

[Help](#)

```
#if defined(PremiaCurrentVersion) && PremiaCurrentVersion < (2007+2) //The "#els
#else

#ifndef LEVY_H
#define LEVY_H

#include <iostream>
#include <fstream>
#include <
href../../common/math/complex_erf_h_src.pdfcomplex>
#include <
href../../common/math/highdim_solver/highdim_vector_h_src.pdfvector>
#include "
href../../common/math/progonka_h_src.pdfprogonka.h"
#include "
href../../common/math/numerics_h_src.pdfnumerics.h"

const complex<double> I(0, 1);

class Levy_measure
/* generic class for a Levy model */
{
    virtual double nu(const double x) const = 0; // value of the Levy density nu a
    virtual double integrated_nu(const double a, const double b) const = 0; // int

protected:
    double drift; // used in calculation of the characteristic function of X_T

public:
    double lambda; // nu(R)
    double alpha; // integral of (exp(x)-1) with respect to nu(dx) on R
    double sigmadiff_squared; // variance of the diffusion part
    double espX1; // expectation of X1
    double varX1; // variance of X1
    vector<double> *nu_array; // values of nu on the grid: nu_array[j-Kmin] = nu(x
    int Kmin;
    int Kmax;
    double dx; // space discretization step
```

```

virtual complex<double> cf(const double T, const complex<double> &u) const = 0

friend class Ref_Levy_measure; /* an auxiliary class which allows to substitute
    as an argument of another function (we use it in the function-template
                                double qromb(T func, double a, double b) from
friend class Levy_nu_expx; /* an auxiliary class which allows to use the function
double qromb(T func, double a, double b) from numerics.h
with func(x) = exp(x)*nu(x) */
virtual ~Levy_measure() {};
};

class Ref_Levy_measure
{
    const Levy_measure &refmeasure;

public:
    Ref_Levy_measure(const Levy_measure &measure) : refmeasure(measure) {}

    double operator()(const double x) const
    {
        return refmeasure.nu(x);
    }
};

class Levy_nu_expx
{
    const Levy_measure &refmeasure;

public:
    Levy_nu_expx(const Levy_measure &measure) : refmeasure(measure) {}

    double operator()(const double x) const
    {
        return exp(x) * refmeasure.nu(x);
    }
};

/* We derive below classes for specific Levy models from the general class Levy_

class Merton_measure : public Levy_measure
{

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double mu;
double delta;
double factor;

double nu(const double x) const
{
    return factor * normPDF((x - mu) / delta) / delta;
}

double integrated_nu(const double a, const double b) const
{
    return factor * (normCDF((b - mu) / delta) - normCDF((a - mu) / delta));
}

public:

    Merton_measure(const double dmuh, const double ddelta,
                    const double dfactor, const double sigma,
                    const double ddx);
    virtual ~Merton_measure();

    complex<double> cf(const double T, const complex<double> &u) const
    {
        return exp(T * (-sigmadiff_squared * u * u / 2. + factor * (exp(I * mu * u -
            + I * u * drift)));
    }
};

/*-----
class Kou_measure : public Levy_measure
{
    double factor;
    double lambdap;
    double lambdam;
    double p;

    double nu(const double x) const
    {
        return (x > 0) ? p * factor * lambdap * exp(-lambdap * x)
            : (1 - p) * factor * lambdam * exp(lambdam * x);
    }
}

```

```

double integrated_nu(const double a, const double b) const
{
    if (a >= b) myerror("in function integrated_nu a must be less than b");
    else if (a >= 0)
        return p * factor * (exp(-lambdap * a) - exp(-lambdap * b));
    else if (b <= 0)
        return (1 - p) * factor * (exp(lambdam * b) - exp(lambdam * a));
    else
        return factor * (1 - p * exp(-lambdap * b) - (1 - p) * exp(lambdam * a));

    /* to avoid a warning */
    return 0;
}

public:

    Kou_measure(const double dfactor, const double dlambdap,
                const double dlambdam, const double dp,
                const double sigma, const double ddx);
    virtual ~Kou_measure();
    complex<double> cf(const double T, const complex<double> &u) const
    {
        return exp(T * (-sigmadiff_squared * u * u / 2. + I * u * factor * p / (lam
                        - I * u * factor * (1 - p) / (lambdam + I * u) + I * u * dr
        }
    };

    /*-----
class VG_measure : public Levy_measure
{
    double theta;
    double sigma;
    double kappa;
    double A;
    double B;
    double epsilon;

    double nu(const double x) const
    {
        if (fabs(x) >= epsilon)

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        {
            return x > 0 ? exp((A - B) * x) / kappa / x : -exp((A + B) * x) / kappa
        }
        else return 0;
    }
    double integrated_nu(const double a, const double b) const;

public:

    VG_measure(const double dtheta, const double dsigma,
               const double dkappa, const double ddx);
    virtual ~VG_measure();
    complex<double> cf(const double T, const complex<double> &u) const
    {
        return exp(-T / kappa * log(1. - I * theta * kappa * u + sigma * sigma * ka
                                   + I * T * u * drift));
    }
};

/*-----
class NIG_measure : public Levy_measure
{
    double theta;
    double sigma;
    double kappa;
    double A;
    double B;
    double C;
    double epsilon;
    double nu(const double x) const
    {
        if (fabs(x) >= epsilon)
        {
            return (A * x < 600) ? C / fabs(x) * exp(A * x) * bessk1(B * fabs(x)) //
                : C * sqrt(M_PI / (2 * B * abs(x))) * exp(A * x - B * abs(x)) / a
        }
        else return 0;
    }
    double integrated_nu(const double a, const double b) const;

public:

```

```

NIG_measure(const double dtheta, const double dsigma,
             const double dkappa, const double ddx);
virtual ~NIG_measure();

complex<double> cf(const double T, const complex<double> &u) const
{
    return exp(T * (1. - sqrt(1. + u * u * sigma * sigma * kappa - 2.*I * theta
                             + I * T * u * drift));
}

friend class NIG_nu_x2; /* an auxiliary class which allows to use the function
    double qromb(T func, double a, double b) from numerics.h
    with func(x) = x^2*nu(x) */
};

class NIG_nu_x2
{
    const NIG_measure &refmeasure;

public:
    NIG_nu_x2(const NIG_measure &measure) : refmeasure(measure) {}

    double operator()(const double x) const
    {
        if (refmeasure.A * x < 600) // to avoid overflow due to exp(Ax)
            return x == 0 ? refmeasure.C / refmeasure.B : refmeasure.C * abs(x) * exp(
        else
            return refmeasure.C * sqrt(M_PI * abs(x) / (2 * refmeasure.B)) * exp(refme
    }
};

/*-----
class TS_measure : public Levy_measure
{
    double alphap, alpham;
    double lambdap, lambdam;
    double cp, cm;
    double epsilonp;
    double epsilonm;

```

```

inline double nu(const double x) const
{
    if (x >= epsilonp) return cp * exp(-lambdap * x) / pow(x, 1 + alphap);
    else if (x <= -epsilonm) return cm * exp(lambdam * x) / pow(-x, 1 + alpham);
    else return 0;
}

double integrated_nu(const double a, const double b) const;

public:

    TS_measure(const double dalphap, const double dalpham,
               const double dlambdap, const double dlambdam,
               const double dcp, const double dcm, const double ddx);
    virtual ~TS_measure();

    complex<double> cf(const double T, const complex<double> &u) const;
};

#endif

#endif //PremiaCurrentVersion

```