GQR Reference Manual

0.1.0

Michael Carley
m.j.carley@bath.ac.uk

Contents

1 GQR Module Index **1**

1.1 GQR Modules 1

2 GQR File Index **3**

2.1 GQR File List 3

3 GQR Module Documentation **5**

3.1 gqr 5

4 GQR File Documentation **9**

4.1 gqr.h File Reference 9

4.2 grule.c File Reference 11

5 GQR Example Documentation **13**

5.1 example.c 13

Chapter 1

GQR Module Index

1.1 GQR Modules

Here is a list of all modules:

gqr 5

Chapter 2

GQR File Index

2.1 GQR File List

Here is a list of all documented files with brief descriptions:

gqr.h (Declarations for the GQR functions) 9
grule.c (Gaussian quadrature rule generation and selection functions) 11

Chapter 3

GQR Module Documentation

3.1 gqr

Functions

- **gqr_rule_t** * **gqr_rule_alloc** (gint n)
- **gqr_rule_t** * **gqr_rule_realloc** (**gqr_rule_t** *g, gint n)
- gint **gqr_rule_free** (**gqr_rule_t** *g)
- gint **gqr_rule_write** (**gqr_rule_t** *g, FILE *f)
- gint **gqr_rule_select** (**gqr_rule_t** *g, **gqr_t** type, gint n, **gqr_parameter_t** *p)
- gint **gqr_rule_scale** (**gqr_rule_t** *g, gdouble a, gdouble b, gdouble *xbar, gdouble *dx)
- gchar * **gqr_rule_name** (**gqr_t** type)

3.1.1 Function Documentation

gqr_rule_t* gqr_rule_alloc (gint *n*)

Allocate a Gaussian quadrature rule.

Parameters:

n maximum length of rule (number of abscissae and weights).

Returns:

newly allocated rule.

gint gqr_rule_free (gqr_rule_t * *g*)

Free all memory associated with a Gaussian quadrature rule.

Parameters:

g rule to be freed.

Returns:

0 on success.

gchar* gqr_rule_name (gqr_t *type*)

Generate a string giving the name of the quadrature rule (Legendre, Hermite, etc.) and any singularities built into it.

Parameters:

type a **gqr_t** (p. 10) describing a quadrature rule.

Returns:

a string giving the name of rule *type*.

gqr_rule_t* gqr_rule_realloc (gqr_rule_t * *g*, gint *n*)

Reallocate memory for a Gaussian quadrature rule to allow for a change in rule length.

Parameters:

g **gqr_rule_t** (p. 10) to reallocate;

n new maximum length of rule (number of abscissae and weights).

Returns:

newly allocated rule.

gint gqr_rule_scale (gqr_rule_t * *g*, gdouble *a*, gdouble *b*, gdouble * *xbar*, gdouble * *dx*)

Set the scaling for a rule so that the integral is approximated by: $I \approx \Delta x \sum_{j=0}^{n} w_j f(x_j)$ where $x = \bar{x} + \Delta x t_j$.

Parameters:

g Gaussian quadrature rule;

a lower limit of integration;

b upper limit of integration;

xbar $\bar{x}$;

dx Δx.

Returns:

0 on success.

gint gqr_rule_select (gqr_rule_t * *g*, gqr_t *type*, gint *n*, gqr_parameter_t * *p*)

Fill a Gaussian quadrature rule with abscissae and weights of a chosen type.

Parameters:

g rule to fill;

type a gqr_t for the rule;

n number of points in rule;

p gqr_parameter_t of parameters for rule.

Returns:

0 on success.

gint gqr_rule_write (gqr_rule_t * *g*, FILE * *f*)

Write the abscissae and weights of a Gaussian quadrature rule to a file.

Parameters:

g Gaussian quadrature rule;

f file stream to write to.

Returns:

0 on success.

Chapter 4

GQR File Documentation

4.1 gqr.h File Reference

Declarations for the GQR functions.

Typedefs

- typedef _gqr_parameter_t **gqr_parameter_t**
- typedef _gqr_rule_t **gqr_rule_t**

Enumerations

- enum **gqr_t** {

  GQR_GAUSS_LEGENDRE = 1, **GQR_GAUSS_CHEBYSHEV_1** = 2, **GQR_GAUSS_-CHEBYSHEV_2** = 3, **GQR_GAUSS_HERMITE** = 4,

  GQR_GAUSS_LAGUERRE = 5, **GQR_GAUSS_JACOBI** = 6, **GQR_GAUSS_-LOGARITHMIC** = 1 << 8, **GQR_GAUSS_SINGULAR** = 1 << 9,

  GQR_GAUSS_HYPERSINGULAR = 1 << 10, **GQR_GAUSS_MULTISINGULAR** = 1 << 11
  }

Functions

- gint **gqr_rule_free** (**gqr_rule_t** *g)
- **gqr_rule_t** * **gqr_rule_alloc** (gint n)
- **gqr_rule_t** * **gqr_rule_realloc** (**gqr_rule_t** *g, gint n)
- gint **gqr_rule_write** (**gqr_rule_t** *g, FILE *f)
- gint **gqr_rule_select** (**gqr_rule_t** *g, **gqr_t** type, gint n, **gqr_parameter_t** *p)
- gint **gqr_rule_scale** (**gqr_rule_t** *g, gdouble a, gdouble b, gdouble *xbar, gdouble *dx)
- gchar * **gqr_rule_name** (**gqr_t** type)

4.1.1 Detailed Description

Declarations for the GQR functions.

Author:

Michael Carley

Date:

Wed Nov 7 15:24:13 2007

4.1.2 Typedef Documentation

gqr_parameter_t

An data structure containing parameters for quadrature rules which require them.

gqr_rule_t

Data structure containing the nodes and weights of a quadrature rule. The rule is allocated using **gqr_rule_alloc** (p. 5) and initialized using **gqr_rule_select** (p. 6). To transform the range of integration use **gqr_rule_scale** (p. 6).

4.1.3 Enumeration Type Documentation

enum gqr_t

A type defining the quadrature rules available. A quadrature rule is defined as a basic type possibly combined with a singularity. For example GQR_GAUSS_LEGENDRE | GQR_GAUSS_HYPERSINGULAR specifies a Gauss-Legendre rule which handles singularities up to and including second order. Note that not all of these rules are implemented yet. GQR will return an error message if you try to use an unimplemented rule.

Enumerator:

GQR_GAUSS_LEGENDRE Gauss-Legendre

GQR_GAUSS_CHEBYSHEV_1 Gauss-Chebyshev of the first kind

GQR_GAUSS_CHEBYSHEV_2 Gauss-Chebyshev of the second kind

GQR_GAUSS_HERMITE Hermite

GQR_GAUSS_LAGUERRE Laguerre

GQR_GAUSS_JACOBI Jacobi

GQR_GAUSS_LOGARITHMIC Logarithmic singularities

GQR_GAUSS_SINGULAR First order and logarithmic singularities

GQR_GAUSS_HYPERSINGULAR Singularities up to second order

GQR_GAUSS_MULTISINGULAR Multiple singularities which must be specified in the rule initialization

4.2 grule.c File Reference

Gaussian quadrature rule generation and selection functions.

Functions

- **gqr_rule_t** ∗ **gqr_rule_alloc** (gint n)
- **gqr_rule_t** ∗ **gqr_rule_realloc** (**gqr_rule_t** ∗g, gint n)
- gint **gqr_rule_free** (**gqr_rule_t** ∗g)
- gint **gqr_rule_write** (**gqr_rule_t** ∗g, FILE ∗f)
- gint **gqr_rule_select** (**gqr_rule_t** ∗g, **gqr_t** type, gint n, **gqr_parameter_t** ∗p)
- gint **gqr_rule_scale** (**gqr_rule_t** ∗g, gdouble a, gdouble b, gdouble ∗xbar, gdouble ∗dx)
- gchar ∗ **gqr_rule_name** (**gqr_t** type)

4.2.1 Detailed Description

Gaussian quadrature rule generation and selection functions.

Author:

Michael Carley

Date:

Tue Jul 4 12:57:44 2006

The GQR library computes Gaussian and Gaussian-type quadrature rules including some which handle singular integrands. A simple example of its use to integrate a function is:

Chapter 5

GQR Example Documentation

5.1 example.c

```
1 #include <stdio.h>
2 #include <math.h>
3 #include <unistd.h>
4
5 #include <glib.h>
6 #include <gsl/gsl_sf.h>
7 #include <gsl/gsl_math.h>
8
9 #include <gqr.h>
10
11 gdouble func(gdouble t, gdouble x, gdouble y)
12
13 {
14   return (1.0/((x-t)*(x-t) + y*y)) ;
15 }
16
17 gint main()
18
19 {
20   gqr_rule_t *g ;
21   gqr_parameter_t p ;
22   gdouble x, y ;
23   gdouble a, b ;
24   gdouble dx, xbar ;
25   gdouble I, t ;
26   gint i, N, M ;
27   gqr_t rule ;
28
29   M = 4 ; N = 16 ;
30   x = 0.3 ; y = 0.2 ;
31   a = -1 ; b = 1 ;
32   rule = GQR_GAUSS_LEGENDRE | GQR_GAUSS_HYPERSINGULAR ;
33   g = gqr_rule_alloc(N) ;
34
35   gqr_parameter_clear(&p) ;
36   gqr_parameter_set_int(&p, M) ;
37   gqr_parameter_set_double(&p, x) ;
38   gqr_parameter_set_double(&p, y) ;
39
40   gqr_rule_select(g, rule, N, &p) ;
41
42   gqr_rule_scale(g, a, b, &xbar, &dx) ;
43
44   I = 0.0 ;
```

```
45   for ( i = 0 ; i < gqr_rule_length(g) ; i ++ ) {
46     t = gqr_rule_abscissa(g,i)*dx + xbar ;
47     I += gqr_rule_weight(g,i)*dx*func(t, x, y) ;
48   }
49
50   fprintf(stdout, "I: %lg\n", I) ;
51
52   return 0 ;
53 }
```

Index

GQR
    gqr_rule_alloc, 5
    gqr_rule_free, 5
    gqr_rule_name, 5
    gqr_rule_realloc, 6
    gqr_rule_scale, 6
    gqr_rule_select, 6
    gqr_rule_write, 7
gqr, 5
gqr.h, 9
    GQR_GAUSS_CHEBYSHEV_1, 10
    GQR_GAUSS_CHEBYSHEV_2, 10
    GQR_GAUSS_HERMITE, 10
    GQR_GAUSS_HYPERSINGULAR, 10
    GQR_GAUSS_JACOBI, 10
    GQR_GAUSS_LAGUERRE, 10
    GQR_GAUSS_LEGENDRE, 10
    GQR_GAUSS_LOGARITHMIC, 10
    GQR_GAUSS_MULTISINGULAR, 10
    GQR_GAUSS_SINGULAR, 10
    gqr_parameter_t, 10
    gqr_rule_t, 10
    gqr_t, 10
GQR_GAUSS_CHEBYSHEV_1
    gqr.h, 10
GQR_GAUSS_CHEBYSHEV_2
    gqr.h, 10
GQR_GAUSS_HERMITE
    gqr.h, 10
GQR_GAUSS_HYPERSINGULAR
    gqr.h, 10
GQR_GAUSS_JACOBI
    gqr.h, 10
GQR_GAUSS_LAGUERRE
    gqr.h, 10
GQR_GAUSS_LEGENDRE
    gqr.h, 10
GQR_GAUSS_LOGARITHMIC
    gqr.h, 10
GQR_GAUSS_MULTISINGULAR
    gqr.h, 10
GQR_GAUSS_SINGULAR
    gqr.h, 10
gqr_parameter_t
    gqr.h, 10
gqr_rule_alloc
    GQR, 5
gqr_rule_free
    GQR, 5
gqr_rule_name
    GQR, 5
gqr_rule_realloc
    GQR, 6
gqr_rule_scale
    GQR, 6
gqr_rule_select
    GQR, 6
gqr_rule_t
    gqr.h, 10
gqr_rule_write
    GQR, 7
gqr_t
    gqr.h, 10
grule.c, 11