

# Fisher-Bingham MLE Manual

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### 0.0.1 nk\_fb\_gen\_c.gen\_c

`nk_fb_gen_c.gen_c(N)`

: It generates a C program to make a MLE (maximal likelihood estimate) by the HGD (holonomic gradient descent) for  $N$  dimensional Fisher-Bingham distribution.

Description:

This function generates two C programs `testN.c` and `testN.h`. After setting data and an initial point to make MLE in `testN.c`, build an executable file by the command

```
gcc testN.c $OpenXM_HOME/lib/libko_fb.a -lgsl -lblas
```

The library file `libko_fb.a` is generated by `make install` in the folder '`OpenXM/src/hgm/fisher-bingham/src/`'. The GSL (Gnu Scientific Library) should also be installed in the system. Sample data and initial points are in '`OpenXM/src/hgm/fisher-bingham/src/Testdata`'.

The definition `#define MULTIMIN_FDFMINIMIZER_TYPE` in `testN.h` specifies an optimization problem solver of `gsl`. The definition `#define ODEIV_STEP_TYPE` in `testN.h` specifies a solver of the ordinary differential equation of `gsl`.

As to the algorithm, refer to T. Koyama, H. Nakayama, K. Nishiyama, N. Takayama, Holonomic Gradient Descent for the Fisher-Bingham Distribution on the  $d$ -dimensional Sphere, Computational Statistics (2013), <http://dx.doi.org/10.1007/s00180-013-0456-z>

Authors; T.Koyama, H.Nakayama, K.Nishiyama, N.Takayama.

Example:

```
[1854] load("nk_fb_gen_c.rr");
[2186] nk_fb_gen_c.gen_c(1);      Generate a program to solve MLE on S^1
generate test1.h
generate test1.c
1
[2187] quit;
$ emacs test1.c &
```

Find a line which contains

Write data here

and insert `$(OpenXM_HOME)/src/hgm/fisher-bingham/Testdata/s1_wind_data.h` after this line.

Save and quit emacs.

```
$ gcc test1.c $OpenXM_HOME/lib/libko_fb.a -lgsl -lblas
```

```
$ ./a.out
```

```
--- snip
```

```
points = [1.11945, 3.33044, -0.469454, 0.904504, -0.770373]
```

```
values = [3.4421, 1.13891, -0.0217944, 2.28474]
```

```
grad ; 0.005644 -0.033429 -0.005644 0.045820 0.047695
```

```
norm(grad) ; 0.074535
```

```
--- snip
```

where 'points' is the estimated value of the parameter  $x_{11}, x_{12}, x_{22}, y_1, y_2$ .  
Value 3.4421 is the inverse of the likelihood which is minimized.

# Index

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(Index is nonexistent)

## Short Contents

Index .....	3
-------------	---

## Table of Contents

0.0.1 nk_fb_gen_c.gen_c .....	1
<b>Index .....</b>	<b>3</b>