

gds

Generated by Doxygen 1.8.1.2

Tue Nov 11 2014 19:21:37



# Contents

|          |  |           |
|----------|--|-----------|
| <b>1</b> | <b>Generic Data Structures Library</b>                             | <b>1</b>  |
| <b>2</b> | <b>Todo List</b>   | <b>3</b>  |
| <b>3</b> | <b>Module Index</b>  | <b>5</b>  |
| 3.1      | Modules . . . . .  | 5         |
| <b>4</b> | <b>Data Structure Index</b>  | <b>7</b>  |
| 4.1      | Data Structures . . . . .  | 7         |
| <b>5</b> | <b>File Index</b>  | <b>9</b>  |
| 5.1      | File List . . . . .  | 9         |
| <b>6</b> | <b>Module Documentation</b>  | <b>11</b> |
| 6.1      | Private functionality for manipulating generic datatypes . . . . . | 11        |
| 6.1.1    | Detailed Description . . . . .                                     | 12        |
| 6.1.2    | Typedef Documentation . . . . .                                    | 12        |
| 6.1.2.1  | gds_cfunc . . . . .  | 12        |
| 6.1.3    | Enumeration Type Documentation . . . . .                           | 12        |
| 6.1.3.1  | gds_datatype . . . . .   | 12        |
| 6.1.4    | Function Documentation . . . . .                                   | 12        |
| 6.1.4.1  | gdt_compare . . . . .  | 12        |
| 6.1.4.2  | gdt_compare_void . . . . .   | 13        |
| 6.1.4.3  | gdt_free . . . . .   | 13        |
| 6.1.4.4  | gdt_get_value . . . . .  | 13        |
| 6.1.4.5  | gdt_reverse_compare_void . . . . .                                 | 13        |
| 6.1.4.6  | gdt_set_value . . . . .  | 14        |
| 6.2      | Public general generic data structures functionality . . . . .     | 15        |
| 6.2.1    | Detailed Description . . . . .                                     | 15        |
| 6.2.2    | Enumeration Type Documentation . . . . .                           | 15        |
| 6.2.2.1  | gds_option . . . . .   | 15        |
| 6.2.3    | Function Documentation . . . . .                                   | 15        |
| 6.2.3.1  | gds_assert_quit . . . . .  | 15        |

|          |  |    |
|----------|--|----|
| 6.2.3.2  | <code>gds_error_quit</code>                      | 16 |
| 6.2.3.3  | <code>gds_strdup</code>                          | 16 |
| 6.2.3.4  | <code>gds_strerror_quit</code>                   | 16 |
| 6.3      | Public interface to generic list data structure  | 17 |
| 6.3.1    | Detailed Description                             | 18 |
| 6.3.2    | Typedef Documentation                            | 18 |
| 6.3.2.1  | <code>List</code>                                | 18 |
| 6.3.2.2  | <code>ListItr</code>                             | 18 |
| 6.3.3    | Function Documentation                           | 18 |
| 6.3.3.1  | <code>list_append</code>                         | 18 |
| 6.3.3.2  | <code>list_create</code>                         | 18 |
| 6.3.3.3  | <code>list_delete_back</code>                    | 19 |
| 6.3.3.4  | <code>list_delete_front</code>                   | 19 |
| 6.3.3.5  | <code>list_delete_index</code>                   | 19 |
| 6.3.3.6  | <code>list_destroy</code>                        | 19 |
| 6.3.3.7  | <code>list_element_at_index</code>               | 19 |
| 6.3.3.8  | <code>list_find</code>                           | 20 |
| 6.3.3.9  | <code>list_find_itr</code>                       | 20 |
| 6.3.3.10 | <code>list_get_value_itr</code>                  | 20 |
| 6.3.3.11 | <code>list_insert</code>                         | 21 |
| 6.3.3.12 | <code>list_is_empty</code>                       | 21 |
| 6.3.3.13 | <code>list_itr_first</code>                      | 21 |
| 6.3.3.14 | <code>list_itr_last</code>                       | 21 |
| 6.3.3.15 | <code>list_itr_next</code>                       | 22 |
| 6.3.3.16 | <code>list_itr_previous</code>                   | 22 |
| 6.3.3.17 | <code>list_length</code>                         | 22 |
| 6.3.3.18 | <code>list_prepend</code>                        | 22 |
| 6.3.3.19 | <code>list_reverse_sort</code>                   | 23 |
| 6.3.3.20 | <code>list_set_element_at_index</code>           | 23 |
| 6.3.3.21 | <code>list_sort</code>                           | 23 |
| 6.4      | Public interface to generic queue data structure | 24 |
| 6.4.1    | Detailed Description                             | 24 |
| 6.4.2    | Typedef Documentation                            | 24 |
| 6.4.2.1  | <code>Queue</code>                               | 24 |
| 6.4.3    | Function Documentation                           | 24 |
| 6.4.3.1  | <code>queue_capacity</code>                      | 24 |
| 6.4.3.2  | <code>queue_create</code>                        | 25 |
| 6.4.3.3  | <code>queue_destroy</code>                       | 25 |
| 6.4.3.4  | <code>queue_free_space</code>                    | 25 |
| 6.4.3.5  | <code>queue_is_empty</code>                      | 25 |

|          |  |    |
|----------|--|----|
| 6.4.3.6  | <a href="#">queue_is_full</a>                                      | 26 |
| 6.4.3.7  | <a href="#">queue_peek</a>   | 26 |
| 6.4.3.8  | <a href="#">queue_pop</a>  | 26 |
| 6.4.3.9  | <a href="#">queue_push</a>   | 27 |
| 6.4.3.10 | <a href="#">queue_size</a>   | 27 |
| 6.5      | <a href="#">Public interface to generic stack data structure</a>   | 28 |
| 6.5.1    | <a href="#">Detailed Description</a>                               | 28 |
| 6.5.2    | <a href="#">Typedef Documentation</a>                              | 28 |
| 6.5.2.1  | <a href="#">Stack</a>  | 28 |
| 6.5.3    | <a href="#">Function Documentation</a>                             | 28 |
| 6.5.3.1  | <a href="#">stack_capacity</a>                                     | 28 |
| 6.5.3.2  | <a href="#">stack_create</a>                                       | 29 |
| 6.5.3.3  | <a href="#">stack_destroy</a>                                      | 29 |
| 6.5.3.4  | <a href="#">stack_free_space</a>                                   | 29 |
| 6.5.3.5  | <a href="#">stack_is_empty</a>                                     | 29 |
| 6.5.3.6  | <a href="#">stack_is_full</a>                                      | 30 |
| 6.5.3.7  | <a href="#">stack_peek</a>   | 30 |
| 6.5.3.8  | <a href="#">stack_pop</a>  | 30 |
| 6.5.3.9  | <a href="#">stack_push</a>   | 31 |
| 6.5.3.10 | <a href="#">stack_size</a>   | 31 |
| 6.6      | <a href="#">General purpose string manipulation functions</a>      | 32 |
| 6.6.1    | <a href="#">Detailed Description</a>                               | 32 |
| 6.6.2    | <a href="#">Function Documentation</a>                             | 32 |
| 6.6.2.1  | <a href="#">pair_string_create</a>                                 | 32 |
| 6.6.2.2  | <a href="#">pair_string_destroy</a>                                | 32 |
| 6.6.2.3  | <a href="#">pg_strdup</a>  | 33 |
| 6.6.2.4  | <a href="#">pg_strndup</a>   | 33 |
| 6.6.2.5  | <a href="#">trim</a>   | 33 |
| 6.6.2.6  | <a href="#">trim_left</a>  | 33 |
| 6.6.2.7  | <a href="#">trim_line_ending</a>                                   | 34 |
| 6.6.2.8  | <a href="#">trim_right</a>   | 34 |
| 6.7      | <a href="#">Public interface to generic vector data structure.</a> | 35 |
| 6.7.1    | <a href="#">Detailed Description</a>                               | 35 |
| 6.7.2    | <a href="#">Typedef Documentation</a>                              | 36 |
| 6.7.2.1  | <a href="#">Vector</a>   | 36 |
| 6.7.3    | <a href="#">Function Documentation</a>                             | 36 |
| 6.7.3.1  | <a href="#">vector_append</a>                                      | 36 |
| 6.7.3.2  | <a href="#">vector_capacity</a>                                    | 36 |
| 6.7.3.3  | <a href="#">vector_create</a>                                      | 36 |
| 6.7.3.4  | <a href="#">vector_delete_back</a>                                 | 37 |

|          |   |           |
|----------|---|-----------|
| 6.7.3.5  | <a href="#">vector_delete_front</a>                   | 37        |
| 6.7.3.6  | <a href="#">vector_delete_index</a>                   | 37        |
| 6.7.3.7  | <a href="#">vector_destroy</a>                        | 37        |
| 6.7.3.8  | <a href="#">vector_element_at_index</a>               | 38        |
| 6.7.3.9  | <a href="#">vector_find</a>                           | 38        |
| 6.7.3.10 | <a href="#">vector_free_space</a>                     | 38        |
| 6.7.3.11 | <a href="#">vector_insert</a>                         | 39        |
| 6.7.3.12 | <a href="#">vector_is_empty</a>                       | 39        |
| 6.7.3.13 | <a href="#">vector_length</a>                         | 39        |
| 6.7.3.14 | <a href="#">vector_prepend</a>                        | 39        |
| 6.7.3.15 | <a href="#">vector_reverse_sort</a>                   | 40        |
| 6.7.3.16 | <a href="#">vector_set_element_at_index</a>           | 40        |
| 6.7.3.17 | <a href="#">vector_sort</a>                           | 40        |
| <b>7</b> | <b>Data Structure Documentation</b>                   | <b>41</b> |
| 7.1      | <a href="#">dict Struct Reference</a>                 | 41        |
| 7.1.1    | <a href="#">Detailed Description</a>                  | 42        |
| 7.1.2    | <a href="#">Field Documentation</a>                   | 42        |
| 7.1.2.1  | <a href="#">buckets</a>                               | 42        |
| 7.1.2.2  | <a href="#">exit_on_error</a>                         | 42        |
| 7.1.2.3  | <a href="#">free_on_destroy</a>                       | 42        |
| 7.1.2.4  | <a href="#">num_buckets</a>                           | 42        |
| 7.1.2.5  | <a href="#">type</a>                                  | 42        |
| 7.2      | <a href="#">gdt_generic_datatype Struct Reference</a> | 42        |
| 7.2.1    | <a href="#">Detailed Description</a>                  | 43        |
| 7.2.2    | <a href="#">Field Documentation</a>                   | 43        |
| 7.2.2.1  | <a href="#">c</a>                                     | 43        |
| 7.2.2.2  | <a href="#">compfunc</a>                              | 43        |
| 7.2.2.3  | <a href="#">d</a>                                     | 43        |
| 7.2.2.4  | <a href="#">data</a>                                  | 43        |
| 7.2.2.5  | <a href="#">i</a>                                     | 43        |
| 7.2.2.6  | <a href="#">l</a>                                     | 43        |
| 7.2.2.7  | <a href="#">ll</a>                                    | 43        |
| 7.2.2.8  | <a href="#">p</a>                                     | 43        |
| 7.2.2.9  | <a href="#">pc</a>                                    | 43        |
| 7.2.2.10 | <a href="#">sc</a>                                    | 43        |
| 7.2.2.11 | <a href="#">st</a>                                    | 44        |
| 7.2.2.12 | <a href="#">type</a>                                  | 44        |
| 7.2.2.13 | <a href="#">uc</a>                                    | 44        |
| 7.2.2.14 | <a href="#">ui</a>                                    | 44        |

|          |                              |    |
|----------|------------------------------|----|
| 7.2.2.15 | ul                           | 44 |
| 7.2.2.16 | ull                          | 44 |
| 7.3      | kvpair Struct Reference      | 44 |
| 7.3.1    | Detailed Description         | 45 |
| 7.3.2    | Field Documentation          | 45 |
| 7.3.2.1  | key                          | 45 |
| 7.3.2.2  | value                        | 45 |
| 7.4      | list Struct Reference        | 45 |
| 7.4.1    | Detailed Description         | 46 |
| 7.4.2    | Field Documentation          | 46 |
| 7.4.2.1  | compfunc                     | 46 |
| 7.4.2.2  | exit_on_error                | 46 |
| 7.4.2.3  | free_on_destroy              | 46 |
| 7.4.2.4  | head                         | 46 |
| 7.4.2.5  | length                       | 46 |
| 7.4.2.6  | tail                         | 46 |
| 7.4.2.7  | type                         | 46 |
| 7.5      | list_node Struct Reference   | 47 |
| 7.5.1    | Detailed Description         | 47 |
| 7.5.2    | Field Documentation          | 47 |
| 7.5.2.1  | element                      | 47 |
| 7.5.2.2  | next                         | 47 |
| 7.5.2.3  | prev                         | 47 |
| 7.6      | pair_string Struct Reference | 47 |
| 7.6.1    | Detailed Description         | 48 |
| 7.6.2    | Field Documentation          | 48 |
| 7.6.2.1  | first                        | 48 |
| 7.6.2.2  | second                       | 48 |
| 7.7      | queue Struct Reference       | 48 |
| 7.7.1    | Detailed Description         | 49 |
| 7.7.2    | Field Documentation          | 49 |
| 7.7.2.1  | back                         | 49 |
| 7.7.2.2  | capacity                     | 49 |
| 7.7.2.3  | elements                     | 49 |
| 7.7.2.4  | exit_on_error                | 49 |
| 7.7.2.5  | free_on_destroy              | 49 |
| 7.7.2.6  | front                        | 49 |
| 7.7.2.7  | resizable                    | 49 |
| 7.7.2.8  | size                         | 49 |
| 7.7.2.9  | type                         | 49 |

|          |  |           |
|----------|--|-----------|
| 7.8      | stack Struct Reference                           | 50        |
| 7.8.1    | Detailed Description                             | 50        |
| 7.8.2    | Field Documentation                              | 50        |
| 7.8.2.1  | capacity   | 50        |
| 7.8.2.2  | elements   | 50        |
| 7.8.2.3  | exit_on_error                                    | 50        |
| 7.8.2.4  | free_on_destroy                                  | 50        |
| 7.8.2.5  | resizable  | 51        |
| 7.8.2.6  | top  | 51        |
| 7.8.2.7  | type   | 51        |
| 7.9      | vector Struct Reference                          | 51        |
| 7.9.1    | Detailed Description                             | 51        |
| 7.9.2    | Field Documentation                              | 52        |
| 7.9.2.1  | capacity   | 52        |
| 7.9.2.2  | compfunc   | 52        |
| 7.9.2.3  | elements   | 52        |
| 7.9.2.4  | exit_on_error                                    | 52        |
| 7.9.2.5  | free_on_destroy                                  | 52        |
| 7.9.2.6  | length   | 52        |
| 7.9.2.7  | type   | 52        |
| <b>8</b> | <b>File Documentation</b>                        | <b>53</b> |
| 8.1      | gds.dox File Reference                           | 53        |
| 8.2      | include/private/gds_common.h File Reference      | 53        |
| 8.2.1    | Detailed Description                             | 54        |
| 8.3      | include/private/gdt.dox File Reference           | 54        |
| 8.4      | include/private/gdt.h File Reference             | 54        |
| 8.4.1    | Detailed Description                             | 56        |
| 8.5      | include/public/dict.h File Reference             | 56        |
| 8.5.1    | Detailed Description                             | 57        |
| 8.5.2    | Typedef Documentation                            | 57        |
| 8.5.2.1  | Dict   | 57        |
| 8.5.3    | Function Documentation                           | 58        |
| 8.5.3.1  | dict_create                                      | 58        |
| 8.5.3.2  | dict_destroy                                     | 58        |
| 8.5.3.3  | dict_has_key                                     | 58        |
| 8.5.3.4  | dict_insert                                      | 58        |
| 8.5.3.5  | dict_value_for_key                               | 59        |
| 8.6      | include/public/gds_public_types.h File Reference | 59        |
| 8.6.1    | Detailed Description                             | 60        |



|           |   |    |
|-----------|---|----|
| 8.7       | <a href="#">include/public/gds_util.h File Reference</a>      | 60 |
| 8.7.1     | <a href="#">Detailed Description</a>                          | 61 |
| 8.8       | <a href="#">include/public/general.dox File Reference</a>     | 61 |
| 8.9       | <a href="#">include/public/list.dox File Reference</a>        | 61 |
| 8.10      | <a href="#">include/public/list.h File Reference</a>          | 61 |
| 8.10.1    | <a href="#">Detailed Description</a>                          | 63 |
| 8.11      | <a href="#">include/public/queue.dox File Reference</a>       | 64 |
| 8.12      | <a href="#">include/public/queue.h File Reference</a>         | 64 |
| 8.12.1    | <a href="#">Detailed Description</a>                          | 65 |
| 8.13      | <a href="#">include/public/stack.dox File Reference</a>       | 65 |
| 8.14      | <a href="#">include/public/stack.h File Reference</a>         | 65 |
| 8.14.1    | <a href="#">Detailed Description</a>                          | 67 |
| 8.15      | <a href="#">include/public/string_util.dox File Reference</a> | 67 |
| 8.16      | <a href="#">include/public/string_util.h File Reference</a>   | 67 |
| 8.16.1    | <a href="#">Detailed Description</a>                          | 68 |
| 8.17      | <a href="#">include/public/vector.dox File Reference</a>      | 68 |
| 8.18      | <a href="#">include/public/vector.h File Reference</a>        | 68 |
| 8.18.1    | <a href="#">Detailed Description</a>                          | 70 |
| 8.19      | <a href="#">src/dict.c File Reference</a>                     | 70 |
| 8.19.1    | <a href="#">Detailed Description</a>                          | 72 |
| 8.19.2    | <a href="#">Typedef Documentation</a>                         | 72 |
| 8.19.2.1  | <a href="#">KVPair</a>  | 72 |
| 8.19.3    | <a href="#">Function Documentation</a>                        | 72 |
| 8.19.3.1  | <a href="#">dict_buckets_create</a>                           | 72 |
| 8.19.3.2  | <a href="#">dict_buckets_destroy</a>                          | 72 |
| 8.19.3.3  | <a href="#">dict_create</a>                                   | 72 |
| 8.19.3.4  | <a href="#">dict_destroy</a>                                  | 73 |
| 8.19.3.5  | <a href="#">dict_has_key</a>                                  | 73 |
| 8.19.3.6  | <a href="#">dict_has_key_internal</a>                         | 73 |
| 8.19.3.7  | <a href="#">dict_insert</a>                                   | 74 |
| 8.19.3.8  | <a href="#">dict_value_for_key</a>                            | 74 |
| 8.19.3.9  | <a href="#">djb2hash</a>                                      | 74 |
| 8.19.3.10 | <a href="#">kvpair_compare</a>                                | 74 |
| 8.19.3.11 | <a href="#">kvpair_create</a>                                 | 75 |
| 8.19.3.12 | <a href="#">kvpair_destroy</a>                                | 75 |
| 8.19.4    | <a href="#">Variable Documentation</a>                        | 75 |
| 8.19.4.1  | <a href="#">BUCKETS</a>                                       | 75 |
| 8.20      | <a href="#">src/gds_util.c File Reference</a>                 | 75 |
| 8.20.1    | <a href="#">Detailed Description</a>                          | 76 |
| 8.21      | <a href="#">src/gdt.c File Reference</a>                      | 76 |

|   |    |
|---|----|
| 8.21.1 Detailed Description . . . . .           | 78 |
| 8.21.2 Function Documentation . . . . .         | 78 |
| 8.21.2.1 gdt_compare_char . . . . .             | 78 |
| 8.21.2.2 gdt_compare_double . . . . .           | 78 |
| 8.21.2.3 gdt_compare_int . . . . .              | 79 |
| 8.21.2.4 gdt_compare_long . . . . .             | 79 |
| 8.21.2.5 gdt_compare_longlong . . . . .         | 79 |
| 8.21.2.6 gdt_compare_schar . . . . .            | 79 |
| 8.21.2.7 gdt_compare_sizet . . . . .            | 80 |
| 8.21.2.8 gdt_compare_string . . . . .           | 80 |
| 8.21.2.9 gdt_compare_uchar . . . . .            | 80 |
| 8.21.2.10 gdt_compare_uint . . . . .            | 81 |
| 8.21.2.11 gdt_compare_ulong . . . . .           | 81 |
| 8.21.2.12 gdt_compare_ulonglong . . . . .       | 81 |
| 8.22 src/list.c File Reference . . . . .        | 81 |
| 8.22.1 Detailed Description . . . . .           | 83 |
| 8.22.2 Typedef Documentation . . . . .          | 84 |
| 8.22.2.1 ListNode . . . . .                     | 84 |
| 8.22.3 Function Documentation . . . . .         | 84 |
| 8.22.3.1 list_insert_internal . . . . .         | 84 |
| 8.22.3.2 list_node_at_index . . . . .           | 84 |
| 8.22.3.3 list_node_create . . . . .             | 84 |
| 8.22.3.4 list_node_destroy . . . . .            | 85 |
| 8.23 src/queue.c File Reference . . . . .       | 85 |
| 8.23.1 Detailed Description . . . . .           | 86 |
| 8.23.2 Variable Documentation . . . . .         | 86 |
| 8.23.2.1 GROWTH . . . . .                       | 86 |
| 8.24 src/stack.c File Reference . . . . .       | 86 |
| 8.24.1 Detailed Description . . . . .           | 88 |
| 8.24.2 Variable Documentation . . . . .         | 88 |
| 8.24.2.1 GROWTH . . . . .                       | 88 |
| 8.25 src/string_util.c File Reference . . . . . | 88 |
| 8.25.1 Detailed Description . . . . .           | 89 |
| 8.26 src/vector.c File Reference . . . . .      | 89 |
| 8.26.1 Detailed Description . . . . .           | 91 |
| 8.26.2 Function Documentation . . . . .         | 91 |
| 8.26.2.1 vector_insert_internal . . . . .       | 91 |
| 8.26.3 Variable Documentation . . . . .         | 91 |
| 8.26.3.1 GROWTH . . . . .                       | 91 |

## **Chapter 1**

# **Generic Data Structures Library**

GDS is a C language generic data structures library.



## Chapter 2

# Todo List

Global `queue_push` (Queue queue,...)

Rewrite to move only the required elements



## Chapter 3

# Module Index

### 3.1 Modules

Here is a list of all modules:

|  |    |
|--|----|
| Private functionality for manipulating generic datatypes . . . . . | 11 |
| Public general generic data structures functionality . . . . .     | 15 |
| Public interface to generic list data structure . . . . .          | 17 |
| Public interface to generic queue data structure . . . . .         | 24 |
| Public interface to generic stack data structure . . . . .         | 28 |
| General purpose string manipulation functions . . . . .            | 32 |
| Public interface to generic vector data structure. . . . .         | 35 |





## Chapter 4

# Data Structure Index

### 4.1 Data Structures

Here are the data structures with brief descriptions:

|                                      |    |
|--------------------------------------|----|
| <a href="#">dict</a>                 | 41 |
| <a href="#">gdt_generic_datatype</a> |    |
| Generic datatype structure           | 42 |
| <a href="#">kvpair</a>               | 44 |
| <a href="#">list</a>                 | 45 |
| <a href="#">list_node</a>            | 47 |
| <a href="#">pair_string</a>          |    |
| Structure to hold a string pair      | 47 |
| <a href="#">queue</a>                | 48 |
| <a href="#">stack</a>                | 50 |
| <a href="#">vector</a>               | 51 |



## Chapter 5

# File Index

### 5.1 File List

Here is a list of all files with brief descriptions:

|   |    |
|---|----|
| include/private/ <a href="#">gds_common.h</a>                     |    |
| Common internal headers for data structures . . . . .             | 53 |
| include/private/ <a href="#">gdt.h</a>                            |    |
| Interface to generic data element functionality . . . . .         | 54 |
| include/public/ <a href="#">dict.h</a>                            |    |
| Interface to generic dictionary data structure . . . . .          | 56 |
| include/public/ <a href="#">gds_public_types.h</a>                |    |
| Common public types for generic data structures library . . . . . | 59 |
| include/public/ <a href="#">gds_util.h</a>                        |    |
| Interface to general utility functions . . . . .                  | 60 |
| include/public/ <a href="#">list.h</a>                            |    |
| Interface to generic list data structure . . . . .                | 61 |
| include/public/ <a href="#">queue.h</a>                           |    |
| Interface to generic queue data structure . . . . .               | 64 |
| include/public/ <a href="#">stack.h</a>                           |    |
| Interface to generic stack data structure . . . . .               | 65 |
| include/public/ <a href="#">string_util.h</a>                     |    |
| Interface to string utility functions . . . . .                   | 67 |
| include/public/ <a href="#">vector.h</a>                          |    |
| Interface to generic vector data structure . . . . .              | 68 |
| src/ <a href="#">dict.c</a>                                       |    |
| Implementation of generic dictionary data structure . . . . .     | 70 |
| src/ <a href="#">gds_util.c</a>                                   |    |
| Implementation of general utility functions . . . . .             | 75 |
| src/ <a href="#">gdt.c</a>  |    |
| Implementation of generic data element functionality . . . . .    | 76 |
| src/ <a href="#">list.c</a>                                       |    |
| Implementation of generic list data structure . . . . .           | 81 |
| src/ <a href="#">queue.c</a>                                      |    |
| Implementation of generic queue data structure . . . . .          | 85 |
| src/ <a href="#">stack.c</a>                                      |    |
| Implementation of generic stack data structure . . . . .          | 86 |
| src/ <a href="#">string_util.c</a>                                |    |
| Implementation of string utility functions . . . . .              | 88 |
| src/ <a href="#">vector.c</a>                                     |    |
| Implementation of generic vector data structure . . . . .         | 89 |



## Chapter 6

# Module Documentation

### 6.1 Private functionality for manipulating generic datatypes

#### Data Structures

- struct [gdt\\_generic\\_datatype](#)  
*Generic datatype structure.*

#### Typedefs

- typedef int(\* [gds\\_cfunc](#))(const void \*, const void \*)  
*Type definition for comparison function pointer.*

#### Enumerations

- enum [gds\\_datatype](#) {  
    [DATATYPE\\_CHAR](#), [DATATYPE\\_UNSIGNED\\_CHAR](#), [DATATYPE\\_SIGNED\\_CHAR](#), [DATATYPE\\_INT](#),  
    [DATATYPE\\_UNSIGNED\\_INT](#), [DATATYPE\\_LONG](#), [DATATYPE\\_UNSIGNED\\_LONG](#), [DATATYPE\\_LONG\\_](#)-  
    [LONG](#),  
    [DATATYPE\\_UNSIGNED\\_LONG\\_LONG](#), [DATATYPE\\_SIZE\\_T](#), [DATATYPE\\_DOUBLE](#), [DATATYPE\\_STRIN-](#)  
    [G](#),  
    [DATATYPE\\_POINTER](#) }  
*Enumeration type for data element type.*

#### Functions

- void [gdt\\_set\\_value](#) (struct [gdt\\_generic\\_datatype](#) \*data, const enum [gds\\_datatype](#) type, [gds\\_cfunc](#) cfunc, va\_list ap)  
*Sets the value of a generic datatype.*
- void [gdt\\_get\\_value](#) (const struct [gdt\\_generic\\_datatype](#) \*data, void \*p)  
*Gets the value of a generic datatype.*
- void [gdt\\_free](#) (struct [gdt\\_generic\\_datatype](#) \*data)  
*Frees memory pointed to by a generic datatype.*
- int [gdt\\_compare](#) (const struct [gdt\\_generic\\_datatype](#) \*d1, const struct [gdt\\_generic\\_datatype](#) \*d2)  
*Compares two generic datatypes.*
- int [gdt\\_compare\\_void](#) (const void \*p1, const void \*p2)  
*Compares two generic datatypes via void pointers.*
- int [gdt\\_reverse\\_compare\\_void](#) (const void \*p1, const void \*p2)  
*Reverse compares two generic datatypes via void pointers.*

### 6.1.1 Detailed Description

This module implements the mechanism for allowing generic datatypes. Each datatype implements a C `union` containing all the allowable fundamental types. Functions are provided for getting, setting, `free()`ing, and comparing values.

### 6.1.2 Typedef Documentation

#### 6.1.2.1 `typedef int(* gds_cfunc)(const void *, const void *)`

Type definition for comparison function pointer.

### 6.1.3 Enumeration Type Documentation

#### 6.1.3.1 `enum gds_datatype`

Enumeration type for data element type.

Enumerator:

```
DATATYPE_CHAR   char
DATATYPE_UNSIGNED_CHAR unsigned char
DATATYPE_SIGNED_CHAR signed char
DATATYPE_INT    int
DATATYPE_UNSIGNED_INT unsigned int
DATATYPE_LONG   long
DATATYPE_UNSIGNED_LONG unsigned long
DATATYPE_LONG_LONG long long
DATATYPE_UNSIGNED_LONG_LONG unsigned long long
DATATYPE_SIZE_T size_t
DATATYPE_DOUBLE double
DATATYPE_STRING char *, string
DATATYPE_POINTER void *
```

### 6.1.4 Function Documentation

#### 6.1.4.1 `int gdt_compare ( const struct gdt_generic_datatype * d1, const struct gdt_generic_datatype * d2 )`

Compares two generic datatypes.

Parameters

|           |   |
|-----------|---|
| <i>d1</i> | A pointer to the first generic datatype.  |
| <i>d2</i> | A pointer to the second generic datatype. |

Return values

|           |   |
|-----------|---|
| <i>0</i>  | The two datatypes are equal.                            |
| <i>-1</i> | The first datatype is less than the second datatype.    |
| <i>1</i>  | The first datatype is greater than the second datatype. |

**6.1.4.2 int gdt\_compare\_void ( const void \* *p1*, const void \* *p2* )**

Compares two generic datatypes via `void` pointers.

This function is suitable for passing to `qsort()`.

**Parameters**

|           |   |
|-----------|---|
| <i>p1</i> | A pointer to the first generic datatype.  |
| <i>p2</i> | A pointer to the second generic datatype. |

**Return values**

|    |   |
|----|---|
| 0  | The two datatypes are equal.                            |
| -1 | The first datatype is less than the second datatype.    |
| 1  | The first datatype is greater than the second datatype. |

**6.1.4.3 void gdt\_free ( struct gdt\_generic\_datatype \* *data* )**

Frees memory pointed to by a generic datatype.

This function does nothing if the type of the generic datatype set by the last call to `gdt_set_value()` is neither `DATATYPE_STRING` nor `DATATYPE_POINTER`. If the type of the generic datatype is one of these values, the caller is responsible for ensuring that the last value set contains an address on which it is appropriate to call `free()`.

**Parameters**

|             |                                    |
|-------------|------------------------------------|
| <i>data</i> | A pointer to the generic datatype. |
|-------------|------------------------------------|

**6.1.4.4 void gdt\_get\_value ( const struct gdt\_generic\_datatype \* *data*, void \* *p* )**

Gets the value of a generic datatype.

**Parameters**

|             |   |
|-------------|---|
| <i>data</i> | A pointer to the generic datatype.  |
| <i>p</i>    | A pointer containing the address of an object of type appropriate to the type of the generic datatype set by the last call to <code>gdt_set_value()</code> . This object will be modified to contain the value of the generic datatype. |

**6.1.4.5 int gdt\_reverse\_compare\_void ( const void \* *p1*, const void \* *p2* )**

Reverse compares two generic datatypes via `void` pointers.

This function is suitable for passing to `qsort()` when the desired behavior is to sort in reverse order.

**Parameters**

|           |   |
|-----------|---|
| <i>p1</i> | A pointer to the first generic datatype.  |
| <i>p2</i> | A pointer to the second generic datatype. |

**Return values**

|    |   |
|----|---|
| 0  | The two datatypes are equal.                            |
| -1 | The first datatype is greater than the second datatype. |
| 1  | The first datatype is less than the second datatype.    |

6.1.4.6 void gdt\_set\_value ( struct gdt\_generic\_datatype \* *data*, const enum gds\_datatype *type*, gds\_cfunc *cfunc*, va\_list *ap* )

Sets the value of a generic datatype.

Parameters

|              |  |
|--------------|--|
| <i>data</i>  | A pointer to the generic datatype.   |
| <i>type</i>  | The type of data for the datatype to contain.  |
| <i>cfunc</i> | A pointer to a comparison function. This is ignored for all types other than DATATYPE_POINTER. For DATATYPE_POINTER, this should contain the address of a function of type <code>int (*)(const void *, const void *)</code> if the datatype will ever need to be compared with another datatype of the same type (e.g. for finding or sorting elements within a data structure). If this functionality is not required, <code>NULL</code> can be provided. |
| <i>ap</i>    | A <code>va_list</code> containing a single argument of the type appropriate to <code>type</code> , containing the value to which to set the generic datatype.  |



## 6.2 Public general generic data structures functionality

### Enumerations

- enum `gds_option` { `GDS_RESIZABLE` = 1, `GDS_FREE_ON_DESTROY` = 2, `GDS_EXIT_ON_ERROR` = 4 }

*Enumeration type for data structure options.*

### Functions

- void `gds_strerror_quit` (const char \*msg,...)  
*Prints an error message with error number and exits.*
- void `gds_error_quit` (const char \*msg,...)  
*Prints an error message exits.*
- void `gds_assert_quit` (const char \*msg,...)  
*Prints an error message exits via assert().*
- char \* `gds_strdup` (const char \*str)  
*Dynamically duplicates a string.*

#### 6.2.1 Detailed Description

This module contains general functionality used with or by the other data structures, including common creation options, and functions for outputting error messages.

#### 6.2.2 Enumeration Type Documentation

##### 6.2.2.1 enum gds\_option

Enumeration type for data structure options.

Enumerator:

**`GDS_RESIZABLE`** Dynamically resizes on demand

**`GDS_FREE_ON_DESTROY`** Automatically frees pointer members

**`GDS_EXIT_ON_ERROR`** Exits on error

#### 6.2.3 Function Documentation

##### 6.2.3.1 void gds\_assert\_quit ( const char \* msg, ... )

Prints an error message exits via assert().

This function will do nothing if `NDEBUG` is defined. Otherwise, it behaves in a manner identical to `gds_error_quit()` except it terminates via `assert()`, rather than `exit()`.

Parameters

|                  |  |
|------------------|--|
| <code>msg</code> | The format string for the message to print. Format specifiers are the same as the <code>printf()</code> family of functions. |
| <code>...</code> | Any arguments to the format string.  |

### 6.2.3.2 void gds\_error\_quit ( const char \* *msg*, ... )

Prints an error message exits.

#### Parameters

|            |  |
|------------|--|
| <i>msg</i> | The format string for the message to print. Format specifiers are the same as the <code>printf()</code> family of functions. |
| ...        | Any arguments to the format string.  |

### 6.2.3.3 char\* gds\_strdup ( const char \* *str* )

Dynamically duplicates a string.

Provided in case POSIX `strdup()` is not available.

#### Parameters

|            |                          |
|------------|--------------------------|
| <i>str</i> | The string to duplicate. |
|------------|--------------------------|

#### Return values

|                 |                                    |
|-----------------|------------------------------------|
| <i>NULL</i>     | Failure, dynamic allocation failed |
| <i>non-NULL</i> | A pointer to the new string        |

### 6.2.3.4 void gds\_strerror\_quit ( const char \* *msg*, ... )

Prints an error message with error number and exits.

This function can be called to print an error message and quit following a function which has indicated failure and has set `errno`. A message containing the error number and a text representation of that error will be printed, following by the message supplied to the function.

#### Parameters

|            |  |
|------------|--|
| <i>msg</i> | The format string for the message to print. Format specifiers are the same as the <code>printf()</code> family of functions. |
| ...        | Any arguments to the format string.  |

## 6.3 Public interface to generic list data structure

### Typedefs

- typedef struct `list` \* `List`  
*Opaque list type definition.*
- typedef struct `list_node` \* `Listltr`  
*Opaque list iterator type definition.*

### Functions

- `List list_create` (const enum `gds_datatype` type, const int opts,...)  
*Creates a new list.*
- void `list_destroy` (`List` list)  
*Destroys a list.*
- bool `list_append` (`List` list,...)  
*Appends a value to the back of a list.*
- bool `list_prepend` (`List` list,...)  
*Prepends a value to the front of a list.*
- bool `list_insert` (`List` list, const `size_t` index,...)  
*Inserts a value into a list.*
- bool `list_delete_front` (`List` list)  
*Deletes the value at the front of the list.*
- bool `list_delete_back` (`List` list)  
*Deletes the value at the back of the list.*
- bool `list_delete_index` (`List` list, const `size_t` index)  
*Deletes the value at the specified index of the list.*
- bool `list_element_at_index` (`List` list, const `size_t` index, void \*p)  
*Gets the value at the specified index of the list.*
- bool `list_set_element_at_index` (`List` list, const `size_t` index,...)  
*Sets the value at the specified index of the list.*
- bool `list_find` (`List` list, `size_t` \*index,...)  
*Tests if a value is contained in a list.*
- `Listltr list_find_itr` (`List` list,...)  
*Tests if a value is contained in a list.*
- bool `list_sort` (`List` list)  
*Sorts a list in-place, in ascending order.*
- bool `list_reverse_sort` (`List` list)  
*Sorts a list in-place, in descending order.*
- `Listltr list_itr_first` (`List` list)  
*Returns an iterator to the first element of the list.*
- `Listltr list_itr_last` (`List` list)  
*Returns an iterator to the last element of the list.*
- `Listltr list_itr_next` (`Listltr` itr)  
*Increments a list iterator.*
- `Listltr list_itr_previous` (`Listltr` itr)  
*Decrements a list iterator.*
- void `list_get_value_itr` (`Listltr` itr, void \*p)  
*Retrieves a value from an iterator.*
- bool `list_is_empty` (`List` list)  
*Tests if a list is empty.*
- `size_t` `list_length` (`List` list)  
*Returns the length of a list.*

### 6.3.1 Detailed Description

A list is data structure containing a finite ordered collection of values which allows sequential access (compared to a vector, or array, which allows random access).

### 6.3.2 Typedef Documentation

#### 6.3.2.1 typedef struct list\* List

Opaque list type definition.

#### 6.3.2.2 typedef struct list\_node\* ListItr

Opaque list iterator type definition.

### 6.3.3 Function Documentation

#### 6.3.3.1 bool list\_append ( List list, ... )

Appends a value to the back of a list.

##### Parameters

|             |  |
|-------------|--|
| <i>list</i> | A pointer to the list.   |
| ...         | The value to append to the end of the list. This should be of a type appropriate to the type set when creating the list. |

##### Return values

|              |  |
|--------------|--|
| <i>true</i>  | Success                                    |
| <i>false</i> | Failure, dynamic memory allocation failed. |

#### 6.3.3.2 List list\_create ( const enum gds\_datatype type, const int opts, ... )

Creates a new list.

##### Parameters

|             |   |
|-------------|---|
| <i>type</i> | The datatype for the list.  |
| <i>opts</i> | The following options can be OR'd together: <code>GDS_FREE_ON_DESTROY</code> to automatically <code>free()</code> pointer members when they are deleted or when the list is destroyed; <code>GDS_EXIT_ON_ERROR</code> to print a message to the standard error stream and <code>exit()</code> , rather than returning a failure status. |
| ...         | If <code>type</code> is <code>DATATYPE_POINTER</code> , this argument should be a pointer to a comparison function. In all other cases, this argument is not required, and will be ignored if it is provided.   |

##### Return values

|                 |                            |
|-----------------|----------------------------|
| <i>NULL</i>     | List creation failed.      |
| <i>non-NULL</i> | A pointer to the new list. |

**6.3.3.3 bool list\_delete\_back ( List *list* )**

Deletes the value at the back of the list.

**Parameters**

|             |                        |
|-------------|------------------------|
| <i>list</i> | A pointer to the list. |
|-------------|------------------------|

**Return values**

|              |  |
|--------------|--|
| <i>true</i>  | Success                                    |
| <i>false</i> | Failure, dynamic memory allocation failed. |

**6.3.3.4 bool list\_delete\_front ( List *list* )**

Deletes the value at the front of the list.

**Parameters**

|             |                        |
|-------------|------------------------|
| <i>list</i> | A pointer to the list. |
|-------------|------------------------|

**Return values**

|              |  |
|--------------|--|
| <i>true</i>  | Success                                    |
| <i>false</i> | Failure, dynamic memory allocation failed. |

**6.3.3.5 bool list\_delete\_index ( List *list*, const size\_t *index* )**

Deletes the value at the specified index of the list.

**Parameters**

|              |                                   |
|--------------|-----------------------------------|
| <i>list</i>  | A pointer to the list.            |
| <i>index</i> | The index of the value to delete. |

**Return values**

|              |  |
|--------------|--|
| <i>true</i>  | Success  |
| <i>false</i> | Failure, dynamic memory allocation failed or index was out of range. |

**6.3.3.6 void list\_destroy ( List *list* )**

Destroys a list.

If the `GDS_FREE_ON_DESTROY` option was specified when creating the list, any pointer values still in the list will be `free()`d prior to destruction.

**Parameters**

|             |                        |
|-------------|------------------------|
| <i>list</i> | A pointer to the list. |
|-------------|------------------------|

**6.3.3.7 bool list\_element\_at\_index ( List *list*, const size\_t *index*, void \* *p* )**

Gets the value at the specified index of the list.

## Parameters

|              |   |
|--------------|---|
| <i>list</i>  | A pointer to the list.  |
| <i>index</i> | The index of the value to get.  |
| <i>p</i>     | A pointer to an object of a type appropriate to the type set when creating the list. The object at this address will be modified to contain the value at the specified index. |

## Return values

|              |                                  |
|--------------|----------------------------------|
| <i>true</i>  | Success                          |
| <i>false</i> | Failure, index was out of range. |

6.3.3.8 `bool list_find ( List list, size_t * index, ... )`

Tests if a value is contained in a list.

## Parameters

|              |  |
|--------------|--|
| <i>list</i>  | A pointer to the list.   |
| <i>index</i> | A pointer to a <code>size_t</code> object which, if the value is contained within the list, will be modified to contain the index of the first occurrence of that value in the list. |
| <i>...</i>   | The value for which to search. This should be of a type appropriate to the type set when creating the list.  |

## Return values

|              |                                     |
|--------------|-------------------------------------|
| <i>true</i>  | The value was found in the list     |
| <i>false</i> | The value was not found in the list |

6.3.3.9 `Listltr list_find_itr ( List list, ... )`

Tests if a value is contained in a list.

## Parameters

|             |   |
|-------------|---|
| <i>list</i> | A pointer to the list.  |
| <i>...</i>  | The value for which to search. This should be of a type appropriate to the type set when creating the list. |

## Return values

|                 |  |
|-----------------|--|
| <i>NULL</i>     | The value was not found in the list  |
| <i>non-NULL</i> | A list iterator pointing to the first occurrence of the value in the list. |

6.3.3.10 `void list_get_value_itr ( Listltr itr, void * p )`

Retrieves a value from an iterator.

## Parameters

|            |  |
|------------|--|
| <i>itr</i> | A pointer to the iterator.   |
| <i>p</i>   | A pointer to an object of a type appropriate to the type set when creating the list. The object at this address will be modified to contain the value at the given iterator. |

**6.3.3.11** `bool list_insert ( List list, const size_t index, ... )`

Inserts a value into a list.

**Parameters**

|              |   |
|--------------|---|
| <i>list</i>  | A pointer to the list.  |
| <i>index</i> | The index at which to insert the value.   |
| <i>...</i>   | The value to insert into the list. This should be of a type appropriate to the type set when creating the list. |

**Return values**

|              |  |
|--------------|--|
| <i>true</i>  | Success  |
| <i>false</i> | Failure, dynamic memory allocation failed or index was out of range. |

**6.3.3.12** `bool list_is_empty ( List list )`

Tests if a list is empty.

**Parameters**

|             |                        |
|-------------|------------------------|
| <i>list</i> | A pointer to the list. |
|-------------|------------------------|

**Return values**

|              |                       |
|--------------|-----------------------|
| <i>true</i>  | The list is empty     |
| <i>false</i> | The list is not empty |

**6.3.3.13** `ListItr list_itr_first ( List list )`

Returns an iterator to the first element of the list.

**Parameters**

|             |                       |
|-------------|-----------------------|
| <i>list</i> | A pointer to the list |
|-------------|-----------------------|

**Return values**

|                 |  |
|-----------------|--|
| <i>NULL</i>     | Failure, list is empty                       |
| <i>non-NULL</i> | An iterator to the first element of the list |

**6.3.3.14** `ListItr list_itr_last ( List list )`

Returns an iterator to the last element of the list.

**Parameters**

|             |                       |
|-------------|-----------------------|
| <i>list</i> | A pointer to the list |
|-------------|-----------------------|

**Return values**

|                 |   |
|-----------------|---|
| <i>NULL</i>     | Failure, list is empty                      |
| <i>non-NULL</i> | An iterator to the last element of the list |

**6.3.3.15 Listltr list\_itr\_next ( Listltr itr )**

Increments a list iterator.

**Parameters**

|            |                            |
|------------|----------------------------|
| <i>itr</i> | A pointer to the iterator. |
|------------|----------------------------|

**Return values**

|                 |   |
|-----------------|---|
| <i>NULL</i>     | End of list, no next iterator               |
| <i>non-NULL</i> | An iterator to the next element of the list |

**6.3.3.16 Listltr list\_itr\_previous ( Listltr itr )**

Decrements a list iterator.

**Parameters**

|            |                            |
|------------|----------------------------|
| <i>itr</i> | A pointer to the iterator. |
|------------|----------------------------|

**Return values**

|                 |   |
|-----------------|---|
| <i>NULL</i>     | Start of list, no previous iterator             |
| <i>non-NULL</i> | An iterator to the previous element of the list |

**6.3.3.17 size\_t list\_length ( List list )**

Returns the length of a list.

The length of the list is equivalent to the number of values it contains.

**Parameters**

|             |                        |
|-------------|------------------------|
| <i>list</i> | A pointer to the list. |
|-------------|------------------------|

**Returns**

The length of the list.

**6.3.3.18 bool list\_prepend ( List list, ... )**

Prepends a value to the front of a list.

**Parameters**

|             |   |
|-------------|---|
| <i>list</i> | A pointer to the list.  |
| <i>...</i>  | The value to prepend to the start of the list. This should be of a type appropriate to the type set when creating the list. |

**Return values**

|              |  |
|--------------|--|
| <i>true</i>  | Success                                    |
| <i>false</i> | Failure, dynamic memory allocation failed. |



**6.3.3.19** `bool list_reverse_sort ( List list )`

Sorts a list in-place, in descending order.

**Parameters**

|             |                        |
|-------------|------------------------|
| <i>list</i> | A pointer to the list. |
|-------------|------------------------|

**Return values**

|              |  |
|--------------|--|
| <i>true</i>  | Success                                    |
| <i>false</i> | Failure, dynamic memory allocation failed. |

**6.3.3.20** `bool list_set_element_at_index ( List list, const size_t index, ... )`

Sets the value at the specified index of the list.

**Parameters**

|              |   |
|--------------|---|
| <i>list</i>  | A pointer to the list.  |
| <i>index</i> | The index of the value to set.  |
| <i>...</i>   | The value to which to set the specified index of the list. This should be of a type appropriate to the type set when creating the list. |

**Return values**

|              |                                  |
|--------------|----------------------------------|
| <i>true</i>  | Success                          |
| <i>false</i> | Failure, index was out of range. |

**6.3.3.21** `bool list_sort ( List list )`

Sorts a list in-place, in ascending order.

**Parameters**

|             |                        |
|-------------|------------------------|
| <i>list</i> | A pointer to the list. |
|-------------|------------------------|

**Return values**

|              |  |
|--------------|--|
| <i>true</i>  | Success                                    |
| <i>false</i> | Failure, dynamic memory allocation failed. |

## 6.4 Public interface to generic queue data structure

### Typedefs

- typedef struct `queue` \* `Queue`  
*Opaque queue type definition.*

### Functions

- `Queue queue_create` (const size\_t capacity, const enum `gds_datatype` type, const int opts)  
*Creates a new queue.*
- void `queue_destroy` (`Queue queue`)  
*Destroys a queue.*
- bool `queue_push` (`Queue queue`,...)  
*Pushes a value onto the queue.*
- bool `queue_pop` (`Queue queue`, void \*p)  
*Pops a value from the queue.*
- bool `queue_peek` (`Queue queue`, void \*p)  
*Peeks at the top value of the queue.*
- bool `queue_is_full` (`Queue queue`)  
*Checks whether a queue is full.*
- bool `queue_is_empty` (`Queue queue`)  
*Checks whether a queue is empty.*
- size\_t `queue_capacity` (`Queue queue`)  
*Retrieves the current capacity of a queue.*
- size\_t `queue_size` (`Queue queue`)  
*Retrieves the current size of a queue.*
- size\_t `queue_free_space` (`Queue queue`)  
*Retrieves the free space on a queue.*

#### 6.4.1 Detailed Description

A queue is a first-in-first-out (FIFO) data structure. Two fundamental operations are possible. A value can be *pushed* onto the queue, and a value can be *popped* from the queue. By virtue of being a FIFO data structure, pushing and popping happen at opposite ends of the queue. In other words, the value popped will be the first item pushed onto the queue that has not already been popped from it.

#### 6.4.2 Typedef Documentation

##### 6.4.2.1 typedef struct queue\* Queue

Opaque queue type definition.

#### 6.4.3 Function Documentation

##### 6.4.3.1 size\_t queue\_capacity ( Queue queue )

Retrieves the current capacity of a queue.

This value can change dynamically if the `GDS_RESIZABLE` option was specified when creating the queue.

## Parameters

|              |                         |
|--------------|-------------------------|
| <i>queue</i> | A pointer to the queue. |
|--------------|-------------------------|

## Returns

The capacity of the queue.

#### 6.4.3.2 Queue queue\_create ( const size\_t capacity, const enum gds\_datatype type, const int opts )

Creates a new queue.

## Parameters

|                 |  |
|-----------------|--|
| <i>capacity</i> | The initial capacity of the queue.   |
| <i>type</i>     | The datatype for the queue.  |
| <i>opts</i>     | The following options can be OR'd together: GDS_RESIZABLE to dynamically resize the queue on-demand; GDS_FREE_ON_DESTROY to automatically free() pointer members when they are deleted or when the queue is destroyed; GDS_EXIT_ON_ERROR to print a message to the standard error stream and exit(), rather than returning a failure status. |

## Return values

|                 |                             |
|-----------------|-----------------------------|
| <i>NULL</i>     | Queue creation failed.      |
| <i>non-NULL</i> | A pointer to the new queue. |

#### 6.4.3.3 void queue\_destroy ( Queue queue )

Destroys a queue.

If the GDS\_FREE\_ON\_DESTROY option was specified when creating the queue, any pointer values still in the queue will be free()d prior to destruction.

## Parameters

|              |                         |
|--------------|-------------------------|
| <i>queue</i> | A pointer to the queue. |
|--------------|-------------------------|

#### 6.4.3.4 size\_t queue\_free\_space ( Queue queue )

Retrieves the free space on a queue.

The free space on a queue is equivalent to the capacity of the queue less the size of the queue.

## Parameters

|              |                         |
|--------------|-------------------------|
| <i>queue</i> | A pointer to the queue. |
|--------------|-------------------------|

## Returns

The free space on the queue.

#### 6.4.3.5 bool queue\_is\_empty ( Queue queue )

Checks whether a queue is empty.

## Parameters

|              |                         |
|--------------|-------------------------|
| <i>queue</i> | A pointer to the queue. |
|--------------|-------------------------|

## Return values

|              |                    |
|--------------|--------------------|
| <i>true</i>  | Queue is empty     |
| <i>false</i> | Queue is not empty |

6.4.3.6 `bool queue_is_full ( Queue queue )`

Checks whether a queue is full.

## Parameters

|              |                         |
|--------------|-------------------------|
| <i>queue</i> | A pointer to the queue. |
|--------------|-------------------------|

## Return values

|              |                   |
|--------------|-------------------|
| <i>true</i>  | Queue is full     |
| <i>false</i> | Queue is not full |

6.4.3.7 `bool queue_peek ( Queue queue, void * p )`

Peeks at the top value of the queue.

This function retrieves the value which would be popped from the queue, without actually popping it.

## Parameters

|              |   |
|--------------|---|
| <i>queue</i> | A pointer to the queue.   |
| <i>p</i>     | A pointer to an object of a type appropriate to the type set when creating the queue. The object at this address will be modified to contain the value at the top of the queue. |

## Return values

|              |                          |
|--------------|--------------------------|
| <i>true</i>  | Success                  |
| <i>false</i> | Failure, queue is empty. |

6.4.3.8 `bool queue_pop ( Queue queue, void * p )`

Pops a value from the queue.

## Parameters

|              |   |
|--------------|---|
| <i>queue</i> | A pointer to the queue.   |
| <i>p</i>     | A pointer to an object of a type appropriate to the type set when creating the queue. The object at this address will be modified to contain the value popped from the queue. |

## Return values

|              |                          |
|--------------|--------------------------|
| <i>true</i>  | Success                  |
| <i>false</i> | Failure, queue is empty. |

#### 6.4.3.9 `bool queue.push ( Queue queue, ... )`

Pushes a value onto the queue.

##### Parameters

|              |   |
|--------------|---|
| <i>queue</i> | A pointer to the queue.   |
| <i>...</i>   | The value to push onto the queue. This should be of a type appropriate to the type set when creating the queue. |

##### Return values

|              |   |
|--------------|---|
| <i>true</i>  | Success   |
| <i>false</i> | Failure, either because the queue is full or, if the <code>GDS_RESIZABLE</code> option was specified when creating the queue, because dynamic memory reallocation failed. |

**Todo** Rewrite to move only the required elements

#### 6.4.3.10 `size_t queue.size ( Queue queue )`

Retrieves the current size of a queue.

The size of the queue is equivalent to the number of values currently in it.

##### Parameters

|              |                         |
|--------------|-------------------------|
| <i>queue</i> | A pointer to the queue. |
|--------------|-------------------------|

##### Returns

The size of the queue.

## 6.5 Public interface to generic stack data structure

### Typedefs

- typedef struct `stack` \* `Stack`  
*Opaque stack type definition.*

### Functions

- `Stack stack_create` (const size\_t capacity, const enum `gds_datatype` type, const int opts)  
*Creates a new stack.*
- void `stack_destroy` (`Stack stack`)  
*Destroys a stack.*
- bool `stack_push` (`Stack stack`,...)  
*Pushes a value onto the stack.*
- bool `stack_pop` (`Stack stack`, void \*p)  
*Pops a value from the stack.*
- bool `stack_peek` (`Stack stack`, void \*p)  
*Peeks at the top value of the stack.*
- bool `stack_is_full` (`Stack stack`)  
*Checks whether a stack is full.*
- bool `stack_is_empty` (`Stack stack`)  
*Checks whether a stack is empty.*
- size\_t `stack_capacity` (`Stack stack`)  
*Retrieves the current capacity of a stack.*
- size\_t `stack_size` (`Stack stack`)  
*Retrieves the current size of a stack.*
- size\_t `stack_free_space` (`Stack stack`)  
*Retrieves the free space on a stack.*

#### 6.5.1 Detailed Description

A stack is a last-in-first-out (LIFO) data structure. Two fundamental operations are possible. A value can be *pushed* onto the stack, and a value can be *popped* from the stack. By virtue of being a LIFO data structure, pushing and popping happen at the same end of the stack. In other words, the value popped will be the last item pushed onto the stack that has not already been popped from it.

#### 6.5.2 Typedef Documentation

##### 6.5.2.1 typedef struct `stack`\* `Stack`

Opaque stack type definition.

#### 6.5.3 Function Documentation

##### 6.5.3.1 size\_t `stack_capacity` ( `Stack stack` )

Retrieves the current capacity of a stack.

This value can change dynamically if the `GDS_RESIZABLE` option was specified when creating the stack.

## Parameters

|              |                         |
|--------------|-------------------------|
| <i>stack</i> | A pointer to the stack. |
|--------------|-------------------------|

## Returns

The capacity of the stack.

### 6.5.3.2 Stack stack\_create ( const size\_t capacity, const enum gds\_datatype type, const int opts )

Creates a new stack.

## Parameters

|                 |  |
|-----------------|--|
| <i>capacity</i> | The initial capacity of the stack.   |
| <i>type</i>     | The datatype for the stack.  |
| <i>opts</i>     | The following options can be OR'd together: <code>GDS_RESIZABLE</code> to dynamically resize the stack on-demand; <code>GDS_FREE_ON_DESTROY</code> to automatically <code>free()</code> pointer members when they are deleted or when the stack is destroyed; <code>GDS_EXIT_ON_ERROR</code> to print a message to the standard error stream and <code>exit()</code> , rather than returning a failure status. |

## Return values

|                 |                             |
|-----------------|-----------------------------|
| <i>NULL</i>     | Stack creation failed.      |
| <i>non-NULL</i> | A pointer to the new stack. |

### 6.5.3.3 void stack\_destroy ( Stack stack )

Destroys a stack.

If the `GDS_FREE_ON_DESTROY` option was specified when creating the stack, any pointer values still in the stack will be `free()`d prior to destruction.

## Parameters

|              |                         |
|--------------|-------------------------|
| <i>stack</i> | A pointer to the stack. |
|--------------|-------------------------|

### 6.5.3.4 size\_t stack\_free\_space ( Stack stack )

Retrieves the free space on a stack.

The free space on a stack is equivalent to the capacity of the stack less the size of the stack.

## Parameters

|              |                         |
|--------------|-------------------------|
| <i>stack</i> | A pointer to the stack. |
|--------------|-------------------------|

## Returns

The free space on the stack.

### 6.5.3.5 bool stack\_is\_empty ( Stack stack )

Checks whether a stack is empty.

## Parameters

|              |                         |
|--------------|-------------------------|
| <i>stack</i> | A pointer to the stack. |
|--------------|-------------------------|

## Return values

|              |                    |
|--------------|--------------------|
| <i>true</i>  | Stack is empty     |
| <i>false</i> | Stack is not empty |

6.5.3.6 `bool stack_is_full ( Stack stack )`

Checks whether a stack is full.

## Parameters

|              |                         |
|--------------|-------------------------|
| <i>stack</i> | A pointer to the stack. |
|--------------|-------------------------|

## Return values

|              |                   |
|--------------|-------------------|
| <i>true</i>  | Stack is full     |
| <i>false</i> | Stack is not full |

6.5.3.7 `bool stack_peek ( Stack stack, void * p )`

Peeks at the top value of the stack.

This function retrieves the value which would be popped from the stack, without actually popping it.

## Parameters

|              |   |
|--------------|---|
| <i>stack</i> | A pointer to the stack.   |
| <i>p</i>     | A pointer to an object of a type appropriate to the type set when creating the stack. The object at this address will be modified to contain the value at the top of the stack. |

## Return values

|              |                          |
|--------------|--------------------------|
| <i>true</i>  | Success                  |
| <i>false</i> | Failure, stack is empty. |

6.5.3.8 `bool stack_pop ( Stack stack, void * p )`

Pops a value from the stack.

## Parameters

|              |   |
|--------------|---|
| <i>stack</i> | A pointer to the stack.   |
| <i>p</i>     | A pointer to an object of a type appropriate to the type set when creating the stack. The object at this address will be modified to contain the value popped from the stack. |

## Return values

|              |                          |
|--------------|--------------------------|
| <i>true</i>  | Success                  |
| <i>false</i> | Failure, stack is empty. |



### 6.5.3.9 `bool stack_push ( Stack stack, ... )`

Pushes a value onto the stack.

#### Parameters

|              |   |
|--------------|---|
| <i>stack</i> | A pointer to the stack.   |
| <i>...</i>   | The value to push onto the stack. This should be of a type appropriate to the type set when creating the stack. |

#### Return values

|              |   |
|--------------|---|
| <i>true</i>  | Success   |
| <i>false</i> | Failure, either because the stack is full or, if the <code>GDS_RESIZABLE</code> option was specified when creating the stack, because dynamic memory reallocation failed. |

### 6.5.3.10 `size_t stack_size ( Stack stack )`

Retrieves the current size of a stack.

The size of the stack is equivalent to the number of values currently in it.

#### Parameters

|              |                         |
|--------------|-------------------------|
| <i>stack</i> | A pointer to the stack. |
|--------------|-------------------------|

#### Returns

The size of the stack.

## 6.6 General purpose string manipulation functions

### Functions

- char \* [trim\\_line\\_ending](#) (char \*str)  
*Trims CR and LF characters from the end of a string.*
- char \* [trim\\_right](#) (char \*str)  
*Trims trailing whitespace from a string.*
- char \* [trim\\_left](#) (char \*str)  
*Trims leading whitespace from a string.*
- char \* [trim](#) (char \*str)  
*Trims leading and trailing whitespace from a string.*
- char \* [pg\\_strdup](#) (const char \*str)  
*Duplicates a string.*
- char \* [pg\\_strndup](#) (const char \*str, const size\_t n)  
*Duplicates at most n characters of a string.*
- struct [pair\\_string](#) \* [pair\\_string\\_create](#) (const char \*str, const char delim)  
*Splits a string into a string pair.*
- void [pair\\_string\\_destroy](#) (struct [pair\\_string](#) \*pair)  
*Destroys a string pair.*

### 6.6.1 Detailed Description

This module contains general purpose functions for working with and manipulating C-style strings.

### 6.6.2 Function Documentation

#### 6.6.2.1 struct [pair\\_string](#)\* [pair\\_string\\_create](#) ( const char \* *str*, const char *delim* ) [read]

Splits a string into a string pair.

##### Parameters

|              |                                  |
|--------------|----------------------------------|
| <i>str</i>   | The string to split.             |
| <i>delim</i> | The character on which to split. |

##### Return values

|                 |   |
|-----------------|---|
| <i>NULL</i>     | Failure, dynamic memory allocation failed |
| <i>non-NULL</i> | A pointer to the new string pair          |

#### 6.6.2.2 void [pair\\_string\\_destroy](#) ( struct [pair\\_string](#) \* *pair* )

Destroys a string pair.

##### Parameters

|             |                      |
|-------------|----------------------|
| <i>pair</i> | The pair to destroy. |
|-------------|----------------------|

**6.6.2.3 char\* pg\_strdup ( const char \* *str* )**

Duplicates a string.

**Parameters**

|            |                          |
|------------|--------------------------|
| <i>str</i> | The string to duplicate. |
|------------|--------------------------|

**Return values**

|                 |   |
|-----------------|---|
| <i>NULL</i>     | Failure, dynamic memory allocation failed |
| <i>non-NULL</i> | A pointer to the duplicated string        |

**6.6.2.4 char\* pg\_strndup ( const char \* *str*, const size\_t *n* )**

Duplicates at most *n* characters of a string.

**Parameters**

|            |  |
|------------|--|
| <i>str</i> | The string to duplicate.                       |
| <i>n</i>   | The maximum number of characters to duplicate. |

**Return values**

|                 |   |
|-----------------|---|
| <i>NULL</i>     | Failure, dynamic memory allocation failed |
| <i>non-NULL</i> | A pointer to the duplicated string        |

**6.6.2.5 char\* trim ( char \* *str* )**

Trims leading and trailing whitespace from a string.

**Parameters**

|            |                     |
|------------|---------------------|
| <i>str</i> | The string to trim. |
|------------|---------------------|

**Returns**

A pointer to the passed string.

**6.6.2.6 char\* trim\_left ( char \* *str* )**

Trims leading whitespace from a string.

**Parameters**

|            |                     |
|------------|---------------------|
| <i>str</i> | The string to trim. |
|------------|---------------------|

**Returns**

A pointer to the passed string.

**6.6.2.7 char\* trim\_line\_ending ( char \* *str* )**

Trims CR and LF characters from the end of a string.

**Parameters**

|            |                     |
|------------|---------------------|
| <i>str</i> | The string to trim. |
|------------|---------------------|

**Returns**

A pointer to the passed string.

**6.6.2.8 char\* trim\_right ( char \* *str* )**

Trims trailing whitespace from a string.

**Parameters**

|            |                     |
|------------|---------------------|
| <i>str</i> | The string to trim. |
|------------|---------------------|

**Returns**

A pointer to the passed string.

## 6.7 Public interface to generic vector data structure.

### Typedefs

- typedef struct `vector` \* `Vector`  
*Opaque vector type definition.*

### Functions

- `Vector vector_create` (const size\_t capacity, const enum `gds_datatype` type, const int opts,...)  
*Creates a new vector.*
- void `vector_destroy` (`Vector vector`)  
*Destroys a vector.*
- bool `vector_append` (`Vector vector`,...)  
*Appends a value to the back of a vector.*
- bool `vector_prepend` (`Vector vector`,...)  
*Prepends a value to the front of a vector.*
- bool `vector_insert` (`Vector vector`, const size\_t index,...)  
*Inserts a value into a vector.*
- bool `vector_delete_front` (`Vector vector`)  
*Deletes the value at the front of the vector.*
- bool `vector_delete_back` (`Vector vector`)  
*Deletes the value at the back of the vector.*
- bool `vector_delete_index` (`Vector vector`, const size\_t index)  
*Deletes the value at the specified index of the vector.*
- bool `vector_element_at_index` (`Vector vector`, const size\_t index, void \*p)  
*Gets the value at the specified index of the vector.*
- bool `vector_set_element_at_index` (`Vector vector`, const size\_t index,...)  
*Sets the value at the specified index of the vector.*
- bool `vector_find` (`Vector vector`, size\_t \*index,...)  
*Tests if a value is contained in a vector.*
- void `vector_sort` (`Vector vector`)  
*Sorts a vector in-place, in ascending order.*
- void `vector_reverse_sort` (`Vector vector`)  
*Sorts a vector in-place, in descending order.*
- bool `vector_is_empty` (`Vector vector`)  
*Tests if a vector is empty.*
- size\_t `vector_length` (`Vector vector`)  
*Returns the length of a vector.*
- size\_t `vector_capacity` (`Vector vector`)  
*Returns the capacity of a vector.*
- size\_t `vector_free_space` (`Vector vector`)  
*Returns the free space in a vector.*

#### 6.7.1 Detailed Description

A vector (or array) is a data structure containing a finite ordered collection of values which allows random access (compared to a list, which only allows sequential access).

## 6.7.2 Typedef Documentation

### 6.7.2.1 typedef struct vector\* Vector

Opaque vector type definition.

## 6.7.3 Function Documentation

### 6.7.3.1 bool vector\_append ( Vector vector, ... )

Appends a value to the back of a vector.

#### Parameters

|               |  |
|---------------|--|
| <i>vector</i> | A pointer to the vector.   |
| ...           | The value to append to the end of the vector. This should be of a type appropriate to the type set when creating the vector. |

#### Return values

|              |  |
|--------------|--|
| <i>true</i>  | Success                                    |
| <i>false</i> | Failure, dynamic memory allocation failed. |

### 6.7.3.2 size\_t vector\_capacity ( Vector vector )

Returns the capacity of a vector.

The capacity of the vector is equivalent to the number of values it is capable of holding. This value can dynamically change if a vector resizes to append an element at the back of the vector. The capacity does not change when elements are deleted from a vector.

#### Parameters

|               |                          |
|---------------|--------------------------|
| <i>vector</i> | A pointer to the vector. |
|---------------|--------------------------|

#### Returns

The capacity of the vector.

### 6.7.3.3 Vector vector\_create ( const size\_t capacity, const enum gds\_datatype type, const int opts, ... )

Creates a new vector.

#### Parameters

|                 |   |
|-----------------|---|
| <i>capacity</i> | The initial capacity for the vector.        |
| <i>type</i>     | The datatype for the vector.                |
| <i>opts</i>     | The following options can be OR'd together: |

- `GDS_FREE_ON_DESTROY` to automatically `free()` pointer members when they are deleted or when the vector is destroyed. If this option is specified, then the caller should ensure that all the elements of the vector have been initialized prior to destruction.
- `GDS_EXIT_ON_ERROR` to print a message to the standard error stream and `exit()`, rather than returning a failure status.

## Parameters

|     |   |
|-----|---|
| ... | If <code>type</code> is <code>DATATYPE_POINTER</code> , this argument should be a pointer to a comparison function. In all other cases, this argument is not required, and will be ignored if it is provided. |
|-----|---|

## Return values

|                 |                              |
|-----------------|------------------------------|
| <i>NULL</i>     | Vector creation failed.      |
| <i>non-NULL</i> | A pointer to the new vector. |

6.7.3.4 `bool vector_delete_back ( Vector vector )`

Deletes the value at the back of the vector.

## Parameters

|               |                          |
|---------------|--------------------------|
| <i>vector</i> | A pointer to the vector. |
|---------------|--------------------------|

## Return values

|              |  |
|--------------|--|
| <i>true</i>  | Success                                    |
| <i>false</i> | Failure, dynamic memory allocation failed. |

6.7.3.5 `bool vector_delete_front ( Vector vector )`

Deletes the value at the front of the vector.

## Parameters

|               |                          |
|---------------|--------------------------|
| <i>vector</i> | A pointer to the vector. |
|---------------|--------------------------|

## Return values

|              |  |
|--------------|--|
| <i>true</i>  | Success                                    |
| <i>false</i> | Failure, dynamic memory allocation failed. |

6.7.3.6 `bool vector_delete_index ( Vector vector, const size_t index )`

Deletes the value at the specified index of the vector.

## Parameters

|               |                                   |
|---------------|-----------------------------------|
| <i>vector</i> | A pointer to the vector.          |
| <i>index</i>  | The index of the value to delete. |

## Return values

|              |  |
|--------------|--|
| <i>true</i>  | Success  |
| <i>false</i> | Failure, dynamic memory allocation failed or index was out of range. |

6.7.3.7 `void vector_destroy ( Vector vector )`

Destroys a vector.

If the `GDS_FREE_ON_DESTROY` option was specified when creating the vector, any pointer values still in the vector will be `free()`d prior to destruction.

#### Parameters

|               |                          |
|---------------|--------------------------|
| <i>vector</i> | A pointer to the vector. |
|---------------|--------------------------|

#### 6.7.3.8 `bool vector_element_at_index ( Vector vector, const size_t index, void * p )`

Gets the value at the specified index of the vector.

#### Parameters

|               |   |
|---------------|---|
| <i>vector</i> | A pointer to the vector.  |
| <i>index</i>  | The index of the value to get.  |
| <i>p</i>      | A pointer to an object of a type appropriate to the type set when creating the vector. The object at this address will be modified to contain the value at the specified index. |

#### Return values

|              |                                  |
|--------------|----------------------------------|
| <i>true</i>  | Success                          |
| <i>false</i> | Failure, index was out of range. |

#### 6.7.3.9 `bool vector_find ( Vector vector, size_t * index, ... )`

Tests if a value is contained in a vector.

#### Parameters

|               |  |
|---------------|--|
| <i>vector</i> | A pointer to the vector.   |
| <i>index</i>  | A pointer to a <code>size_t</code> object which, if the value is contained within the vector, will be modified to contain the index of the first occurrence of that value in the vector. |
| <i>...</i>    | The value for which to search. This should be of a type appropriate to the type set when creating the vector.  |

#### Return values

|              |                                       |
|--------------|---------------------------------------|
| <i>true</i>  | The value was found in the vector     |
| <i>false</i> | The value was not found in the vector |

#### 6.7.3.10 `size_t vector_free_space ( Vector vector )`

Returns the free space in a vector.

The free space in a vector is equivalent to its capacity less its length. The free space can change if a vector dynamically resizes to append an element at the back of the vector, or if elements are deleted from the vector.

#### Parameters

|               |                          |
|---------------|--------------------------|
| <i>vector</i> | A pointer to the vector. |
|---------------|--------------------------|

#### Returns

The free space in the vector.



6.7.3.11 `bool vector_insert ( Vector vector, const size_t index, ... )`

Inserts a value into a vector.

## Parameters

|               |   |
|---------------|---|
| <i>vector</i> | A pointer to the list.  |
| <i>index</i>  | The index at which to insert the value.   |
| <i>...</i>    | The value to insert into the vector. This should be of a type appropriate to the type set when creating the vector. |

## Return values

|              |  |
|--------------|--|
| <i>true</i>  | Success  |
| <i>false</i> | Failure, dynamic memory allocation failed or index was out of range. |

6.7.3.12 `bool vector_is_empty ( Vector vector )`

Tests if a vector is empty.

## Parameters

|               |                          |
|---------------|--------------------------|
| <i>vector</i> | A pointer to the vector. |
|---------------|--------------------------|

## Return values

|              |                         |
|--------------|-------------------------|
| <i>true</i>  | The vector is empty     |
| <i>false</i> | The vector is not empty |

6.7.3.13 `size_t vector_length ( Vector vector )`

Returns the length of a vector.

The length of the vector is equivalent to the number of values it contains. This can be less than the initial capacity, and as low as zero, if elements have been deleted from the vector.

## Parameters

|               |                          |
|---------------|--------------------------|
| <i>vector</i> | A pointer to the vector. |
|---------------|--------------------------|

## Returns

The length of the vector.

6.7.3.14 `bool vector_prepend ( Vector vector, ... )`

Prepends a value to the front of a vector.

## Parameters

|               |   |
|---------------|---|
| <i>vector</i> | A pointer to the vector.  |
| <i>...</i>    | The value to prepend to the start of the vector. This should be of a type appropriate to the type set when creating the vector. |

## Return values

|              |  |
|--------------|--|
| <i>true</i>  | Success                                    |
| <i>false</i> | Failure, dynamic memory allocation failed. |

**6.7.3.15** void `vector_reverse_sort` ( **Vector** *vector* )

Sorts a vector in-place, in descending order.

## Parameters

|               |                          |
|---------------|--------------------------|
| <i>vector</i> | A pointer to the vector. |
|---------------|--------------------------|

**6.7.3.16** bool `vector_set_element_at_index` ( **Vector** *vector*, const size\_t *index*, ... )

Sets the value at the specified index of the vector.

## Parameters

|               |   |
|---------------|---|
| <i>vector</i> | A pointer to the vector.  |
| <i>index</i>  | The index of the value to set.  |
| ...           | The value to which to set the specified index of the vector. This should be of a type appropriate to the type set when creating the vector. |

## Return values

|              |                                  |
|--------------|----------------------------------|
| <i>true</i>  | Success                          |
| <i>false</i> | Failure, index was out of range. |

**6.7.3.17** void `vector_sort` ( **Vector** *vector* )

Sorts a vector in-place, in ascending order.

## Parameters

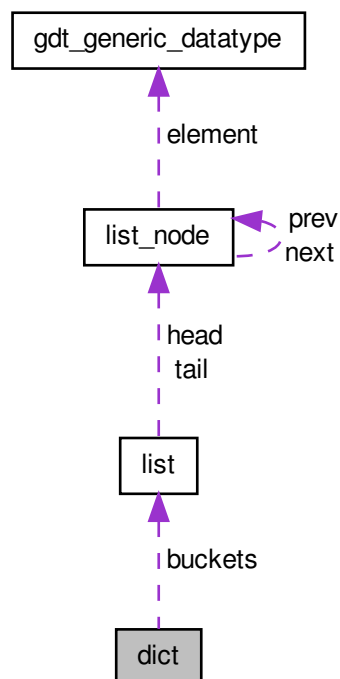
|               |                          |
|---------------|--------------------------|
| <i>vector</i> | A pointer to the vector. |
|---------------|--------------------------|

## Chapter 7

# Data Structure Documentation

### 7.1 dict Struct Reference

Collaboration diagram for dict:



#### Data Fields

- `size_t num_buckets`
- `List * buckets`
- `enum gds_datatype type`
- `bool free_on_destroy`
- `bool exit_on_error`

### 7.1.1 Detailed Description

Dict structure

### 7.1.2 Field Documentation

#### 7.1.2.1 List\* dict::buckets

The buckets

#### 7.1.2.2 bool dict::exit\_on\_error

Exit on error if true

#### 7.1.2.3 bool dict::free\_on\_destroy

Free pointer elements on destroy if true

#### 7.1.2.4 size\_t dict::num\_buckets

Number of buckets

#### 7.1.2.5 enum gds\_datatype dict::type

Dict datatype

The documentation for this struct was generated from the following file:

- [src/dict.c](#)

## 7.2 gdt\_generic\_datatype Struct Reference

Generic datatype structure.

```
#include <gdt.h>
```

### Data Fields

- enum [gds\\_datatype](#) type
- [gds\\_cfunc](#) compfunc
- union {
  - char [c](#)
  - unsigned char [uc](#)
  - signed char [sc](#)
  - int [i](#)
  - unsigned int [ui](#)
  - long [l](#)
  - unsigned long [ul](#)
  - long long int [ll](#)
  - unsigned long long int [ull](#)
  - size\_t [st](#)
  - double [d](#)

```
char * pc  
void * p  
} data
```

### 7.2.1 Detailed Description

Generic datatype structure.

### 7.2.2 Field Documentation

#### 7.2.2.1 char gdt\_generic\_datatype::c

char

#### 7.2.2.2 gds\_cfunc gdt\_generic\_datatype::compfunc

Comparison function pointer

#### 7.2.2.3 double gdt\_generic\_datatype::d

double

#### 7.2.2.4 union { ... } gdt\_generic\_datatype::data

Data union

#### 7.2.2.5 int gdt\_generic\_datatype::i

int

#### 7.2.2.6 long gdt\_generic\_datatype::l

long

#### 7.2.2.7 long long int gdt\_generic\_datatype::ll

long long

#### 7.2.2.8 void\* gdt\_generic\_datatype::p

void \*

#### 7.2.2.9 char\* gdt\_generic\_datatype::pc

char \*, string

#### 7.2.2.10 signed char gdt\_generic\_datatype::sc

signed char

#### 7.2.2.11 `size_t gdt_generic_datatype::st`

`size_t`

#### 7.2.2.12 `enum gds_datatype gdt_generic_datatype::type`

Data type

#### 7.2.2.13 `unsigned char gdt_generic_datatype::uc`

unsigned char

#### 7.2.2.14 `unsigned int gdt_generic_datatype::ui`

unsigned int

#### 7.2.2.15 `unsigned long gdt_generic_datatype::ul`

unsigned long

#### 7.2.2.16 `unsigned long long int gdt_generic_datatype::ull`

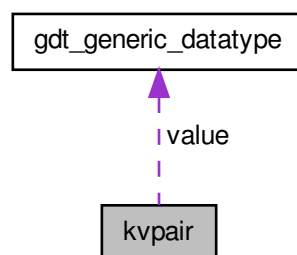
unsigned long long

The documentation for this struct was generated from the following file:

- [include/private/gdt.h](#)

## 7.3 kvpair Struct Reference

Collaboration diagram for kvpair:



### Data Fields

- `char * key`
- `struct gdt\_generic\_datatype value`

### 7.3.1 Detailed Description

Key-Value pair structure

### 7.3.2 Field Documentation

#### 7.3.2.1 `char* kvpair::key`

String key

#### 7.3.2.2 `struct gdt_generic_datatype kvpair::value`

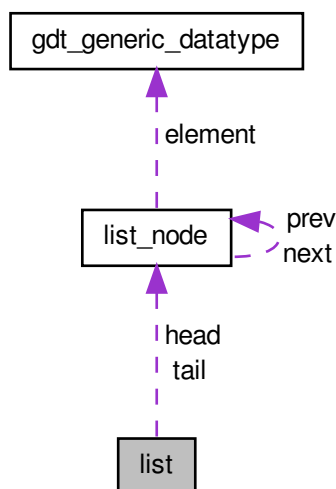
Generic datatype value

The documentation for this struct was generated from the following file:

- [src/dict.c](#)

## 7.4 list Struct Reference

Collaboration diagram for list:



### Data Fields

- `size_t` [length](#)
- `enum` [gds\\_datatype](#) `type`
- `gds_cfunc` `compfunc`
- `struct list_node *` `head`
- `struct list_node *` `tail`
- `bool` `free_on_destroy`
- `bool` `exit_on_error`

### 7.4.1 Detailed Description

List structure

### 7.4.2 Field Documentation

#### 7.4.2.1 `gds_cfunc list::compfunc`

Element comparison function

#### 7.4.2.2 `bool list::exit_on_error`

Exit on error if true

#### 7.4.2.3 `bool list::free_on_destroy`

Free pointer elements on destroy if true

#### 7.4.2.4 `struct list_node* list::head`

Pointer to head of list

#### 7.4.2.5 `size_t list::length`

Length of list

#### 7.4.2.6 `struct list_node* list::tail`

Pointer to tail of list

#### 7.4.2.7 `enum gds_datatype list::type`

List datatype

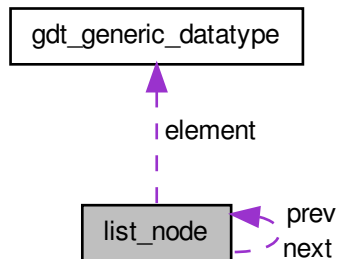
The documentation for this struct was generated from the following file:

- [src/list.c](#)



## 7.5 list\_node Struct Reference

Collaboration diagram for list\_node:



### Data Fields

- struct [gdt\\_generic\\_datatype](#) [element](#)
- struct [list\\_node](#) \* [prev](#)
- struct [list\\_node](#) \* [next](#)

### 7.5.1 Detailed Description

List node structure

### 7.5.2 Field Documentation

#### 7.5.2.1 struct [gdt\\_generic\\_datatype](#) list\_node::element

Data element

#### 7.5.2.2 struct [list\\_node](#)\* list\_node::next

Pointer to next node

#### 7.5.2.3 struct [list\\_node](#)\* list\_node::prev

Pointer to previous node

The documentation for this struct was generated from the following file:

- [src/list.c](#)

## 7.6 pair\_string Struct Reference

Structure to hold a string pair.

```
#include <string_util.h>
```

## Data Fields

- char \* [first](#)
- char \* [second](#)

### 7.6.1 Detailed Description

Structure to hold a string pair.

### 7.6.2 Field Documentation

#### 7.6.2.1 char\* pair\_string::first

First string of pair

#### 7.6.2.2 char\* pair\_string::second

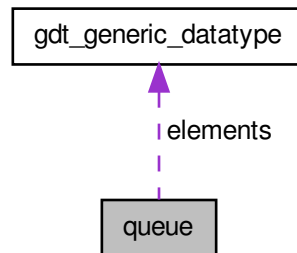
Second string of pair

The documentation for this struct was generated from the following file:

- include/public/[string\\_util.h](#)

## 7.7 queue Struct Reference

Collaboration diagram for queue:



## Data Fields

- size\_t [front](#)
- size\_t [back](#)
- size\_t [capacity](#)
- size\_t [size](#)
- enum [gds\\_datatype](#) type
- struct [gdt\\_generic\\_datatype](#) \* [elements](#)
- bool [resizable](#)
- bool [free\\_on\\_destroy](#)
- bool [exit\\_on\\_error](#)

### 7.7.1 Detailed Description

Queue structure

### 7.7.2 Field Documentation

#### 7.7.2.1 `size_t queue::back`

Back of queue

#### 7.7.2.2 `size_t queue::capacity`

Capacity of queue

#### 7.7.2.3 `struct gdt_generic_datatype* queue::elements`

Pointer to elements

#### 7.7.2.4 `bool queue::exit_on_error`

Exit on error if true

#### 7.7.2.5 `bool queue::free_on_destroy`

Free pointer elements on destroy if true

#### 7.7.2.6 `size_t queue::front`

Front of queue

#### 7.7.2.7 `bool queue::resizable`

Dynamically resizable if true

#### 7.7.2.8 `size_t queue::size`

Size of queue

#### 7.7.2.9 `enum gds_datatype queue::type`

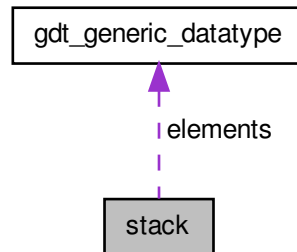
Queue datatype

The documentation for this struct was generated from the following file:

- [src/queue.c](#)

## 7.8 stack Struct Reference

Collaboration diagram for stack:



### Data Fields

- `size_t` [top](#)
- `size_t` [capacity](#)
- `enum` [gds\\_datatype](#) `type`
- `struct` [gdt\\_generic\\_datatype](#) \* `elements`
- `bool` [resizable](#)
- `bool` [free\\_on\\_destroy](#)
- `bool` [exit\\_on\\_error](#)

### 7.8.1 Detailed Description

Stack structure

### 7.8.2 Field Documentation

#### 7.8.2.1 `size_t` `stack::capacity`

Stack capacity

#### 7.8.2.2 `struct gdt_generic_datatype*` `stack::elements`

Pointer to elements

#### 7.8.2.3 `bool` `stack::exit_on_error`

Exit on error if true

#### 7.8.2.4 `bool` `stack::free_on_destroy`

Free pointer elements on destroy if true

#### 7.8.2.5 bool stack::resizable

Dynamically resizable if true

#### 7.8.2.6 size\_t stack::top

Top of stack

#### 7.8.2.7 enum gds\_datatype stack::type

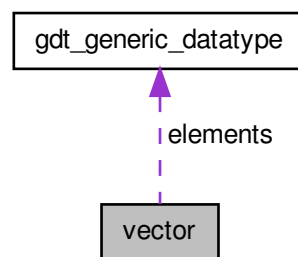
Stack datatype

The documentation for this struct was generated from the following file:

- [src/stack.c](#)

## 7.9 vector Struct Reference

Collaboration diagram for vector:



### Data Fields

- size\_t [length](#)
- size\_t [capacity](#)
- enum [gds\\_datatype](#) [type](#)
- struct [gdt\\_generic\\_datatype](#) \* [elements](#)
- int(\* [compfunc](#) )(const void \*, const void \*)
- bool [free\\_on\\_destroy](#)
- bool [exit\\_on\\_error](#)

### 7.9.1 Detailed Description

Vector structure

## 7.9.2 Field Documentation

### 7.9.2.1 `size_t vector::capacity`

Vector capacity

### 7.9.2.2 `int(* vector::compfunc)(const void *, const void *)`

Compare function

### 7.9.2.3 `struct gdt_generic_datatype* vector::elements`

Pointer to elements

### 7.9.2.4 `bool vector::exit_on_error`

Exit on error if true

### 7.9.2.5 `bool vector::free_on_destroy`

Free pointer elements on destroy if true

### 7.9.2.6 `size_t vector::length`

Vector length

### 7.9.2.7 `enum gds_datatype vector::type`

Vector datatype

The documentation for this struct was generated from the following file:

- [src/vector.c](#)

## Chapter 8

# File Documentation

### 8.1 gds.dox File Reference

### 8.2 include/private/gds\_common.h File Reference

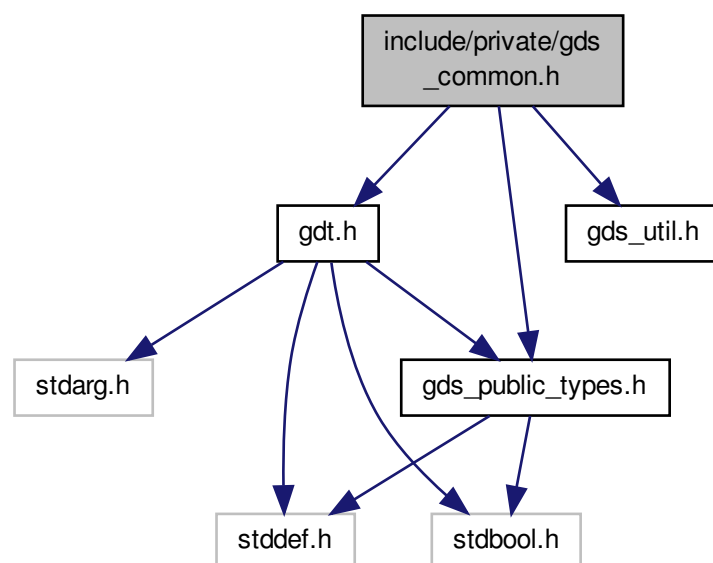
Common internal headers for data structures.

```
#include "gds_public_types.h"
```

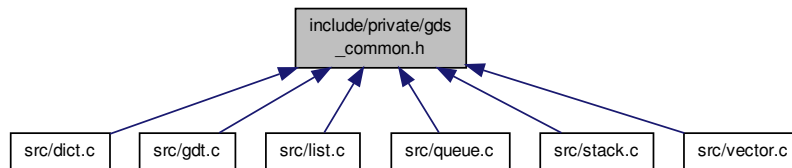
```
#include "gdt.h"
```

```
#include "gds_util.h"
```

Include dependency graph for gds\_common.h:



This graph shows which files directly or indirectly include this file:



### 8.2.1 Detailed Description

Common internal headers for data structures.

#### Author

Paul Griffiths

#### Copyright

Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

## 8.3 include/private/gdt.dox File Reference

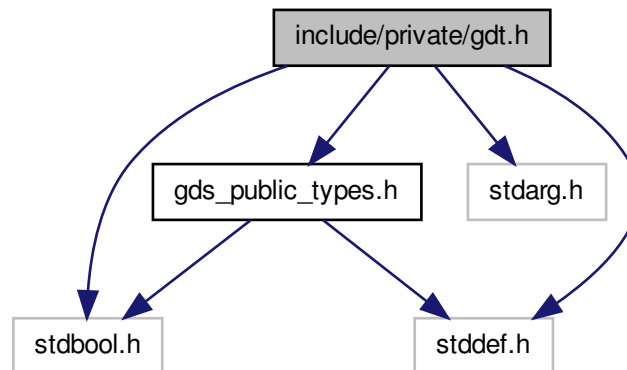
## 8.4 include/private/gdt.h File Reference

Interface to generic data element functionality.

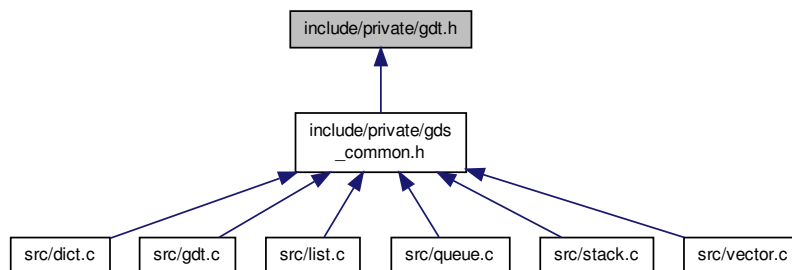
```
#include <stdbool.h>
#include <stddef.h>
#include <stdarg.h>
#include "gds_public_types.h"
```



Include dependency graph for gdt.h:



This graph shows which files directly or indirectly include this file:



## Data Structures

- struct [gdt\\_generic\\_datatype](#)  
*Generic datatype structure.*

## Functions

- void [gdt\\_set\\_value](#) (struct [gdt\\_generic\\_datatype](#) \*data, const enum [gds\\_datatype](#) type, [gds\\_cfunc](#) cfunc, va\_list ap)  
*Sets the value of a generic datatype.*
- void [gdt\\_get\\_value](#) (const struct [gdt\\_generic\\_datatype](#) \*data, void \*p)  
*Gets the value of a generic datatype.*
- void [gdt\\_free](#) (struct [gdt\\_generic\\_datatype](#) \*data)  
*Frees memory pointed to by a generic datatype.*
- int [gdt\\_compare](#) (const struct [gdt\\_generic\\_datatype](#) \*d1, const struct [gdt\\_generic\\_datatype](#) \*d2)  
*Compares two generic datatypes.*

- int [gdt\\_compare\\_void](#) (const void \*p1, const void \*p2)

*Compares two generic datatypes via void pointers.*

- int [gdt\\_reverse\\_compare\\_void](#) (const void \*p1, const void \*p2)

*Reverse compares two generic datatypes via void pointers.*

### 8.4.1 Detailed Description

Interface to generic data element functionality.

#### Author

Paul Griffiths

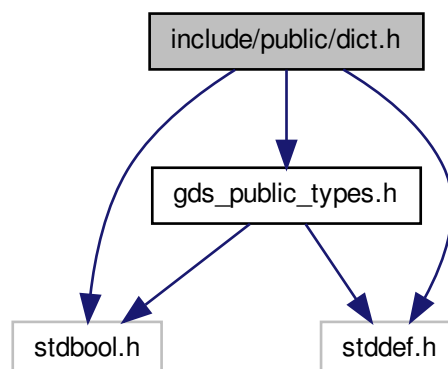
#### Copyright

Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

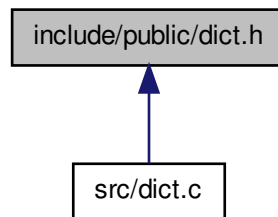
## 8.5 include/public/dict.h File Reference

Interface to generic dictionary data structure.

```
#include <stdbool.h>
#include <stddef.h>
#include "gds_public_types.h"
Include dependency graph for dict.h:
```



This graph shows which files directly or indirectly include this file:



## Typedefs

- typedef struct `dict` \* `Dict`  
*Opaque dictionary type definition.*

## Functions

- `Dict dict_create` (const enum `gds_datatype` type, const int opts)  
*Creates a new dictionary.*
- void `dict_destroy` (`Dict dict`)  
*Destroys a dictionary.*
- bool `dict_insert` (`Dict dict`, const char \*key,...)  
*Inserts a key-value into a dictionary.*
- bool `dict_has_key` (`Dict dict`, const char \*key)  
*Checks whether a key exists in a dictionary.*
- bool `dict_value_for_key` (`Dict dict`, const char \*key, void \*p)  
*Retrieves the value for a key in the dictionary.*

### 8.5.1 Detailed Description

Interface to generic dictionary data structure.

#### Author

Paul Griffiths

#### Copyright

Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

### 8.5.2 Typedef Documentation

#### 8.5.2.1 typedef struct `dict`\* `Dict`

Opaque dictionary type definition.

### 8.5.3 Function Documentation

#### 8.5.3.1 Dict dict\_create ( const enum gds\_datatype type, const int opts )

Creates a new dictionary.

##### Parameters

|             |   |
|-------------|---|
| <i>type</i> | The datatype for the dictionary.  |
| <i>opts</i> | The following options can be OR'd together: <code>GDS_FREE_ON_DESTROY</code> to automatically <code>free()</code> pointer members when they are deleted or when the dictionary is destroyed; <code>GDS_EXIT_ON_ERROR</code> to print a message to the standard error stream and <code>exit()</code> , rather than returning a failure status. |

##### Return values

|                 |                                  |
|-----------------|----------------------------------|
| <i>NULL</i>     | Dictionary creation failed.      |
| <i>non-NULL</i> | A pointer to the new dictionary. |

#### 8.5.3.2 void dict\_destroy ( Dict dict )

Destroys a dictionary.

If the `GDS_FREE_ON_DESTROY` option was specified when creating the dictionary, any pointer values still in the dictionary will be `free()`d prior to destruction.

##### Parameters

|             |                              |
|-------------|------------------------------|
| <i>dict</i> | A pointer to the dictionary. |
|-------------|------------------------------|

#### 8.5.3.3 bool dict\_has\_key ( Dict dict, const char \* key )

Checks whether a key exists in a dictionary.

##### Parameters

|             |                              |
|-------------|------------------------------|
| <i>dict</i> | A pointer to the dictionary. |
| <i>key</i>  | The key for which to search. |

##### Return values

|              |  |
|--------------|--|
| <i>true</i>  | The key exists in the dictionary         |
| <i>false</i> | The key does not exist in the dictionary |

#### 8.5.3.4 bool dict\_insert ( Dict dict, const char \* key, ... )

Inserts a key-value into a dictionary.

If the key already exists in the dictionary, the existing value will be overwritten. If `GDS_FREE_ON_DESTROY` was specified during dictionary creation, the existing element will be `free()`d prior to overwriting it.

##### Parameters

|             |                              |
|-------------|------------------------------|
| <i>dict</i> | A pointer to the dictionary. |
| <i>key</i>  | The key.                     |

|     |  |
|-----|--|
| ... | The value corresponding to the key. This should be of a type appropriate to the type set when creating the dictionary. |
|-----|--|

## Return values

|              |   |
|--------------|---|
| <i>true</i>  | Success                                   |
| <i>false</i> | Failure, dynamic memory allocation failed |

## 8.5.3.5 bool dict\_value\_for\_key ( Dict dict, const char \* key, void \* p )

Retrieves the value for a key in the dictionary.

## Parameters

|             |  |
|-------------|--|
| <i>dict</i> | A pointer to the dictionary.   |
| <i>key</i>  | The key for which to retrieve the value.   |
| <i>p</i>    | A pointer to an object of a type appropriate to the type set when creating the dictionary. The object at this address will be modified to contain the value for the specified key. |

## Return values

|              |                            |
|--------------|----------------------------|
| <i>true</i>  | Success                    |
| <i>false</i> | Failure, key was not found |

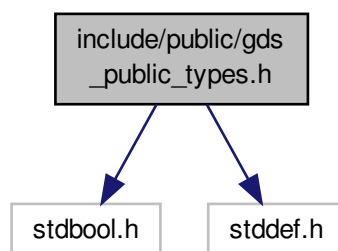
## 8.6 include/public/gds\_public\_types.h File Reference

Common public types for generic data structures library.

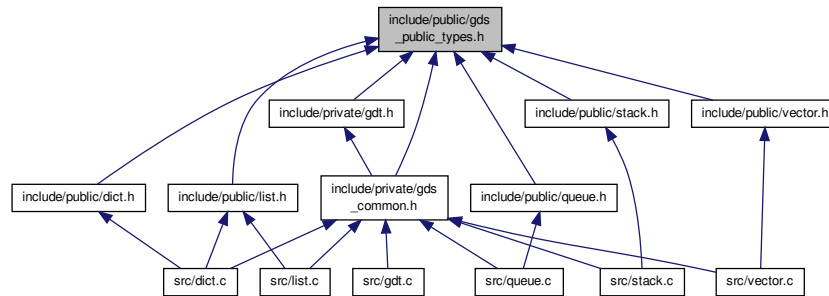
```
#include <stdbool.h>
```

```
#include <stddef.h>
```

Include dependency graph for gds\_public\_types.h:



This graph shows which files directly or indirectly include this file:



## Typedefs

- typedef int(\* [gds\\_cfunc](#))(const void \*, const void \*)

*Type definition for comparison function pointer.*

## Enumerations

- enum [gds\\_option](#) { [GDS\\_RESIZABLE](#) = 1, [GDS\\_FREE\\_ON\\_DESTROY](#) = 2, [GDS\\_EXIT\\_ON\\_ERROR](#) = 4 }

*Enumeration type for data structure options.*

- enum [gds\\_datatype](#) { [DATATYPE\\_CHAR](#), [DATATYPE\\_UNSIGNED\\_CHAR](#), [DATATYPE\\_SIGNED\\_CHAR](#), [DATATYPE\\_INT](#), [DATATYPE\\_UNSIGNED\\_INT](#), [DATATYPE\\_LONG](#), [DATATYPE\\_UNSIGNED\\_LONG](#), [DATATYPE\\_LONG\\_LONG](#), [DATATYPE\\_UNSIGNED\\_LONG\\_LONG](#), [DATATYPE\\_SIZE\\_T](#), [DATATYPE\\_DOUBLE](#), [DATATYPE\\_STRING](#), [DATATYPE\\_POINTER](#) }

*Enumeration type for data element type.*

### 8.6.1 Detailed Description

Common public types for generic data structures library.

#### Author

Paul Griffiths

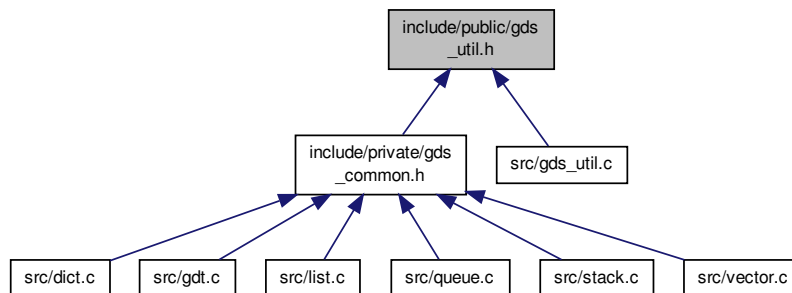
#### Copyright

Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

## 8.7 include/public/gds\_util.h File Reference

Interface to general utility functions.

This graph shows which files directly or indirectly include this file:



## Functions

- void `gds_strerror_quit` (const char \*msg,...)  
*Prints an error message with error number and exits.*
- void `gds_error_quit` (const char \*msg,...)  
*Prints an error message exits.*
- void `gds_assert_quit` (const char \*msg,...)  
*Prints an error message exits via assert().*
- char \* `gds_strdup` (const char \*str)  
*Dynamically duplicates a string.*

### 8.7.1 Detailed Description

Interface to general utility functions.

#### Author

Paul Griffiths

#### Copyright

Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

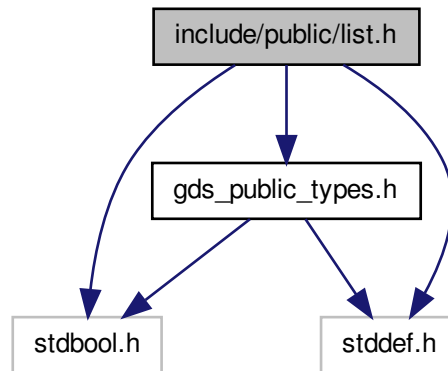
## 8.8 include/public/general.dox File Reference

## 8.9 include/public/list.dox File Reference

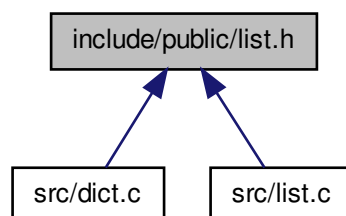
## 8.10 include/public/list.h File Reference

Interface to generic list data structure.

```
#include <stdbool.h>
#include <stddef.h>
#include "gds_public_types.h"
Include dependency graph for list.h:
```



This graph shows which files directly or indirectly include this file:



## Typedefs

- typedef struct `list` \* `List`  
*Opaque list type definition.*
- typedef struct `list_node` \* `ListIter`  
*Opaque list iterator type definition.*

## Functions

- `List list_create` (const enum `gds_datatype` type, const int opts,...)  
*Creates a new list.*
- void `list_destroy` (`List list`)  
*Destroys a list.*



- `bool list_append (List list,...)`  
*Appends a value to the back of a list.*
- `bool list_prepend (List list,...)`  
*Prepends a value to the front of a list.*
- `bool list_insert (List list, const size_t index,...)`  
*Inserts a value into a list.*
- `bool list_delete_front (List list)`  
*Deletes the value at the front of the list.*
- `bool list_delete_back (List list)`  
*Deletes the value at the back of the list.*
- `bool list_delete_index (List list, const size_t index)`  
*Deletes the value at the specified index of the list.*
- `bool list_element_at_index (List list, const size_t index, void *p)`  
*Gets the value at the specified index of the list.*
- `bool list_set_element_at_index (List list, const size_t index,...)`  
*Sets the value at the specified index of the list.*
- `bool list_find (List list, size_t *index,...)`  
*Tests if a value is contained in a list.*
- `Listltr list_find_itr (List list,...)`  
*Tests if a value is contained in a list.*
- `bool list_sort (List list)`  
*Sorts a list in-place, in ascending order.*
- `bool list_reverse_sort (List list)`  
*Sorts a list in-place, in descending order.*
- `Listltr list_itr_first (List list)`  
*Returns an iterator to the first element of the list.*
- `Listltr list_itr_last (List list)`  
*Returns an iterator to the last element of the list.*
- `Listltr list_itr_next (Listltr itr)`  
*Increments a list iterator.*
- `Listltr list_itr_previous (Listltr itr)`  
*Decrements a list iterator.*
- `void list_get_value_itr (Listltr itr, void *p)`  
*Retrieves a value from an iterator.*
- `bool list_is_empty (List list)`  
*Tests if a list is empty.*
- `size_t list_length (List list)`  
*Returns the length of a list.*

### 8.10.1 Detailed Description

Interface to generic list data structure. The list is implemented as a double-ended, double-linked list.

#### Author

Paul Griffiths

#### Copyright

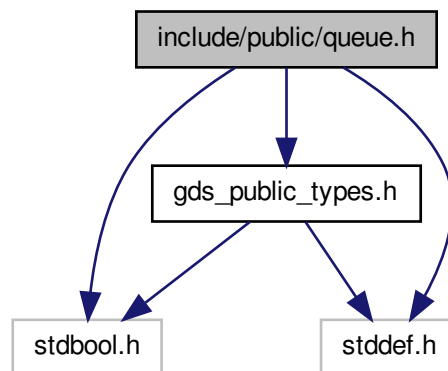
Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

## 8.11 include/public/queue.dox File Reference

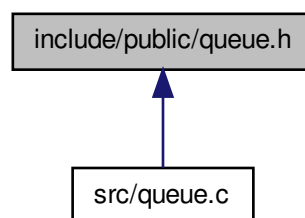
## 8.12 include/public/queue.h File Reference

Interface to generic queue data structure.

```
#include <stdbool.h>
#include <stddef.h>
#include "gds_public_types.h"
Include dependency graph for queue.h:
```



This graph shows which files directly or indirectly include this file:



### Typedefs

- typedef struct `queue` \* `Queue`  
*Opaque queue type definition.*

## Functions

- `Queue queue_create` (const size\_t capacity, const enum `gds_datatype` type, const int opts)  
*Creates a new queue.*
- void `queue_destroy` (Queue queue)  
*Destroys a queue.*
- bool `queue_push` (Queue queue,...)  
*Pushes a value onto the queue.*
- bool `queue_pop` (Queue queue, void \*p)  
*Pops a value from the queue.*
- bool `queue_peek` (Queue queue, void \*p)  
*Peeks at the top value of the queue.*
- bool `queue_is_full` (Queue queue)  
*Checks whether a queue is full.*
- bool `queue_is_empty` (Queue queue)  
*Checks whether a queue is empty.*
- size\_t `queue_capacity` (Queue queue)  
*Retrieves the current capacity of a queue.*
- size\_t `queue_size` (Queue queue)  
*Retrieves the current size of a queue.*
- size\_t `queue_free_space` (Queue queue)  
*Retrieves the free space on a queue.*

### 8.12.1 Detailed Description

Interface to generic queue data structure.

#### Author

Paul Griffiths

#### Copyright

Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

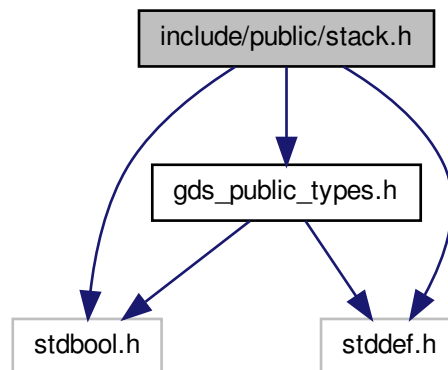
## 8.13 include/public/stack.dox File Reference

## 8.14 include/public/stack.h File Reference

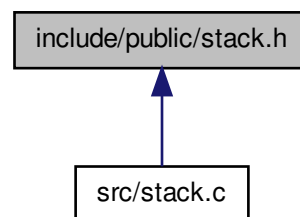
Interface to generic stack data structure.

```
#include <stdbool.h>
#include <stddef.h>
#include "gds_public_types.h"
```

Include dependency graph for `stack.h`:



This graph shows which files directly or indirectly include this file:



## Typedefs

- `typedef struct stack * Stack`  
*Opaque stack type definition.*

## Functions

- `Stack stack\_create (const size_t capacity, const enum gds\_datatype type, const int opts)`  
*Creates a new stack.*
- `void stack\_destroy (Stack stack)`  
*Destroys a stack.*
- `bool stack\_push (Stack stack,...)`  
*Pushes a value onto the stack.*
- `bool stack\_pop (Stack stack, void *p)`  
*Pops a value from the stack.*

- bool [stack\\_peek](#) (Stack stack, void \*p)  
*Peeks at the top value of the stack.*
- bool [stack\\_is\\_full](#) (Stack stack)  
*Checks whether a stack is full.*
- bool [stack\\_is\\_empty](#) (Stack stack)  
*Checks whether a stack is empty.*
- size\_t [stack\\_capacity](#) (Stack stack)  
*Retrieves the current capacity of a stack.*
- size\_t [stack\\_size](#) (Stack stack)  
*Retrieves the current size of a stack.*
- size\_t [stack\\_free\\_space](#) (Stack stack)  
*Retrieves the free space on a stack.*

### 8.14.1 Detailed Description

Interface to generic stack data structure.

#### Author

Paul Griffiths

#### Copyright

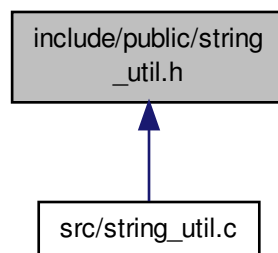
Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

## 8.15 include/public/string\_util.dox File Reference

## 8.16 include/public/string\_util.h File Reference

Interface to string utility functions.

This graph shows which files directly or indirectly include this file:



### Data Structures

- struct [pair\\_string](#)  
*Structure to hold a string pair.*

## Functions

- char \* [trim\\_line\\_ending](#) (char \*str)  
*Trims CR and LF characters from the end of a string.*
- char \* [trim\\_right](#) (char \*str)  
*Trims trailing whitespace from a string.*
- char \* [trim\\_left](#) (char \*str)  
*Trims leading whitespace from a string.*
- char \* [trim](#) (char \*str)  
*Trims leading and trailing whitespace from a string.*
- char \* [pg\\_strdup](#) (const char \*str)  
*Duplicates a string.*
- char \* [pg\\_strndup](#) (const char \*str, const size\_t n)  
*Duplicates at most n characters of a string.*
- struct [pair\\_string](#) \* [pair\\_string\\_create](#) (const char \*str, const char delim)  
*Splits a string into a string pair.*
- void [pair\\_string\\_destroy](#) (struct [pair\\_string](#) \*pair)  
*Destroys a string pair.*

### 8.16.1 Detailed Description

Interface to string utility functions.

#### Author

Paul Griffiths

#### Copyright

Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

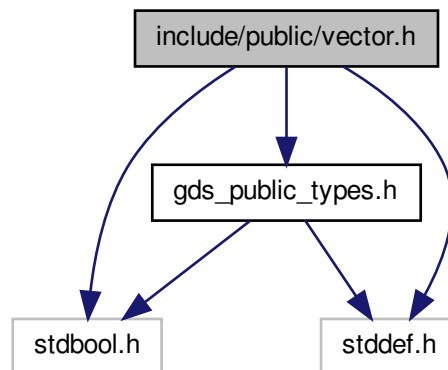
## 8.17 include/public/vector.dox File Reference

## 8.18 include/public/vector.h File Reference

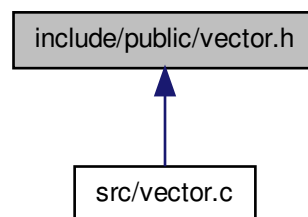
Interface to generic vector data structure.

```
#include <stdbool.h>
#include <stddef.h>
#include "gds_public_types.h"
```

Include dependency graph for vector.h:



This graph shows which files directly or indirectly include this file:



## Typedefs

- typedef struct `vector` \* `Vector`  
*Opaque vector type definition.*

## Functions

- `Vector vector_create` (const size\_t capacity, const enum `gds_datatype` type, const int opts,...)  
*Creates a new vector.*
- void `vector_destroy` (`Vector vector`)  
*Destroys a vector.*
- bool `vector_append` (`Vector vector`,...)  
*Appends a value to the back of a vector.*
- bool `vector_prepend` (`Vector vector`,...)  
*Prepends a value to the front of a vector.*

- bool `vector_insert` (`Vector vector`, const size\_t index,...)  
*Inserts a value into a vector.*
- bool `vector_delete_front` (`Vector vector`)  
*Deletes the value at the front of the vector.*
- bool `vector_delete_back` (`Vector vector`)  
*Deletes the value at the back of the vector.*
- bool `vector_delete_index` (`Vector vector`, const size\_t index)  
*Deletes the value at the specified index of the vector.*
- bool `vector_element_at_index` (`Vector vector`, const size\_t index, void \*p)  
*Gets the value at the specified index of the vector.*
- bool `vector_set_element_at_index` (`Vector vector`, const size\_t index,...)  
*Sets the value at the specified index of the vector.*
- bool `vector_find` (`Vector vector`, size\_t \*index,...)  
*Tests if a value is contained in a vector.*
- void `vector_sort` (`Vector vector`)  
*Sorts a vector in-place, in ascending order.*
- void `vector_reverse_sort` (`Vector vector`)  
*Sorts a vector in-place, in descending order.*
- bool `vector_is_empty` (`Vector vector`)  
*Tests if a vector is empty.*
- size\_t `vector_length` (`Vector vector`)  
*Returns the length of a vector.*
- size\_t `vector_capacity` (`Vector vector`)  
*Returns the capacity of a vector.*
- size\_t `vector_free_space` (`Vector vector`)  
*Returns the free space in a vector.*

### 8.18.1 Detailed Description

Interface to generic vector data structure.

#### Author

Paul Griffiths

#### Copyright

Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

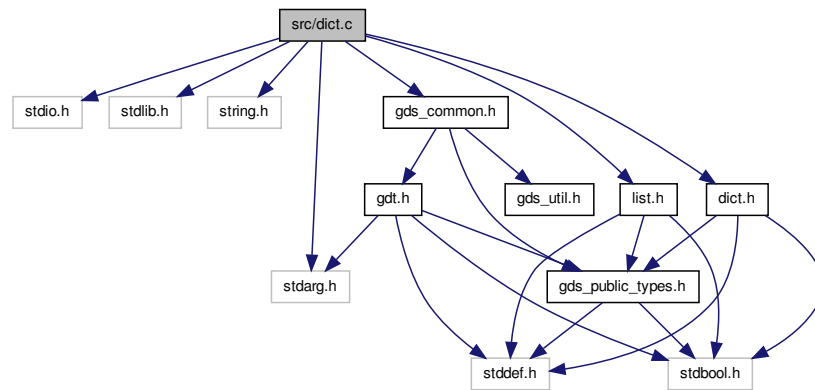
## 8.19 src/dict.c File Reference

Implementation of generic dictionary data structure.

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <stdarg.h>
#include "gds_common.h"
#include "dict.h"
#include "list.h"
```



Include dependency graph for dict.c:



## Data Structures

- struct [kvpair](#)
- struct [dict](#)

## Typedefs

- typedef struct [kvpair](#) \* [KVPair](#)

## Functions

- static [KVPair](#) [kvpair\\_create](#) (const char \*key, const enum [gds\\_datatype](#) type, va\_list ap)  
*Creates a new key-value pair.*
- static void [kvpair\\_destroy](#) ([KVPair](#) pair, const bool free\_value)  
*Destroys a key-value pair.*
- static int [kvpair\\_compare](#) (const void \*p1, const void \*p2)  
*Compares two key-value pairs by key.*
- static bool [dict\\_has\\_key\\_internal](#) ([Dict](#) dict, const char \*key, [KVPair](#) \*pair)  
*Internal function to check for the existence of a key.*
- static bool [dict\\_buckets\\_create](#) ([Dict](#) dict)  
*Helper function to create the dictionary buckets.*
- static void [dict\\_buckets\\_destroy](#) ([Dict](#) dict)  
*Helper function to destroy the dictionary buckets.*
- static size\_t [djb2hash](#) (const char \*str)  
*Calculates a hash of a string.*
- [Dict](#) [dict\\_create](#) (const enum [gds\\_datatype](#) type, const int opts)  
*Creates a new dictionary.*
- void [dict\\_destroy](#) ([Dict](#) dict)  
*Destroys a dictionary.*
- bool [dict\\_has\\_key](#) ([Dict](#) dict, const char \*key)  
*Checks whether a key exists in a dictionary.*
- bool [dict\\_insert](#) ([Dict](#) dict, const char \*key,...)  
*Inserts a key-value into a dictionary.*

- bool `dict_value_for_key` (`Dict dict`, `const char *key`, `void *p`)  
*Retrieves the value for a key in the dictionary.*

## Variables

- static const size\_t `BUCKETS` = 256

### 8.19.1 Detailed Description

Implementation of generic dictionary data structure.

#### Author

Paul Griffiths

#### Copyright

Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

### 8.19.2 Typedef Documentation

#### 8.19.2.1 typedef struct kvpair \* KVPair

Key-Value pair structure

### 8.19.3 Function Documentation

#### 8.19.3.1 static bool dict\_buckets\_create ( Dict dict ) [static]

Helper function to create the dictionary buckets.

##### Parameters

|                   |                              |
|-------------------|------------------------------|
| <code>dict</code> | A pointer to the dictionary. |
|-------------------|------------------------------|

##### Return values

|                    |  |
|--------------------|--|
| <code>true</code>  | Success                                    |
| <code>false</code> | Failure, dynamic memory allocation failed. |

#### 8.19.3.2 static void dict\_buckets\_destroy ( Dict dict ) [static]

Helper function to destroy the dictionary buckets.

##### Parameters

|                   |                              |
|-------------------|------------------------------|
| <code>dict</code> | A pointer to the dictionary. |
|-------------------|------------------------------|

#### 8.19.3.3 Dict dict\_create ( const enum gds\_datatype type, const int opts )

Creates a new dictionary.

## Parameters

|             |   |
|-------------|---|
| <i>type</i> | The datatype for the dictionary.  |
| <i>opts</i> | The following options can be OR'd together: <code>GDS_FREE_ON_DESTROY</code> to automatically <code>free()</code> pointer members when they are deleted or when the dictionary is destroyed; <code>GDS_EXIT_ON_ERROR</code> to print a message to the standard error stream and <code>exit()</code> , rather than returning a failure status. |

## Return values

|                 |                                  |
|-----------------|----------------------------------|
| <i>NULL</i>     | Dictionary creation failed.      |
| <i>non-NULL</i> | A pointer to the new dictionary. |

## 8.19.3.4 void dict\_destroy ( Dict dict )

Destroys a dictionary.

If the `GDS_FREE_ON_DESTROY` option was specified when creating the dictionary, any pointer values still in the dictionary will be `free()`d prior to destruction.

## Parameters

|             |                              |
|-------------|------------------------------|
| <i>dict</i> | A pointer to the dictionary. |
|-------------|------------------------------|

## 8.19.3.5 bool dict\_has\_key ( Dict dict, const char \* key )

Checks whether a key exists in a dictionary.

## Parameters

|             |                              |
|-------------|------------------------------|
| <i>dict</i> | A pointer to the dictionary. |
| <i>key</i>  | The key for which to search. |

## Return values

|              |  |
|--------------|--|
| <i>true</i>  | The key exists in the dictionary         |
| <i>false</i> | The key does not exist in the dictionary |

## 8.19.3.6 static bool dict\_has\_key\_internal ( Dict dict, const char \* key, KVPair \* pair ) [static]

Internal function to check for the existence of a key.

If the key is present, `pair` will be modified to contain the address of the key-value pair containing it.

## Parameters

|             |   |
|-------------|---|
| <i>dict</i> | A pointer to the dictionary.  |
| <i>key</i>  | The key for which to search.  |
| <i>pair</i> | A pointer to a key-value pair pointer. If the key is found, the pointer at this address will be modified to contain the address of the pair containing the key. |

## Return values

|              |                   |
|--------------|-------------------|
| <i>true</i>  | Key was found     |
| <i>false</i> | Key was not found |

### 8.19.3.7 `bool dict_insert ( Dict dict, const char * key, ... )`

Inserts a key-value into a dictionary.

If the key already exists in the dictionary, the existing value will be overwritten. If `GDS_FREE_ON_DESTROY` was specified during dictionary creation, the existing element will be `free()`d prior to overwriting it.

#### Parameters

|             |  |
|-------------|--|
| <i>dict</i> | A pointer to the dictionary.   |
| <i>key</i>  | The key.   |
| ...         | The value corresponding to the key. This should be of a type appropriate to the type set when creating the dictionary. |

#### Return values

|              |   |
|--------------|---|
| <i>true</i>  | Success                                   |
| <i>false</i> | Failure, dynamic memory allocation failed |

### 8.19.3.8 `bool dict_value_for_key ( Dict dict, const char * key, void * p )`

Retrieves the value for a key in the dictionary.

#### Parameters

|             |  |
|-------------|--|
| <i>dict</i> | A pointer to the dictionary.   |
| <i>key</i>  | The key for which to retrieve the value.   |
| <i>p</i>    | A pointer to an object of a type appropriate to the type set when creating the dictionary. The object at this address will be modified to contain the value for the specified key. |

#### Return values

|              |                            |
|--------------|----------------------------|
| <i>true</i>  | Success                    |
| <i>false</i> | Failure, key was not found |

### 8.19.3.9 `static size_t djb2hash ( const char * str ) [static]`

Calculates a hash of a string.

Uses Dan Bernstein's djb2 algorithm.

#### Parameters

|            |                       |
|------------|-----------------------|
| <i>str</i> | A pointer to a string |
|------------|-----------------------|

#### Returns

The hash value

### 8.19.3.10 `static int kvpair_compare ( const void * p1, const void * p2 ) [static]`

Compares two key-value pairs by key.

This function is suitable for passing to `qsort()`.

## Parameters

|           |                               |
|-----------|-------------------------------|
| <i>p1</i> | A pointer to the first pair.  |
| <i>p2</i> | A pointer to the second pair. |

## Return values

|           |  |
|-----------|--|
| <i>0</i>  | The keys of the two pairs are equal                                  |
| <i>-1</i> | The key of the first pair is less than the key of the second pair    |
| <i>1</i>  | The key of the first pair is greater than the key of the second pair |

**8.19.3.11** `static KVPair kvpair_create ( const char * key, const enum gds_datatype type, va_list ap )` `[static]`

Creates a new key-value pair.

## Parameters

|             |   |
|-------------|---|
| <i>key</i>  | The key for the new pair.   |
| <i>type</i> | The datatype for the new pair   |
| <i>ap</i>   | A <code>va_list</code> containing the data value for the pair. This should be of a type appropriate to the type set when creating the list. |

## Return values

|                 |   |
|-----------------|---|
| <i>NULL</i>     | Failure, dynamic memory allocation failed |
| <i>non-NULL</i> | Success                                   |

**8.19.3.12** `static void kvpair_destroy ( KVPair pair, const bool free_value )` `[static]`

Destroys a key-value pair.

## Parameters

|                   |  |
|-------------------|--|
| <i>pair</i>       | A pointer to the pair to destroy.                              |
| <i>free_value</i> | If true, the data will be passed to <a href="#">gdt_free()</a> |

## 8.19.4 Variable Documentation

**8.19.4.1** `const size_t BUCKETS = 256` `[static]`

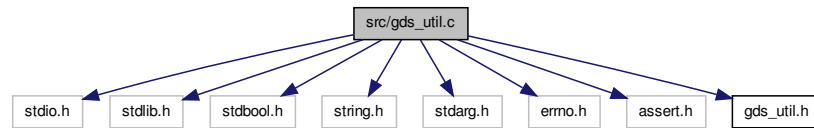
Number of buckets

## 8.20 src/gds\_util.c File Reference

Implementation of general utility functions.

```
#include <stdio.h>
#include <stdlib.h>
#include <stdbool.h>
#include <string.h>
#include <stdarg.h>
#include <errno.h>
#include <assert.h>
#include "gds_util.h"
```

Include dependency graph for gds\_util.c:



## Functions

- void [gds\\_strerror\\_quit](#) (const char \*msg,...)  
*Prints an error message with error number and exits.*
- void [gds\\_error\\_quit](#) (const char \*msg,...)  
*Prints an error message exits.*
- void [gds\\_assert\\_quit](#) (const char \*msg,...)  
*Prints an error message exits via assert().*
- char \* [gds\\_strdup](#) (const char \*str)  
*Dynamically duplicates a string.*

### 8.20.1 Detailed Description

Implementation of general utility functions.

#### Author

Paul Griffiths

#### Copyright

Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

## 8.21 src/gdt.c File Reference

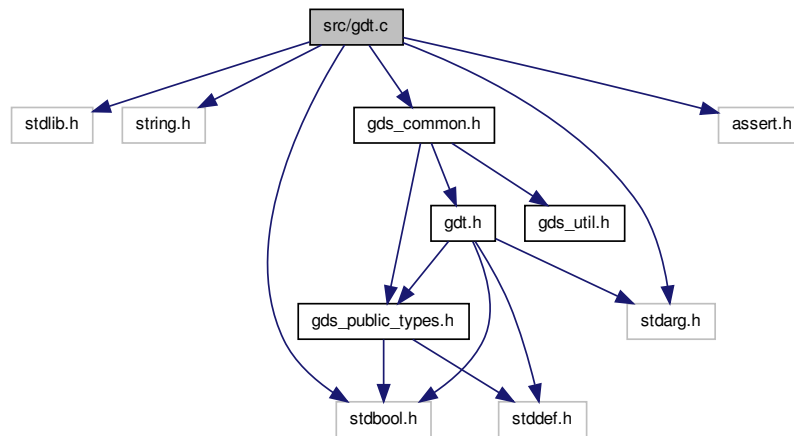
Implementation of generic data element functionality.

```

#include <stdlib.h>
#include <string.h>
#include <stdbool.h>
#include <assert.h>
#include <stdarg.h>
#include "gds_common.h"

```

Include dependency graph for gdt.c:



## Functions

- static int [gdt\\_compare\\_char](#) (const void \*p1, const void \*p2)  
*Compare function for char.*
- static int [gdt\\_compare\\_uchar](#) (const void \*p1, const void \*p2)  
*Compare function for unsigned char.*
- static int [gdt\\_compare\\_schar](#) (const void \*p1, const void \*p2)  
*Compare function for signed char.*
- static int [gdt\\_compare\\_int](#) (const void \*p1, const void \*p2)  
*Compare function for int.*
- static int [gdt\\_compare\\_uint](#) (const void \*p1, const void \*p2)  
*Compare function for unsigned int.*
- static int [gdt\\_compare\\_long](#) (const void \*p1, const void \*p2)  
*Compare function for long.*
- static int [gdt\\_compare\\_ulong](#) (const void \*p1, const void \*p2)  
*Compare function for unsigned long.*
- static int [gdt\\_compare\\_longlong](#) (const void \*p1, const void \*p2)  
*Compare function for long long.*
- static int [gdt\\_compare\\_ulonglong](#) (const void \*p1, const void \*p2)  
*Compare function for unsigned long long.*
- static int [gdt\\_compare\\_sizet](#) (const void \*p1, const void \*p2)  
*Compare function for size\_t.*
- static int [gdt\\_compare\\_double](#) (const void \*p1, const void \*p2)  
*Compare function for double.*
- static int [gdt\\_compare\\_string](#) (const void \*p1, const void \*p2)  
*Compare function for string.*
- void [gdt\\_set\\_value](#) (struct [gdt\\_generic\\_datatype](#) \*data, const enum [gds\\_datatype](#) type, [gds\\_cfunc](#) cfunc, va\_list ap)  
*Sets the value of a generic datatype.*
- void [gdt\\_get\\_value](#) (const struct [gdt\\_generic\\_datatype](#) \*data, void \*p)  
*Gets the value of a generic datatype.*

- void `gdt_free` (struct `gdt_generic_datatype` \*data)  
*Frees memory pointed to by a generic datatype.*
- int `gdt_compare` (const struct `gdt_generic_datatype` \*d1, const struct `gdt_generic_datatype` \*d2)  
*Compares two generic datatypes.*
- int `gdt_compare_void` (const void \*p1, const void \*p2)  
*Compares two generic datatypes via void pointers.*
- int `gdt_reverse_compare_void` (const void \*p1, const void \*p2)  
*Reverse compares two generic datatypes via void pointers.*

### 8.21.1 Detailed Description

Implementation of generic data element functionality.

#### Author

Paul Griffiths

#### Copyright

Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

### 8.21.2 Function Documentation

#### 8.21.2.1 static int `gdt_compare_char` ( const void \* *p1*, const void \* *p2* ) [static]

Compare function for char.

##### Parameters

|           |                         |
|-----------|-------------------------|
| <i>p1</i> | Pointer to first value  |
| <i>p2</i> | Pointer to second value |

##### Return values

|    |  |
|----|--|
| 0  | First value is equal to second value     |
| -1 | First value is less than second value    |
| 1  | First value is greater than second value |

#### 8.21.2.2 static int `gdt_compare_double` ( const void \* *p1*, const void \* *p2* ) [static]

Compare function for double.

##### Parameters

|           |                         |
|-----------|-------------------------|
| <i>p1</i> | Pointer to first value  |
| <i>p2</i> | Pointer to second value |

##### Return values

|    |  |
|----|--|
| 0  | First value is equal to second value     |
| -1 | First value is less than second value    |
| 1  | First value is greater than second value |



**8.21.2.3 static int gdt\_compare\_int ( const void \* *p1*, const void \* *p2* ) [static]**

Compare function for int.

**Parameters**

|           |                         |
|-----------|-------------------------|
| <i>p1</i> | Pointer to first value  |
| <i>p2</i> | Pointer to second value |

**Return values**

|    |  |
|----|--|
| 0  | First value is equal to second value     |
| -1 | First value is less than second value    |
| 1  | First value is greater than second value |

**8.21.2.4 static int gdt\_compare\_long ( const void \* *p1*, const void \* *p2* ) [static]**

Compare function for long.

**Parameters**

|           |                         |
|-----------|-------------------------|
| <i>p1</i> | Pointer to first value  |
| <i>p2</i> | Pointer to second value |

**Return values**

|    |  |
|----|--|
| 0  | First value is equal to second value     |
| -1 | First value is less than second value    |
| 1  | First value is greater than second value |

**8.21.2.5 static int gdt\_compare\_longlong ( const void \* *p1*, const void \* *p2* ) [static]**

Compare function for long long.

**Parameters**

|           |                         |
|-----------|-------------------------|
| <i>p1</i> | Pointer to first value  |
| <i>p2</i> | Pointer to second value |

**Return values**

|    |  |
|----|--|
| 0  | First value is equal to second value     |
| -1 | First value is less than second value    |
| 1  | First value is greater than second value |

**8.21.2.6 static int gdt\_compare\_schar ( const void \* *p1*, const void \* *p2* ) [static]**

Compare function for signed char.

**Parameters**

|           |                         |
|-----------|-------------------------|
| <i>p1</i> | Pointer to first value  |
| <i>p2</i> | Pointer to second value |

## Return values

|    |  |
|----|--|
| 0  | First value is equal to second value     |
| -1 | First value is less than second value    |
| 1  | First value is greater than second value |

8.21.2.7 static int gdt\_compare\_size ( const void \* *p1*, const void \* *p2* ) [static]

Compare function for size\_t.

## Parameters

|           |                         |
|-----------|-------------------------|
| <i>p1</i> | Pointer to first value  |
| <i>p2</i> | Pointer to second value |

## Return values

|    |  |
|----|--|
| 0  | First value is equal to second value     |
| -1 | First value is less than second value    |
| 1  | First value is greater than second value |

8.21.2.8 static int gdt\_compare\_string ( const void \* *p1*, const void \* *p2* ) [static]

Compare function for string.

## Parameters

|           |                         |
|-----------|-------------------------|
| <i>p1</i> | Pointer to first value  |
| <i>p2</i> | Pointer to second value |

## Return values

|    |  |
|----|--|
| 0  | First value is equal to second value     |
| -1 | First value is less than second value    |
| 1  | First value is greater than second value |

8.21.2.9 static int gdt\_compare\_uchar ( const void \* *p1*, const void \* *p2* ) [static]

Compare function for unsigned char.

## Parameters

|           |                         |
|-----------|-------------------------|
| <i>p1</i> | Pointer to first value  |
| <i>p2</i> | Pointer to second value |

## Return values

|    |  |
|----|--|
| 0  | First value is equal to second value     |
| -1 | First value is less than second value    |
| 1  | First value is greater than second value |

8.21.2.10 `static int gdt_compare_uint ( const void * p1, const void * p2 )` `[static]`

Compare function for unsigned int.

## Parameters

|           |                         |
|-----------|-------------------------|
| <i>p1</i> | Pointer to first value  |
| <i>p2</i> | Pointer to second value |

## Return values

|    |  |
|----|--|
| 0  | First value is equal to second value     |
| -1 | First value is less than second value    |
| 1  | First value is greater than second value |

8.21.2.11 `static int gdt_compare_ulong ( const void * p1, const void * p2 )` `[static]`

Compare function for unsigned long.

## Parameters

|           |                         |
|-----------|-------------------------|
| <i>p1</i> | Pointer to first value  |
| <i>p2</i> | Pointer to second value |

## Return values

|    |  |
|----|--|
| 0  | First value is equal to second value     |
| -1 | First value is less than second value    |
| 1  | First value is greater than second value |

8.21.2.12 `static int gdt_compare_ulonglong ( const void * p1, const void * p2 )` `[static]`

Compare function for unsigned long long.

## Parameters

|           |                         |
|-----------|-------------------------|
| <i>p1</i> | Pointer to first value  |
| <i>p2</i> | Pointer to second value |

## Return values

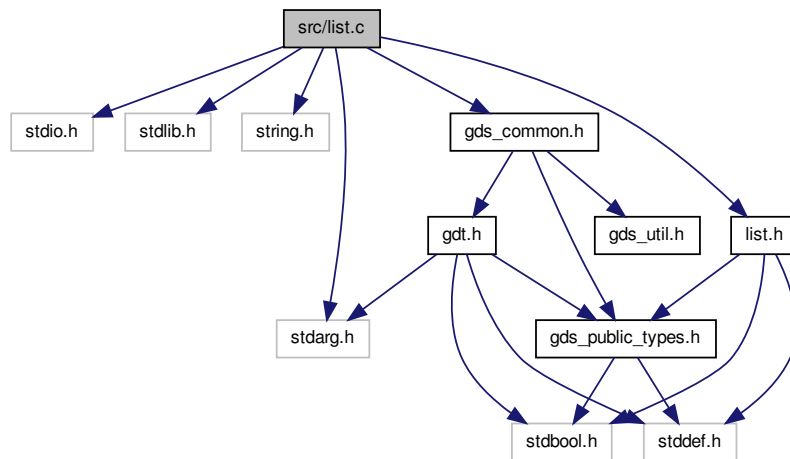
|    |  |
|----|--|
| 0  | First value is equal to second value     |
| -1 | First value is less than second value    |
| 1  | First value is greater than second value |

## 8.22 src/list.c File Reference

Implementation of generic list data structure.

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <stdarg.h>
#include "gds_common.h"
#include "list.h"
```

Include dependency graph for list.c:



## Data Structures

- struct [list\\_node](#)
- struct [list](#)

## Typedefs

- typedef struct [list\\_node](#) \* [ListNode](#)

## Functions

- static [ListNode](#) [list\\_node\\_create](#) ([List](#) list, va\_list ap)  
*Private function to create list node.*
- static void [list\\_node\\_destroy](#) ([List](#) list, [ListNode](#) node)  
*Destroys a list node.*
- static [ListNode](#) [list\\_node\\_at\\_index](#) ([List](#) list, const size\_t index)  
*Private function to return the node at a specified index.*
- static bool [list\\_insert\\_internal](#) ([List](#) list, [ListNode](#) node, const size\_t index)  
*Private function to insert a node into a list.*
- [List](#) [list\\_create](#) (const enum [gds\\_datatype](#) type, const int opts,...)  
*Creates a new list.*
- void [list\\_destroy](#) ([List](#) list)  
*Destroys a list.*
- bool [list\\_append](#) ([List](#) list,...)  
*Appends a value to the back of a list.*

- `bool list_prepend (List list,...)`  
*Prepends a value to the front of a list.*
- `bool list_insert (List list, const size_t index,...)`  
*Inserts a value into a list.*
- `bool list_delete_index (List list, const size_t index)`  
*Deletes the value at the specified index of the list.*
- `bool list_delete_front (List list)`  
*Deletes the value at the front of the list.*
- `bool list_delete_back (List list)`  
*Deletes the value at the back of the list.*
- `bool list_element_at_index (List list, const size_t index, void *p)`  
*Gets the value at the specified index of the list.*
- `bool list_set_element_at_index (List list, const size_t index,...)`  
*Sets the value at the specified index of the list.*
- `bool list_find (List list, size_t *index,...)`  
*Tests if a value is contained in a list.*
- `Listltr list_find_itr (List list,...)`  
*Tests if a value is contained in a list.*
- `bool list_sort (List list)`  
*Sorts a list in-place, in ascending order.*
- `bool list_reverse_sort (List list)`  
*Sorts a list in-place, in descending order.*
- `Listltr list_itr_first (List list)`  
*Returns an iterator to the first element of the list.*
- `Listltr list_itr_last (List list)`  
*Returns an iterator to the last element of the list.*
- `Listltr list_itr_next (Listltr itr)`  
*Increments a list iterator.*
- `Listltr list_itr_previous (Listltr itr)`  
*Decrements a list iterator.*
- `void list_get_value_itr (Listltr itr, void *p)`  
*Retrieves a value from an iterator.*
- `bool list_is_empty (List list)`  
*Tests if a list is empty.*
- `size_t list_length (List list)`  
*Returns the length of a list.*

### 8.22.1 Detailed Description

Implementation of generic list data structure. The list is implemented as a double-ended, double-linked list.

#### Author

Paul Griffiths

#### Copyright

Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

## 8.22.2 Typedef Documentation

### 8.22.2.1 typedef struct list\_node \* ListNode

List node structure

## 8.22.3 Function Documentation

### 8.22.3.1 static bool list\_insert\_internal ( List *list*, ListNode *node*, const size\_t *index* ) [static]

Private function to insert a node into a list.

#### Parameters

|              |                                  |
|--------------|----------------------------------|
| <i>list</i>  | A pointer to the list.           |
| <i>node</i>  | A pointer to the node to insert. |
| <i>index</i> | The index at which to insert.    |

#### Return values

|              |                             |
|--------------|-----------------------------|
| <i>true</i>  | Success                     |
| <i>false</i> | Failure, index out of range |

### 8.22.3.2 static ListNode list\_node\_at\_index ( List *list*, const size\_t *index* ) [static]

Private function to return the node at a specified index.

#### Parameters

|              |                                  |
|--------------|----------------------------------|
| <i>list</i>  | A pointer to the list.           |
| <i>index</i> | The index of the requested node. |

#### Return values

|                 |  |
|-----------------|--|
| <i>NULL</i>     | Failure, index out of range                  |
| <i>non-NULL</i> | A pointer to the node at the specified index |

### 8.22.3.3 static ListNode list\_node\_create ( List *list*, va\_list *ap* ) [static]

Private function to create list node.

#### Parameters

|             |   |
|-------------|---|
| <i>list</i> | A pointer to the list.  |
| <i>ap</i>   | A <i>va_list</i> containing the data value for the node. This should be of a type appropriate to the type set when creating the list. |

#### Return values

|                 |   |
|-----------------|---|
| <i>NULL</i>     | Failure, dynamic memory allocation failed |
| <i>non-NULL</i> | A pointer to the new node                 |

#### 8.22.3.4 static void list\_node\_destroy ( List list, ListNode node ) [static]

Destroys a list node.

If the `GDS_FREE_ON_DESTROY` option was specified when creating the list, any pointer values still in the list will be `free()`d prior to destruction.

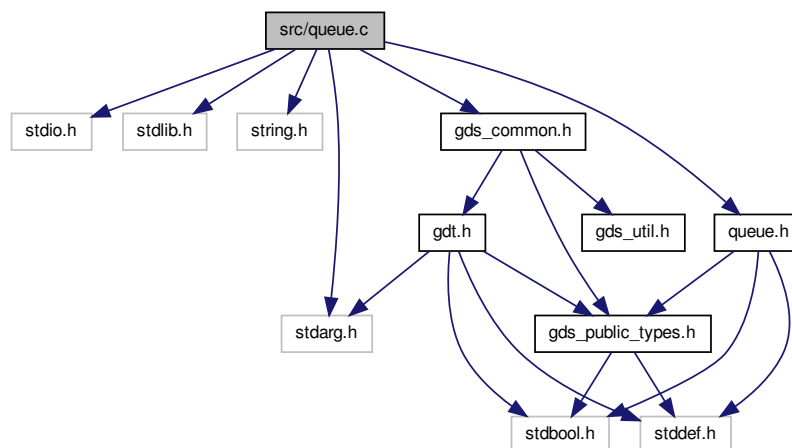
##### Parameters

|             |                        |
|-------------|------------------------|
| <i>list</i> | A pointer to the list. |
| <i>node</i> | A pointer to the node. |

## 8.23 src/queue.c File Reference

Implementation of generic queue data structure.

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <stdarg.h>
#include "gds_common.h"
#include "queue.h"
Include dependency graph for queue.c:
```



## Data Structures

- struct [queue](#)

## Functions

- [Queue queue\\_create](#) (const size\_t capacity, const enum [gds\\_datatype](#) type, const int opts)  
*Creates a new queue.*
- void [queue\\_destroy](#) (Queue queue)  
*Destroys a queue.*
- bool [queue\\_push](#) (Queue queue,...)

*Pushes a value onto the queue.*

- bool `queue_pop` (`Queue queue`, void \*p)

*Pops a value from the queue.*

- bool `queue_peek` (`Queue queue`, void \*p)

*Peeks at the top value of the queue.*

- bool `queue_is_full` (`Queue queue`)

*Checks whether a queue is full.*

- bool `queue_is_empty` (`Queue queue`)

*Checks whether a queue is empty.*

- size\_t `queue_capacity` (`Queue queue`)

*Retrieves the current capacity of a queue.*

- size\_t `queue_free_space` (`Queue queue`)

*Retrieves the free space on a queue.*

- size\_t `queue_size` (`Queue queue`)

*Retrieves the current size of a queue.*

## Variables

- static const size\_t `GROWTH` = 2

*Growth factor for dynamic memory allocation.*

### 8.23.1 Detailed Description

Implementation of generic queue data structure.

#### Author

Paul Griffiths

#### Copyright

Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

### 8.23.2 Variable Documentation

#### 8.23.2.1 `const size_t GROWTH = 2` [static]

Growth factor for dynamic memory allocation.

#### Attention

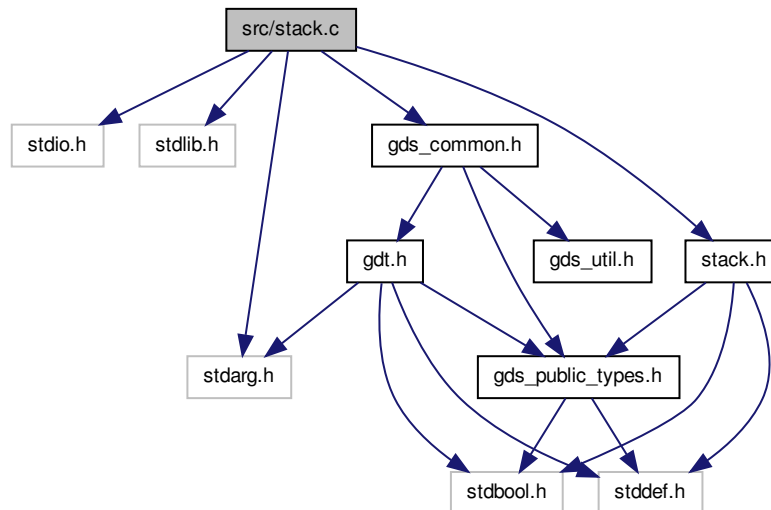
`queue_push()` relies on this being at least 2.

## 8.24 `src/stack.c` File Reference

Implementation of generic stack data structure.



```
#include <stdio.h>
#include <stdlib.h>
#include <stdarg.h>
#include "gds_common.h"
#include "stack.h"
Include dependency graph for stack.c:
```



## Data Structures

- struct [stack](#)

## Functions

- [Stack stack\\_create](#) (const size\_t capacity, const enum [gds\\_datatype](#) type, const int opts)  
*Creates a new stack.*
- void [stack\\_destroy](#) (Stack stack)  
*Destroys a stack.*
- bool [stack\\_push](#) (Stack stack,...)  
*Pushes a value onto the stack.*
- bool [stack\\_pop](#) (Stack stack, void \*p)  
*Pops a value from the stack.*
- bool [stack\\_peek](#) (Stack stack, void \*p)  
*Peeks at the top value of the stack.*
- bool [stack\\_is\\_full](#) (Stack stack)  
*Checks whether a stack is full.*
- bool [stack\\_is\\_empty](#) (Stack stack)  
*Checks whether a stack is empty.*
- size\_t [stack\\_capacity](#) (Stack stack)  
*Retrieves the current capacity of a stack.*
- size\_t [stack\\_free\\_space](#) (Stack stack)  
*Retrieves the free space on a stack.*

- `size_t stack_size` (`Stack stack`)  
*Retrieves the current size of a stack.*

## Variables

- static const `size_t GROWTH` = 2

### 8.24.1 Detailed Description

Implementation of generic stack data structure.

#### Author

Paul Griffiths

#### Copyright

Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

### 8.24.2 Variable Documentation

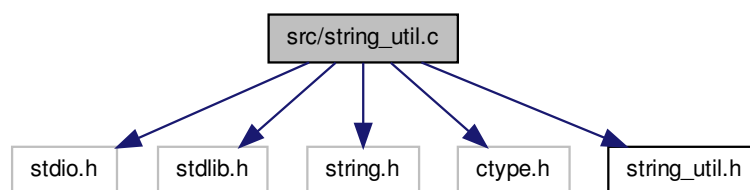
#### 8.24.2.1 `const size_t GROWTH = 2` [static]

Growth factor for dynamic memory allocation

## 8.25 `src/string_util.c` File Reference

Implementation of string utility functions.

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <ctype.h>
#include "string_util.h"
Include dependency graph for string_util.c:
```



## Functions

- `char * trim_line_ending` (`char *str`)

*Trims CR and LF characters from the end of a string.*

- char \* [trim\\_right](#) (char \*str)

*Trims trailing whitespace from a string.*

- char \* [trim\\_left](#) (char \*str)

*Trims leading whitespace from a string.*

- char \* [trim](#) (char \*str)

*Trims leading and trailing whitespace from a string.*

- char \* [pg\\_strdup](#) (const char \*str)

*Duplicates a string.*

- char \* [pg\\_strndup](#) (const char \*str, const size\_t n)

*Duplicates at most n characters of a string.*

- struct [pair\\_string](#) \* [pair\\_string\\_create](#) (const char \*str, const char delim)

*Splits a string into a string pair.*

- void [pair\\_string\\_destroy](#) (struct [pair\\_string](#) \*pair)

*Destroys a string pair.*

### 8.25.1 Detailed Description

Implementation of string utility functions.

#### Author

Paul Griffiths

#### Copyright

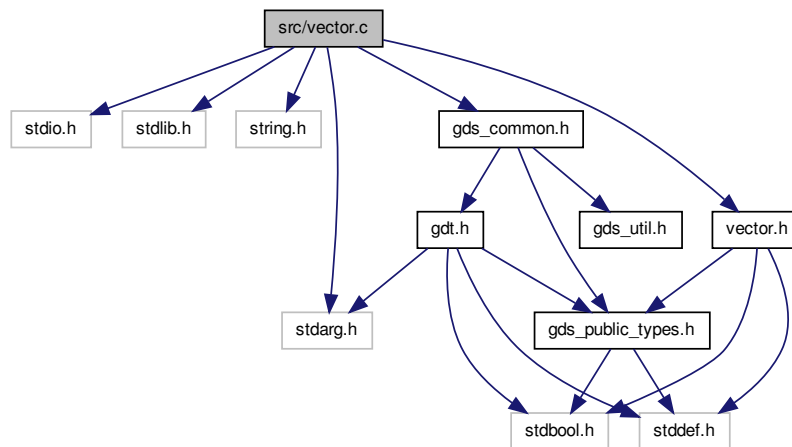
Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

## 8.26 src/vector.c File Reference

Implementation of generic vector data structure.

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <stdarg.h>
#include "gds_common.h"
#include "vector.h"
```

Include dependency graph for vector.c:



## Data Structures

- struct [vector](#)

## Functions

- static bool [vector\\_insert\\_internal](#) ([Vector](#) vector, const size\_t index, va\_list ap)  
*Private function to insert a vector element.*
- [Vector](#) [vector\\_create](#) (const size\_t capacity, const enum [gds\\_datatype](#) type, const int opts,...)  
*Creates a new vector.*
- void [vector\\_destroy](#) ([Vector](#) vector)  
*Destroys a vector.*
- bool [vector\\_append](#) ([Vector](#) vector,...)  
*Appends a value to the back of a vector.*
- bool [vector\\_prepend](#) ([Vector](#) vector,...)  
*Prepends a value to the front of a vector.*
- bool [vector\\_insert](#) ([Vector](#) vector, const size\_t index,...)  
*Inserts a value into a vector.*
- bool [vector\\_delete\\_index](#) ([Vector](#) vector, const size\_t index)  
*Deletes the value at the specified index of the vector.*
- bool [vector\\_delete\\_front](#) ([Vector](#) vector)  
*Deletes the value at the front of the vector.*
- bool [vector\\_delete\\_back](#) ([Vector](#) vector)  
*Deletes the value at the back of the vector.*
- bool [vector\\_element\\_at\\_index](#) ([Vector](#) vector, const size\_t index, void \*p)  
*Gets the value at the specified index of the vector.*
- bool [vector\\_set\\_element\\_at\\_index](#) ([Vector](#) vector, const size\_t index,...)  
*Sets the value at the specified index of the vector.*
- bool [vector\\_find](#) ([Vector](#) vector, size\_t \*index,...)  
*Tests if a value is contained in a vector.*
- void [vector\\_sort](#) ([Vector](#) vector)

- Sorts a vector in-place, in ascending order.
- void `vector_reverse_sort` (`Vector` `vector`)  
Sorts a vector in-place, in descending order.
- bool `vector_is_empty` (`Vector` `vector`)  
Tests if a vector is empty.
- size\_t `vector_length` (`Vector` `vector`)  
Returns the length of a vector.
- size\_t `vector_capacity` (`Vector` `vector`)  
Returns the capacity of a vector.
- size\_t `vector_free_space` (`Vector` `vector`)  
Returns the free space in a vector.

## Variables

- static const size\_t `GROWTH` = 2

### 8.26.1 Detailed Description

Implementation of generic vector data structure.

#### Author

Paul Griffiths

#### Copyright

Copyright 2014 Paul Griffiths. Distributed under the terms of the GNU General Public License. <http://www.gnu.org/licenses/>

### 8.26.2 Function Documentation

8.26.2.1 static bool `vector_insert_internal` ( `Vector` `vector`, const size\_t `index`, va\_list `ap` ) [static]

Private function to insert a vector element.

#### Parameters

|               |  |
|---------------|--|
| <i>vector</i> | A pointer to the vector.   |
| <i>index</i>  | The index at which to insert.  |
| <i>ap</i>     | A <code>va_list</code> containing the value to be inserted. This should be of a type appropriate to the type set when creating the vector. |

#### Return values

|              |   |
|--------------|---|
| <i>true</i>  | Success   |
| <i>false</i> | Failure, dynamic reallocation failed or index out of range. |

### 8.26.3 Variable Documentation

8.26.3.1 const size\_t `GROWTH` = 2 [static]

Growth factor for dynamic memory allocation

# Index

## BUCKETS

dict.c, [75](#)

## back

queue, [49](#)

## buckets

dict, [42](#)

## c

gdt\_generic\_datatype, [43](#)

## capacity

queue, [49](#)

stack, [50](#)

vector, [52](#)

## compfunc

gdt\_generic\_datatype, [43](#)

list, [46](#)

vector, [52](#)

## d

gdt\_generic\_datatype, [43](#)

## DATATYPE\_CHAR

Private functionality for manipulating generic datatypes, [12](#)

## DATATYPE\_DOUBLE

Private functionality for manipulating generic datatypes, [12](#)

## DATATYPE\_INT

Private functionality for manipulating generic datatypes, [12](#)

## DATATYPE\_LONG

Private functionality for manipulating generic datatypes, [12](#)

## DATATYPE\_LONG\_LONG

Private functionality for manipulating generic datatypes, [12](#)

## DATATYPE\_POINTER

Private functionality for manipulating generic datatypes, [12](#)

## DATATYPE\_SIGNED\_CHAR

Private functionality for manipulating generic datatypes, [12](#)

## DATATYPE\_SIZE\_T

Private functionality for manipulating generic datatypes, [12](#)

## DATATYPE\_STRING

Private functionality for manipulating generic datatypes, [12](#)

## DATATYPE\_UNSIGNED\_CHAR

Private functionality for manipulating generic datatypes, [12](#)

## DATATYPE\_UNSIGNED\_INT

Private functionality for manipulating generic datatypes, [12](#)

## DATATYPE\_UNSIGNED\_LONG

Private functionality for manipulating generic datatypes, [12](#)

## DATATYPE\_UNSIGNED\_LONG\_LONG

Private functionality for manipulating generic datatypes, [12](#)

## data

gdt\_generic\_datatype, [43](#)

## Dict

dict.h, [57](#)

## dict, [41](#)

buckets, [42](#)

exit\_on\_error, [42](#)

free\_on\_destroy, [42](#)

num\_buckets, [42](#)

type, [42](#)

## dict.c

BUCKETS, [75](#)

dict\_buckets\_create, [72](#)

dict\_buckets\_destroy, [72](#)

dict\_create, [72](#)

dict\_destroy, [73](#)

dict\_has\_key, [73](#)

dict\_has\_key\_internal, [73](#)

dict\_insert, [73](#)

dict\_value\_for\_key, [74](#)

djb2hash, [74](#)

KVPair, [72](#)

kvpair\_compare, [74](#)

kvpair\_create, [75](#)

kvpair\_destroy, [75](#)

## dict.h

Dict, [57](#)

dict\_create, [58](#)

dict\_destroy, [58](#)

dict\_has\_key, [58](#)

dict\_insert, [58](#)

dict\_value\_for\_key, [59](#)

dict\_buckets\_create

dict.c, [72](#)

dict\_buckets\_destroy

dict.c, [72](#)

dict\_create

dict.c, [72](#)

dict.h, [58](#)

dict\_destroy

- dict.c, [73](#)
- dict.h, [58](#)
- dict\_has\_key
  - dict.c, [73](#)
  - dict.h, [58](#)
- dict\_has\_key\_internal
  - dict.c, [73](#)
- dict\_insert
  - dict.c, [73](#)
  - dict.h, [58](#)
- dict\_value\_for\_key
  - dict.c, [74](#)
  - dict.h, [59](#)
- djb2hash
  - dict.c, [74](#)
- element
  - list\_node, [47](#)
- elements
  - queue, [49](#)
  - stack, [50](#)
  - vector, [52](#)
- exit\_on\_error
  - dict, [42](#)
  - list, [46](#)
  - queue, [49](#)
  - stack, [50](#)
  - vector, [52](#)
- first
  - pair\_string, [48](#)
- free\_on\_destroy
  - dict, [42](#)
  - list, [46](#)
  - queue, [49](#)
  - stack, [50](#)
  - vector, [52](#)
- front
  - queue, [49](#)
- GDS\_EXIT\_ON\_ERROR
  - Public general generic data structures functionality, [15](#)
- GDS\_FREE\_ON\_DESTROY
  - Public general generic data structures functionality, [15](#)
- GDS\_RESIZABLE
  - Public general generic data structures functionality, [15](#)
- GROWTH
  - queue.c, [86](#)
  - stack.c, [88](#)
  - vector.c, [91](#)
- gds.dox, [53](#)
- gds\_assert\_quit
  - Public general generic data structures functionality, [15](#)
- gds\_cfunc
  - Private functionality for manipulating generic datatypes, [12](#)
- gds\_datatype
  - Private functionality for manipulating generic datatypes, [12](#)
- gds\_error\_quit
  - Public general generic data structures functionality, [15](#)
- gds\_option
  - Public general generic data structures functionality, [15](#)
- gds\_strdup
  - Public general generic data structures functionality, [16](#)
- gds\_strerror\_quit
  - Public general generic data structures functionality, [16](#)
- gdt.c
  - gdt\_compare\_char, [78](#)
  - gdt\_compare\_double, [78](#)
  - gdt\_compare\_int, [78](#)
  - gdt\_compare\_long, [79](#)
  - gdt\_compare\_longlong, [79](#)
  - gdt\_compare\_schar, [79](#)
  - gdt\_compare\_sizet, [80](#)
  - gdt\_compare\_string, [80](#)
  - gdt\_compare\_uchar, [80](#)
  - gdt\_compare\_uint, [80](#)
  - gdt\_compare\_ulong, [81](#)
  - gdt\_compare\_ulonglong, [81](#)
- gdt\_compare
  - Private functionality for manipulating generic datatypes, [12](#)
- gdt\_compare\_char
  - gdt.c, [78](#)
- gdt\_compare\_double
  - gdt.c, [78](#)
- gdt\_compare\_int
  - gdt.c, [78](#)
- gdt\_compare\_long
  - gdt.c, [79](#)
- gdt\_compare\_longlong
  - gdt.c, [79](#)
- gdt\_compare\_schar
  - gdt.c, [79](#)
- gdt\_compare\_sizet
  - gdt.c, [80](#)
- gdt\_compare\_string
  - gdt.c, [80](#)
- gdt\_compare\_uchar
  - gdt.c, [80](#)
- gdt\_compare\_uint
  - gdt.c, [80](#)
- gdt\_compare\_ulong
  - gdt.c, [81](#)
- gdt\_compare\_ulonglong
  - gdt.c, [81](#)
- gdt\_compare\_void

- Private functionality for manipulating generic datatypes, [12](#)
- `gdt_free`
  - Private functionality for manipulating generic datatypes, [13](#)
- `gdt_generic_datatype`, [42](#)
  - `c`, [43](#)
  - `compfunc`, [43](#)
  - `d`, [43](#)
  - `data`, [43](#)
  - `i`, [43](#)
  - `l`, [43](#)
  - `ll`, [43](#)
  - `p`, [43](#)
  - `pc`, [43](#)
  - `sc`, [43](#)
  - `st`, [43](#)
  - `type`, [44](#)
  - `uc`, [44](#)
  - `ui`, [44](#)
  - `ul`, [44](#)
  - `ull`, [44](#)
- `gdt_get_value`
  - Private functionality for manipulating generic datatypes, [13](#)
- `gdt_reverse_compare_void`
  - Private functionality for manipulating generic datatypes, [13](#)
- `gdt_set_value`
  - Private functionality for manipulating generic datatypes, [14](#)
- General purpose string manipulation functions, [32](#)
  - `pair_string_create`, [32](#)
  - `pair_string_destroy`, [32](#)
  - `pg_strdup`, [32](#)
  - `pg_strndup`, [33](#)
  - `trim`, [33](#)
  - `trim_left`, [33](#)
  - `trim_line_ending`, [34](#)
  - `trim_right`, [34](#)
- `head`
  - `list`, [46](#)
- `i`
  - `gdt_generic_datatype`, [43](#)
- `include/private/gds_common.h`, [53](#)
- `include/private/gdt.dox`, [54](#)
- `include/private/gdt.h`, [54](#)
- `include/public/dict.h`, [56](#)
- `include/public/gds_public_types.h`, [59](#)
- `include/public/gds_util.h`, [60](#)
- `include/public/general.dox`, [61](#)
- `include/public/list.dox`, [61](#)
- `include/public/list.h`, [61](#)
- `include/public/queue.dox`, [64](#)
- `include/public/queue.h`, [64](#)
- `include/public/stack.dox`, [65](#)
- `include/public/stack.h`, [65](#)
- `include/public/string_util.dox`, [67](#)
- `include/public/string_util.h`, [67](#)
- `include/public/vector.dox`, [68](#)
- `include/public/vector.h`, [68](#)
- `KVPair`
  - `dict.c`, [72](#)
- `key`
  - `kvpair`, [45](#)
- `kvpair`, [44](#)
  - `key`, [45](#)
  - `value`, [45](#)
- `kvpair_compare`
  - `dict.c`, [74](#)
- `kvpair_create`
  - `dict.c`, [75](#)
- `kvpair_destroy`
  - `dict.c`, [75](#)
- `l`
  - `gdt_generic_datatype`, [43](#)
- `length`
  - `list`, [46](#)
  - `vector`, [52](#)
- `List`
  - Public interface to generic list data structure, [18](#)
- `list`, [45](#)
  - `compfunc`, [46](#)
  - `exit_on_error`, [46](#)
  - `free_on_destroy`, [46](#)
  - `head`, [46](#)
  - `length`, [46](#)
  - `tail`, [46](#)
  - `type`, [46](#)
- `list.c`
  - `list_insert_internal`, [84](#)
  - `list_node_at_index`, [84](#)
  - `list_node_create`, [84](#)
  - `list_node_destroy`, [84](#)
  - `ListNode`, [84](#)
- `list_append`
  - Public interface to generic list data structure, [18](#)
- `list_create`
  - Public interface to generic list data structure, [18](#)
- `list_delete_back`
  - Public interface to generic list data structure, [18](#)
- `list_delete_front`
  - Public interface to generic list data structure, [19](#)
- `list_delete_index`
  - Public interface to generic list data structure, [19](#)
- `list_destroy`
  - Public interface to generic list data structure, [19](#)
- `list_element_at_index`
  - Public interface to generic list data structure, [19](#)
- `list_find`
  - Public interface to generic list data structure, [20](#)
- `list_find_itr`
  - Public interface to generic list data structure, [20](#)
- `list_get_value_itr`



- Public interface to generic list data structure, 20
- list\_insert
  - Public interface to generic list data structure, 20
- list\_insert\_internal
  - list.c, 84
- list\_is\_empty
  - Public interface to generic list data structure, 21
- list\_itr\_first
  - Public interface to generic list data structure, 21
- list\_itr\_last
  - Public interface to generic list data structure, 21
- list\_itr\_next
  - Public interface to generic list data structure, 21
- list\_itr\_previous
  - Public interface to generic list data structure, 22
- list\_length
  - Public interface to generic list data structure, 22
- list\_node, 47
  - element, 47
  - next, 47
  - prev, 47
- list\_node\_at\_index
  - list.c, 84
- list\_node\_create
  - list.c, 84
- list\_node\_destroy
  - list.c, 84
- list\_prepend
  - Public interface to generic list data structure, 22
- list\_reverse\_sort
  - Public interface to generic list data structure, 22
- list\_set\_element\_at\_index
  - Public interface to generic list data structure, 23
- list\_sort
  - Public interface to generic list data structure, 23
- Listltr
  - Public interface to generic list data structure, 18
- ListNode
  - list.c, 84
- ll
  - gdt\_generic\_datatype, 43
- next
  - list\_node, 47
- num\_buckets
  - dict, 42
- p
  - gdt\_generic\_datatype, 43
- pair\_string, 47
  - first, 48
  - second, 48
- pair\_string\_create
  - General purpose string manipulation functions, 32
- pair\_string\_destroy
  - General purpose string manipulation functions, 32
- pc
  - gdt\_generic\_datatype, 43
- pg\_strdup
  - General purpose string manipulation functions, 32
- pg\_strdup
  - General purpose string manipulation functions, 33
- prev
  - list\_node, 47
- Private functionality for manipulating generic datatypes, 11
  - DATATYPE\_CHAR, 12
  - DATATYPE\_DOUBLE, 12
  - DATATYPE\_INT, 12
  - DATATYPE\_LONG, 12
  - DATATYPE\_LONG\_LONG, 12
  - DATATYPE\_POINTER, 12
  - DATATYPE\_SIGNED\_CHAR, 12
  - DATATYPE\_SIZE\_T, 12
  - DATATYPE\_STRING, 12
  - DATATYPE\_UNSIGNED\_CHAR, 12
  - DATATYPE\_UNSIGNED\_INT, 12
  - DATATYPE\_UNSIGNED\_LONG, 12
  - DATATYPE\_UNSIGNED\_LONG\_LONG, 12
  - gds\_cfunc, 12
  - gds\_datatype, 12
  - gdt\_compare, 12
  - gdt\_compare\_void, 12
  - gdt\_free, 13
  - gdt\_get\_value, 13
  - gdt\_reverse\_compare\_void, 13
  - gdt\_set\_value, 14
- Public general generic data structures functionality, 15
  - GDS\_EXIT\_ON\_ERROR, 15
  - GDS\_FREE\_ON\_DESTROY, 15
  - GDS\_RESIZABLE, 15
  - gds\_assert\_quit, 15
  - gds\_error\_quit, 15
  - gds\_option, 15
  - gds\_strdup, 16
  - gds\_strerror\_quit, 16
- Public interface to generic list data structure, 17
  - List, 18
  - list\_append, 18
  - list\_create, 18
  - list\_delete\_back, 18
  - list\_delete\_front, 19
  - list\_delete\_index, 19
  - list\_destroy, 19
  - list\_element\_at\_index, 19
  - list\_find, 20
  - list\_find\_itr, 20
  - list\_get\_value\_itr, 20
  - list\_insert, 20
  - list\_is\_empty, 21
  - list\_itr\_first, 21
  - list\_itr\_last, 21
  - list\_itr\_next, 21
  - list\_itr\_previous, 22
  - list\_length, 22
  - list\_prepend, 22
  - list\_reverse\_sort, 22

- list\_set\_element\_at\_index, 23
- list\_sort, 23
- ListItr, 18
- Public interface to generic queue data structure, 24
  - Queue, 24
  - queue\_capacity, 24
  - queue\_create, 25
  - queue\_destroy, 25
  - queue\_free\_space, 25
  - queue\_is\_empty, 25
  - queue\_is\_full, 26
  - queue\_peek, 26
  - queue\_pop, 26
  - queue\_push, 26
  - queue\_size, 27
- Public interface to generic stack data structure, 28
  - Stack, 28
  - stack\_capacity, 28
  - stack\_create, 29
  - stack\_destroy, 29
  - stack\_free\_space, 29
  - stack\_is\_empty, 29
  - stack\_is\_full, 30
  - stack\_peek, 30
  - stack\_pop, 30
  - stack\_push, 30
  - stack\_size, 31
- Public interface to generic vector data structure., 35
  - Vector, 36
  - vector\_append, 36
  - vector\_capacity, 36
  - vector\_create, 36
  - vector\_delete\_back, 37
  - vector\_delete\_front, 37
  - vector\_delete\_index, 37
  - vector\_destroy, 37
  - vector\_element\_at\_index, 38
  - vector\_find, 38
  - vector\_free\_space, 38
  - vector\_insert, 38
  - vector\_is\_empty, 39
  - vector\_length, 39
  - vector\_prepend, 39
  - vector\_reverse\_sort, 40
  - vector\_set\_element\_at\_index, 40
  - vector\_sort, 40
- Queue
  - Public interface to generic queue data structure, 24
- queue, 48
  - back, 49
  - capacity, 49
  - elements, 49
  - exit\_on\_error, 49
  - free\_on\_destroy, 49
  - front, 49
  - resizable, 49
  - size, 49
  - type, 49
- queue.c
  - GROWTH, 86
- queue\_capacity
  - Public interface to generic queue data structure, 24
- queue\_create
  - Public interface to generic queue data structure, 25
- queue\_destroy
  - Public interface to generic queue data structure, 25
- queue\_free\_space
  - Public interface to generic queue data structure, 25
- queue\_is\_empty
  - Public interface to generic queue data structure, 25
- queue\_is\_full
  - Public interface to generic queue data structure, 26
- queue\_peek
  - Public interface to generic queue data structure, 26
- queue\_pop
  - Public interface to generic queue data structure, 26
- queue\_push
  - Public interface to generic queue data structure, 26
- queue\_size
  - Public interface to generic queue data structure, 27
- resizable
  - queue, 49
  - stack, 50
- sc
  - gdt\_generic\_datatype, 43
- second
  - pair\_string, 48
- size
  - queue, 49
- src/dict.c, 70
- src/gds\_util.c, 75
- src/gdt.c, 76
- src/list.c, 81
- src/queue.c, 85
- src/stack.c, 86
- src/string\_util.c, 88
- src/vector.c, 89
- st
  - gdt\_generic\_datatype, 43
- Stack
  - Public interface to generic stack data structure, 28
- stack, 50
  - capacity, 50
  - elements, 50
  - exit\_on\_error, 50
  - free\_on\_destroy, 50
  - resizable, 50
  - top, 51
  - type, 51
- stack.c
  - GROWTH, 88
- stack\_capacity
  - Public interface to generic stack data structure, 28
- stack\_create
  - Public interface to generic stack data structure, 29

- stack\_destroy
  - Public interface to generic stack data structure, [29](#)
- stack\_free\_space
  - Public interface to generic stack data structure, [29](#)
- stack\_is\_empty
  - Public interface to generic stack data structure, [29](#)
- stack\_is\_full
  - Public interface to generic stack data structure, [30](#)
- stack\_peek
  - Public interface to generic stack data structure, [30](#)
- stack\_pop
  - Public interface to generic stack data structure, [30](#)
- stack\_push
  - Public interface to generic stack data structure, [30](#)
- stack\_size
  - Public interface to generic stack data structure, [31](#)
- tail
  - list, [46](#)
- top
  - stack, [51](#)
- trim
  - General purpose string manipulation functions, [33](#)
- trim\_left
  - General purpose string manipulation functions, [33](#)
- trim\_line\_ending
  - General purpose string manipulation functions, [34](#)
- trim\_right
  - General purpose string manipulation functions, [34](#)
- type
  - dict, [42](#)
  - gdt\_generic\_datatype, [44](#)
  - list, [46](#)
  - queue, [49](#)
  - stack, [51](#)
  - vector, [52](#)
- uc
  - gdt\_generic\_datatype, [44](#)
- ui
  - gdt\_generic\_datatype, [44](#)
- ul
  - gdt\_generic\_datatype, [44](#)
- ull
  - gdt\_generic\_datatype, [44](#)
- value
  - kvpair, [45](#)
- Vector
  - Public interface to generic vector data structure., [36](#)
- vector, [51](#)
  - capacity, [52](#)
  - compfunc, [52](#)
  - elements, [52](#)
  - exit\_on\_error, [52](#)
  - free\_on\_destroy, [52](#)
  - length, [52](#)
  - type, [52](#)
- vector.c
  - GROWTH, [91](#)
  - vector\_insert\_internal, [91](#)
- vector\_append
  - Public interface to generic vector data structure., [36](#)
- vector\_capacity
  - Public interface to generic vector data structure., [36](#)
- vector\_create
  - Public interface to generic vector data structure., [36](#)
- vector\_delete\_back
  - Public interface to generic vector data structure., [37](#)
- vector\_delete\_front
  - Public interface to generic vector data structure., [37](#)
- vector\_delete\_index
  - Public interface to generic vector data structure., [37](#)
- vector\_destroy
  - Public interface to generic vector data structure., [37](#)
- vector\_element\_at\_index
  - Public interface to generic vector data structure., [38](#)
- vector\_find
  - Public interface to generic vector data structure., [38](#)
- vector\_free\_space
  - Public interface to generic vector data structure., [38](#)
- vector\_insert
  - Public interface to generic vector data structure., [38](#)
- vector\_insert\_internal
  - vector.c, [91](#)
- vector\_is\_empty
  - Public interface to generic vector data structure., [39](#)
- vector\_length
  - Public interface to generic vector data structure., [39](#)
- vector\_prepend
  - Public interface to generic vector data structure., [39](#)
- vector\_reverse\_sort
  - Public interface to generic vector data structure., [40](#)
- vector\_set\_element\_at\_index
  - Public interface to generic vector data structure., [40](#)
- vector\_sort
  - Public interface to generic vector data structure., [40](#)