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#include <stdlib.h>
#include <math.h>
#include "copulas.h"

typedef struct {
    double          rho;
    double          g_rho;
    double          u_rho;
    double          factor;
} gaussian_params;

static double gaussian_density(const copula *cop, const
    double x){
    return pnl_normal_density (x);
}

static double *gaussian_compute_prob(const copula *cop, cons
    t double f_t)
{
    double          *result;
    gaussian_params  *p;
    double a;
    int i;
    p = cop->parameters;
    result = malloc(cop->size * sizeof(double));
    a = pnl_inv_cdfnor(f_t) / p->g_rho;
    for (i = 0; i < cop->size; i++) {
        result[i] = cdf_nor(a - p->u_rho * cop->points[i]);
    }

    return (result);
}

static void gaussian_generate(copula *cop){
    ((gaussian_params *)cop->parameters)->factor = pnl_rand_
        normal(0);
}

static int gaussian_compute_dt(const copula *cop, const step
    _fun *H, double *time){
```

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    gaussian_params *p;
    double X;
    double zi;
    p = cop->parameters;
    X = p->rho * p->factor + p->g_rho * pnl_rand_normal(0);
    zi = -log(1. - cdf_nor(X));
    if (zi >= H->data[H->size-1].y2) return ( 0 );
    else {
        *time = inverse_sf(H, zi);
        return ( 1 );
    }
}

copula *init_gaussian_copula(const double rho)
{
    copula          *cop;
    gaussian_params *p;
    double          h;
    double          v0;
    int             jv;

    cop = malloc(sizeof(copula));
    cop->name = "One-factor Gaussian Copula";
    cop->nfactor = 1;
    p = malloc(sizeof(gaussian_params));
    p->rho = rho;
    p->g_rho = sqrt(1.0 - rho*rho);
    p->u_rho = rho / p->g_rho;
    cop->parameters = p;
    cop->size = 200;
    cop->points = malloc(cop->size * sizeof(double));
    cop->weights = malloc(cop->size * sizeof(double));
    h = 24. / (cop->size-1);
    for (jv = 0, v0 = -12.; jv < cop->size; jv++, v0 += h) {
        cop->points[jv] = v0;
        cop->weights[jv] = gaussian_density(cop, v0) * h;
    }
    cop->density = gaussian_density;
    cop->generate = gaussian_generate;
    cop->compute_default_time = gaussian_compute_dt;
    cop->compute_cond_prob = gaussian_compute_prob;
}

```

```
    return (cop);  
}
```

## References