



## C interfaces to GALAHAD IR

Jari Fowkes and Nick Gould  
STFC Rutherford Appleton Laboratory  
Wed May 3 2023



---

<b>1 GALAHAD C package ir</b>	<b>1</b>
1.1 Introduction	1
1.1.1 Purpose	1
1.1.2 Authors	1
1.1.3 Originally released	1
<b>2 File Index</b>	<b>3</b>
2.1 File List	3
<b>3 File Documentation</b>	<b>5</b>
3.1 galahad_ir.h File Reference	5
3.1.1 Data Structure Documentation	5
3.1.1.1 struct ir_control_type	5
3.1.1.2 struct ir_inform_type	6



# Chapter 1

## GALAHAD C package

### 1.1 Introduction

#### 1.1.1 Purpose

Given a sparse symmetric  $n \times n$  matrix  $A = a_{ij}$  and the factorization of  $A$  found by the GALAHAD package SLS, this package **solves the system of linear equations**  $Ax = b$  **using iterative refinement**.

Currently, only the control and inform parameters are exposed; these are provided and used by other GALAHAD packages with C interfaces.

#### 1.1.2 Authors

N. I. M. Gould, STFC-Rutherford Appleton Laboratory, England.

C interface, additionally J. Fowkes, STFC-Rutherford Appleton Laboratory.

Julia interface, additionally A. Montoison and D. Orban, Polytechnique Montréal.

#### 1.1.3 Originally released

October 2008, C interface January 2022



## Chapter 2

# File Index

### 2.1 File List

Here is a list of all files with brief descriptions:

<a href="#">galahad_ir.h</a> . . . . .	5
--	---





## Chapter 3

# File Documentation

### 3.1 galahad\_ir.h File Reference

```
#include <stdbool.h>
#include <stdint.h>
#include "galahad_precision.h"
#include "galahad_cfunctions.h"
```

#### Data Structures

- struct [ir\\_control\\_type](#)
- struct [ir\\_inform\\_type](#)

#### 3.1.1 Data Structure Documentation

##### 3.1.1.1 struct ir\_control\_type

control derived type as a C struct

##### Data Fields

bool	f_indexing	use C or Fortran sparse matrix indexing
int	error	unit for error messages
int	out	unit for monitor output
int	print_level	controls level of diagnostic output
int	itref_max	maximum number of iterative refinements allowed
real_wp_	acceptable_residual_relative	refinement will cease as soon as the residual $\ Ax - b\ $ falls below $\max(\text{acceptable\_residual\_relative} * \ b\ , \text{acceptable\_residual\_absolute})$
real_wp_	acceptable_residual_absolute	see acceptable_residual_relative
real_wp_	required_residual_relative	refinement will be judged to have failed if the residual $\ Ax - b\  \geq \text{required\_residual\_relative} * \ b\ $ . No checking if required_residual_relative < 0
bool	record_residuals	record the initial and final residual

## Data Fields

bool	space_critical	if space is critical, ensure allocated arrays are no bigger than needed
bool	deallocate_error_fatal	exit if any deallocation fails
char	prefix[31]	all output lines will be prefixed by prefix(2:LEN(TRIM(.prefix))-1) where prefix contains the required string enclosed in quotes, e.g. "string" or 'string'

## 3.1.1.2 struct ir\_inform\_type

inform derived type as a C struct

## Data Fields

int	status	the return status. Possible values are: <ul style="list-style-type: none"> <li>• 0 the solution has been found.</li> <li>• -1. An allocation error occurred. A message indicating the offending array is written on unit control.error, and the returned allocation status and a string containing the name of the offending array are held in inform.alloc_status and inform.bad_alloc respectively.</li> <li>• -2. A deallocation error occurred. A message indicating the offending array is written on unit control.error and the returned allocation status and a string containing the name of the offending array are held in inform.alloc_status and inform.bad_alloc respectively.</li> <li>• -11. Iterative refinement has not reduced the relative residual by more than control.required_relative_residual.</li> </ul>
int	alloc_status	the status of the last attempted allocation/deallocation.
char	bad_alloc[81]	the name of the array for which an allocation/deallocation error occurred.
real_wp_	norm_initial_residual	the infinity norm of the initial residual
real_wp_	norm_final_residual	the infinity norm of the final residual