
TF Quant Finance: TensorFlow based Quant Finance Library

cloud build success

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Introduction

This library provides high-performance components leveraging the hardware acceleration support and automatic differentiation of TensorFlow. The library will provide TensorFlow support for foundational mathematical methods, mid-level methods, and specific pricing models. The coverage is being expanded over the next few months.

The library is structured along three tiers:

1. **Foundational methods.** Core mathematical methods - optimisation, interpolation, root finders, linear algebra, random and quasi-random number generation, etc.
2. **Mid-level methods.** ODE & PDE solvers, Ito process framework, Diffusion Path Generators, Copula samplers etc.
3. **Pricing methods and other quant finance specific utilities.** Specific Pricing models (e.g., Local Vol (LV), Stochastic Vol (SV), Stochastic Local Vol (SLV), Hull-White (HW)) and their calibration. Rate curve building, payoff descriptions, and schedule generation.

We aim for the library components to be easily accessible at each level. Each layer will be accompanied by many examples that can run independently of higher-level components.

Installation

The easiest way to get started with the library is via the pip package.

Note that the library requires Python 3.7 and Tensorflow ≥ 2.7 .

First, please install the most recent version of TensorFlow by following the TensorFlow installation instructions. For example, you could install TensorFlow

```
1 pip3 install --upgrade tensorflow
```

Then run

```
1 pip3 install --upgrade tf-quant-finance
```

You maybe also have to use the option `--user`.

TensorFlow training

If you are not familiar with TensorFlow, an excellent place to get started is with the following self-study introduction to TensorFlow notebooks:

- Introduction to TensorFlow Part 1 - Basics.
- Introduction to TensorFlow Part 2 - Debugging and Control Flow.
- Introduction to TensorFlow Part 3 - Advanced Tensor Manipulation.

Development roadmap

We are working on expanding the coverage of the library. Areas under active development are:

- Ito Processes: Framework for defining Ito processes. Includes methods for sampling paths from a process and for solving the associated backward Kolmogorov equation.
- Implementation of the following specific processes/models:
 - Brownian Motion
 - Geometric Brownian Motion
 - Ornstein-Uhlenbeck
 - One-Factor Hull-White model
 - Heston model
 - Local volatility model.
 - Quadratic Local Vol model.
 - SABR model

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- Copulas: Support for defining and sampling from copulas.
 - Model Calibration:
 - Dupire local vol calibration.
 - SABR model calibration.
 - Rate curve fitting: Hagan-West algorithm for yield curve bootstrapping and the Monotone Convex interpolation scheme.
 - Support for dates, day-count conventions, holidays, etc.

Examples

See [tf_quant_finance/examples/](#) for end-to-end examples. It includes tutorial notebooks such as:

- American Option pricing under the Black-Scholes model
- Monte Carlo via Euler Scheme
- Black Scholes: Price and Implied Vol
- Forward and Backward mode gradients in TFF
- Root search using Brent's method
- Optimization
- Swap Curve Fitting
- Vectorization and XLA compilation

The above links will open Jupyter Notebooks in Colab.

Contributing

We're eager to collaborate with you! See CONTRIBUTING.md for a guide on how to contribute. This project adheres to TensorFlow's code of conduct. By participating, you are expected to uphold this code.

Development

This section is for developers who want to contribute code to the library. If you are only interested in using the library, please follow the instructions in the Installation section.

Development dependencies

This library has the following dependencies:

1. Bazel
2. Python 3 (Bazel uses Python 3 by default)
3. TensorFlow version ≥ 2.7
4. TensorFlow Probability version between v0.11.0 and v0.12.1
5. Numpy version 1.21 or higher
6. Attrs
7. Dataclasses (not needed if your Python version ≥ 3.7)

This library requires the Bazel build system. Please follow the Bazel installation instructions for your platform.

You can install TensorFlow and related dependencies using the `pip3 install` command:

```
1 pip3 install --upgrade tf-nightly tensorflow-probability==0.12.1 numpy
  ==1.21 attrs dataclasses
```

Commonly used commands

Clone the GitHub repository:

```
1 git clone https://github.com/google/tf-quant-finance.git
```

After you run

```
1 cd tf_quant_finance
```

you can execute tests using the `bazel test` command. For example,

```
1 bazel test tf_quant_finance/math/random_ops/sobol:sobol_test
```

will run tests in `sobol_test.py`.

Tests run using Python version 3. Please make sure that you can run `import tensorflow` in the Python 3 shell. Otherwise, tests might fail.

Building a custom pip package

The following commands will build custom pip package from source and install it:

```
1 # sudo apt-get install bazel git python python-pip rsync # For Ubuntu.
2 git clone https://github.com/google/tf-quant-finance.git
3 cd tf-quant-finance
4 bazel build :build_pip_pkg
5 ./bazel-bin/build_pip_pkg artifacts
6 pip install --user --upgrade artifacts/*.whl
```

Community

1. GitHub repository: Report bugs or make feature requests.
2. TensorFlow Blog: Stay up to date on content from the TensorFlow team and best articles from the community.
3. tf-quant-finance@googlegroups.com: Open mailing list for discussion and questions of this library.
4. TensorFlow Probability: This library will leverage methods from TensorFlow Probability (TFP).

Disclaimers

Google does not officially support this product. This library is under active development, and interfaces may change at any time.

License

This library is licensed under the Apache 2 license (see LICENSE). This library uses Sobol primitive polynomials and initial direction numbers which are licensed under the BSD license.