_Float_Array (J)) then
         B := True;
         exit;
      end if;
   end loop;
end Main;
```

And suppose we call *gnatcheck* from the current directory using the project file as the only parameter of the call:

```
gnatcheck -Pgnatcheck_example.gpr
```

As a result, *gnatcheck* is called to check all the files from the project `gnatcheck_example.gpr` using the coding standard defined by the file `coding_standard`. The *gnatcheck* report file named `gnatcheck.out` will be created in the `obj` directory, and it will have the following content:

```
RULE CHECKING REPORT

1. OVERVIEW

Date and time of execution: 2009.10.28 14:17
```

```
Tool version: GNATCHECK (built with ASIS 2.0.R for GNAT Pro 6.3.0w (20091016))
Command line:

gnatcheck -files=... -cargs -gnatec=... -rules -from=coding_standard

Coding standard (applied rules):
   Abstract_Type_Declarations
   Anonymous_Arrays
   EXIT_Statements_With_No_Loop_Name
   Float_Equality_Checks
   Local_Packages

   Compiler style checks: -gnatye

Number of coding standard violations: 6
Number of exempted coding standard violations: 1

2. DETECTED RULE VIOLATIONS

2.1. NON-EXEMPTED VIOLATIONS

Source files with non-exempted violations
   pack.ads
   pack.adb
   main.adb

List of violations grouped by files, and ordered by increasing source location:

pack.ads:2:4: declaration of abstract type
pack.ads:5:4: declaration of local package
pack.ads:10:30: declaration of abstract type
pack.ads:11:1: (style) "end Pack" required
pack.adb:5:19: use of equality operation for float values
pack.adb:6:7: (style) "end Is_Equal" required
main.adb:9:26: anonymous array type
main.adb:19:10: exit statement with no loop name

2.2. EXEMPTED VIOLATIONS

Source files with exempted violations
   main.adb

List of violations grouped by files, and ordered by increasing source location:

main.adb:6:18: anonymous array type
   (this one is fine)

2.3. SOURCE FILES WITH NO VIOLATION

   No files without violations

END OF REPORT
```

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CHAPTER

TEN

LIST OF RULES

This section contains an alphabetized list of all the predefined GNATcheck rules.

- *Abstract_Type_Declarations*
- *Anonymous_Arrays*
- *Anonymous_Subtypes*
- *Blocks*
- *Boolean_Relational_Operators*
- *Complex_Inlined_Subprograms*
- *Conditional_Expressions*
- *Controlled_Type_Declarations*
- *Declarations_In_Blocks*
- *Deep_Inheritance_Hierarchies*
- *Deeply_Nested_Generics*
- *Deeply_Nested_Inlining*
- *Default_Parameters*
- *Direct_Calls_To_Primitives*
- *Discriminated_Records*
- *Enumeration_Ranges_In_CASE_Statements*
- *Exceptions_As_Control_Flow*
- *Exits_From_Conditional_Loops*
- *EXIT_Statements_With_No_Loop_Name*
- *Expanded_Loop_Exit_Names*
- *Explicit_Full_Discrete_Ranges*
- *Float_Equality_Checks*
- *Forbidden_Attributes*
- *Forbidden_Pragmas*
- *Function_Style_Procedures*
- *Generics_In_Subprograms*

- *GOTO_Statements*

- *Implicit_IN_Mode_Parameters*

- *Implicit_SMALL_For_Fixed_Point_Types*

- *Improperly_Located_Instantiations*

- *Improper_Returns*

- *Maximum_Parameters*

- *Library_Level_Subprograms*

- *Local_Packages*

- *Metrics_Cyclomatic_Complexity*

- *Metrics_Essential_Complexity*

- *Metrics_LSLOC*

- *Misnamed_Controlling_Parameters*

- *Identifier_Suffixes*

- *Multiple_Entries_In_Protected_Definitions*

- *Name_Clashes*

- *Non_Qualified_Aggregates*

- *Non_Short_Circuit_Operators*

- *Non_SPARK_Attributes*

- *Non_Tagged_Derived_Types*

- *Non_Visible_Exceptions*

- *Numeric_Literals*

- *OTHERS_In_Aggregates*

- *OTHERS_In_CASE_Statements*

- *OTHERS_In_Exception_Handlers*

- *Outer_Loop_Exits*

- *Overloaded_Operators*

- *Overly_Nested_Control_Structures*

- *Parameters_Out_Of_Order*

- *Positional_Actuals_For_Defaulted_Generic_Parameters*

- *Positional_Actuals_For_Defaulted_Parameters*

- *Positional_Components*

- *Positional_Generic_Parameters*

- *Positional_Parameters*

- *Predefined_Numeric_Types*

- *Quantified_Expressions*

- *Raising_External_Exceptions*

- *Raising_Predefined_Exceptions*

- *Separate_Numeric_Error_Handlers*

- *Slices*

- *Too_Many_Parents*

- *Unassigned_OUT_Parameters*

- *Uncommented_BEGIN_In_Package_Bodies*

- *Recursive_Subprograms*

- *Unconditional_Exits*

- *Unconstrained_Array_Returns*

- *Universal_Ranges*

- *Unnamed_Blocks_And_Loops*

- *USE_PACKAGE_Clauses*

- *Visible_Components*

- *Volatile_Objects_Without_Address_Clauses*

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APPENDIX

A

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