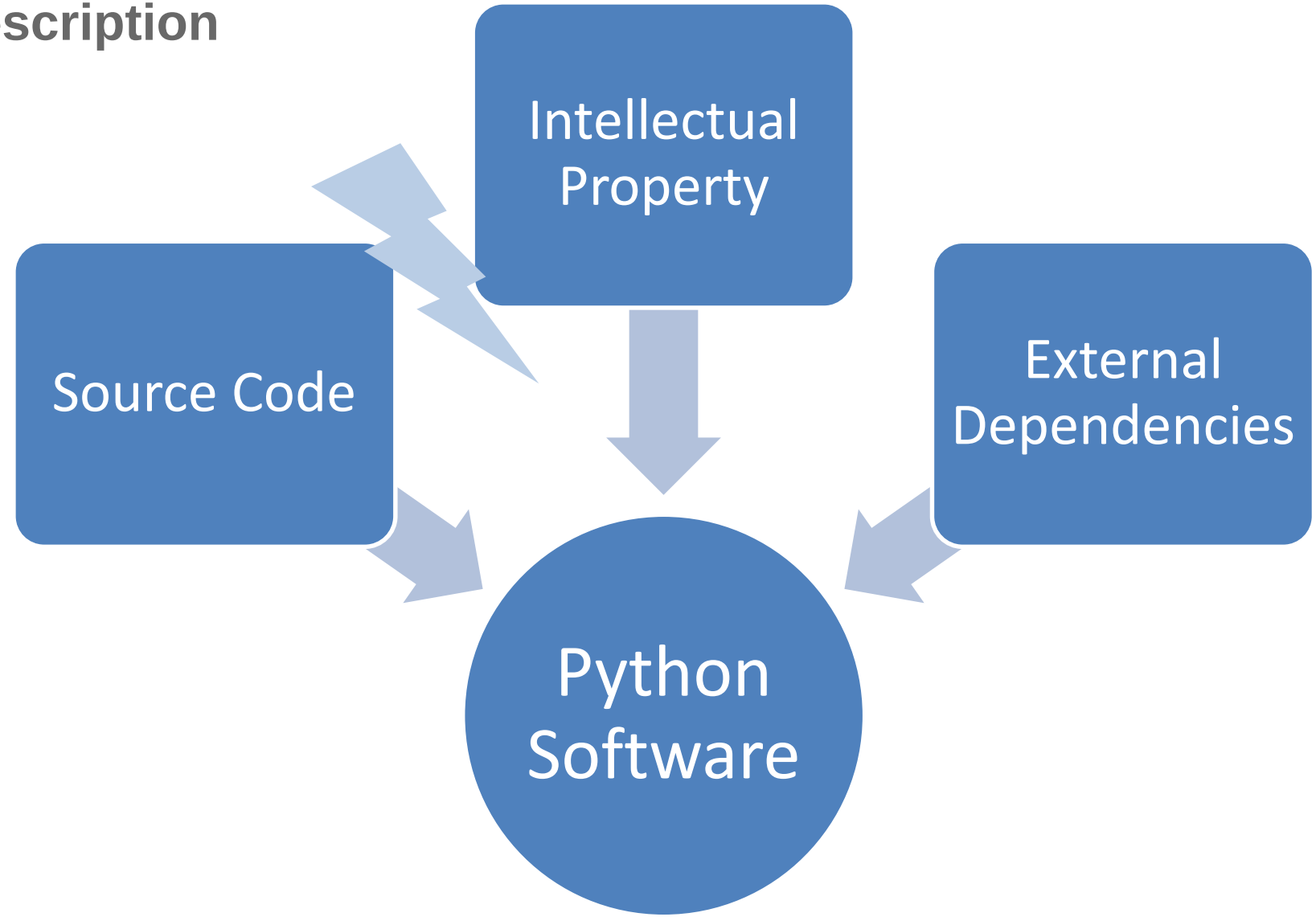
# Keeping your Intellectual Property Safe
with Python Software

*Python Users Berlin, 2022-03-10*

Michael Meinel <Michael.Meinel@dlr.de>
German Aerospace Center (DLR e.V.)
Institute for Software Technology
Berlin-Adlershof

# Problem Description



# Disclaimer

- Most elegant way: Make it Open Source
  - … is problematic with intellectual property
  - … especially with small customer group
  - … especially in science
  - … especially for unpublished results
- Most important rule stays:
  - Don’t roll your own crypto!
  - (… but I’m an expert … somehow)

# About Myself

- Dipl.-Ing. (DH) for Software Engineering
  - … soon to be Master for IT Security
- Research Software Engineer at DLR since 2004
  - Software development
  - Trainings
  - In-house consulting
  - Programming since 1996
  - Python enthusiast
- Member of workers council
  - … with focus on data protection

# Institute for Software Technology

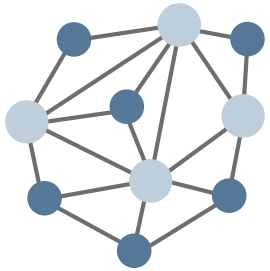
DLR Institute for **Software Research**,
**Software Engineering, Artificial Intelligence** and
**Scientific Computation**

About 100 employees located at

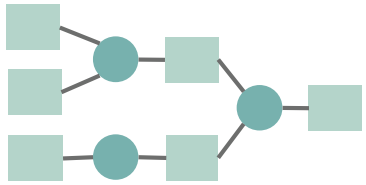
- **Cologne-Porz**
- Berlin-Adlershof
- Brunswick
- Oberpfaffenhofen
- Bremen-Airport (ECOMAT)

`https://www.DLR.de/sc`

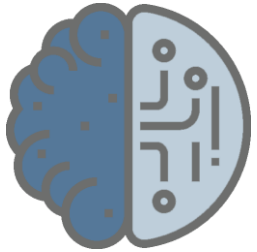
# Current Research



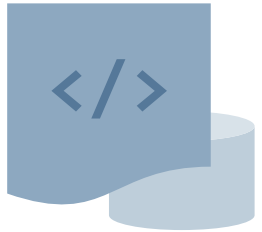
## Distributed & Decentralized Systems



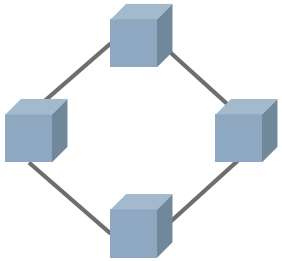
## Workflows & Provenance



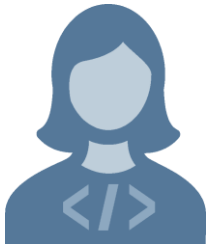
## AI & Knowledge



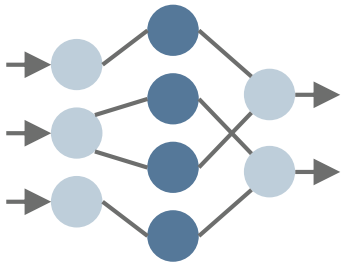
## Software Engineering



## Distributed Databases & Blockchains



## Human Factors

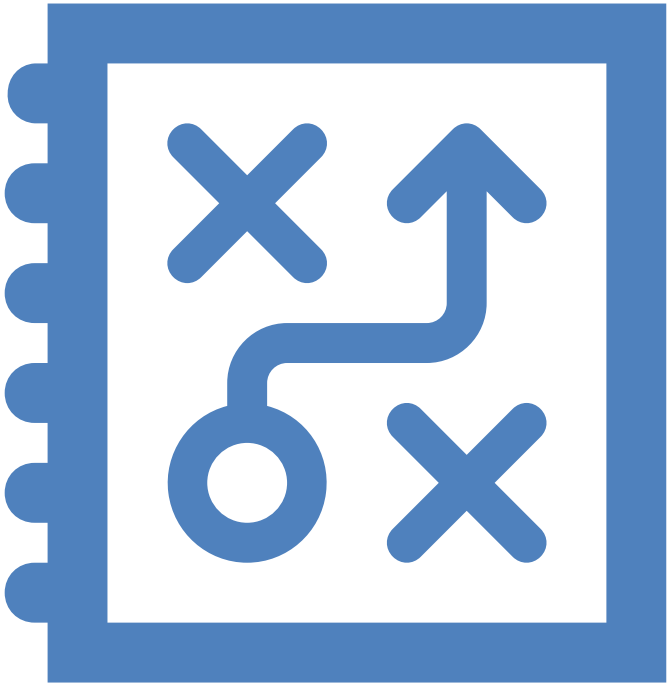


## Machine Learning

## Software Analytics

# Outline

- Goals and strategies to keep your IP safe
- Existing solutions
  - Python byte code / Binary
  - Obfuscators
  - Encryption
- My own solution: dongle/lockup
- Discussion



# Goals and Strategies

## Goals

- Protect source from being read
- Enforce usage restrictions
- Protect from modification
  (e. g., to deactivate license checks)
- Protect from reverse engineering and tampering
- Keep it simple, stupid

## Strategies

- Compile, Obfuscate, Encrypt
- Implement license rules and checks
- Sign scripts
  (and enforce signatures)
- Implement run-time checks
  - … for running debuggers
  - … against tampering

# Compile Your Source

## … using Python

- It‘s easy to create .pyc / .pyo from Python source.
- Platform-independent,
  but depends on Python version
- Very low level of protection
  → e. g., uncompyle6

## … using Cython, Nuitka

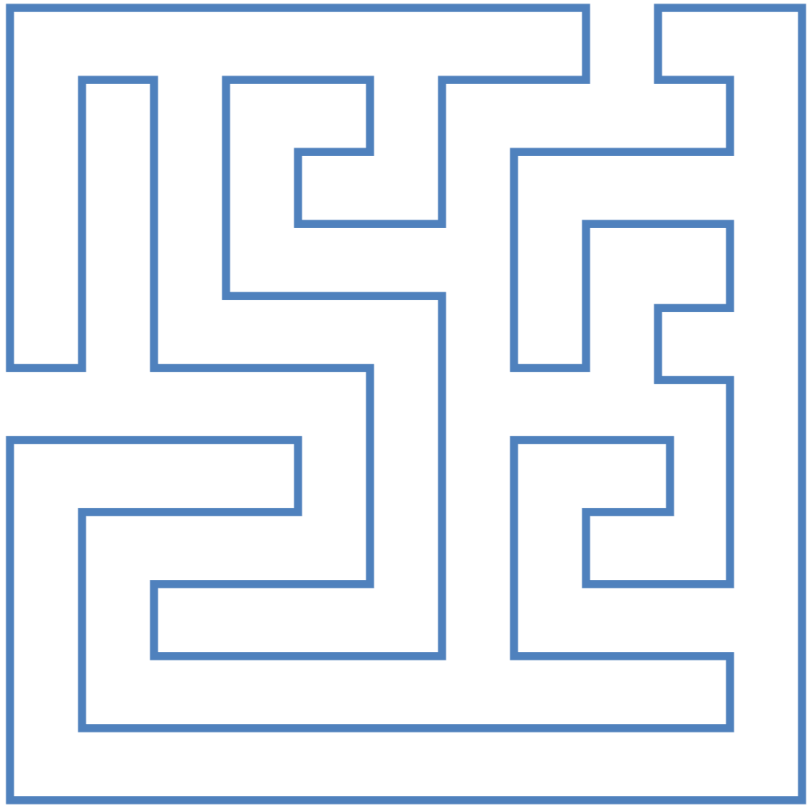
- Still rather easy…
  - (… but I did not test Nuitka yet)
- Less portable, need to build per platfom.
- Less debuggable…
- Good protection for low price…
  - … but depends on compiler –O-level
  - … but still can be analyzed

# Source Code Obfuscation

- Lots of Open Source solutions available.

- Transform source code…
  - ... add red herrings
  - … rename variables
  - … split up lines
  - … apply transformations
    (like base64, mono-alphabetic, …)
  - …

- Complicates problem resolution.
- Hard to read at first, but easly breakable:
  - →Compile to byte code
  - →Decompile
  - →Run formatter / beautifier

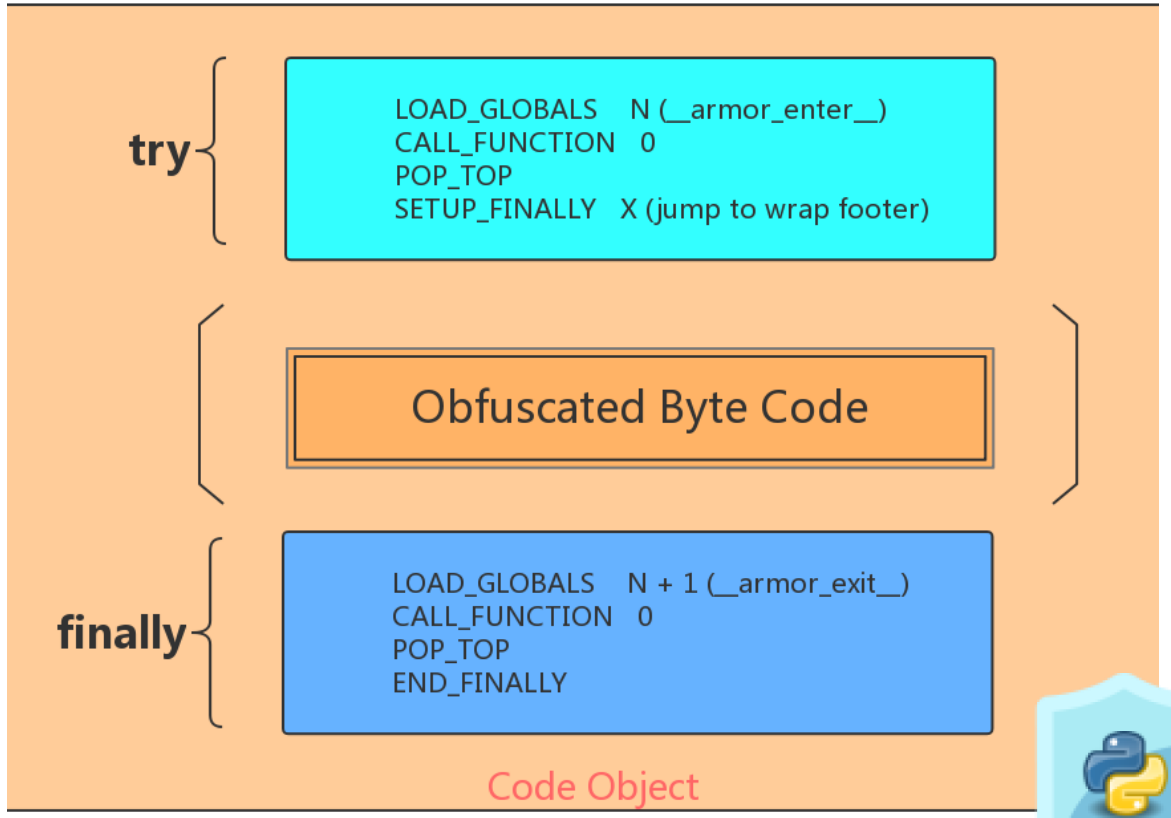


# Byte Code Obfuscation
## using PyArmor

- https://pyarmor.dashingsoft.com/

- Interesting approach:
  - Obfuscate byte code!

- Commercial product (but not expensive).
- Requires adapted runtime.
- Includes basic licensing solution.
  → Custom builds required for each license.



# Source / Byte Code Encryption

- Several solutions exist…
  - … Open Source and commercial.

- Different approaches
  - ... without asymmetric encryption
  - … with and without customer licenses

- Most depend on binary module
  - … platform dependent

- Some integrate transparently into Python (i. e., custom module loader).
- Other provide custom distributables.
- Only few integrate well with PEP 517.



# SOURCEdefender

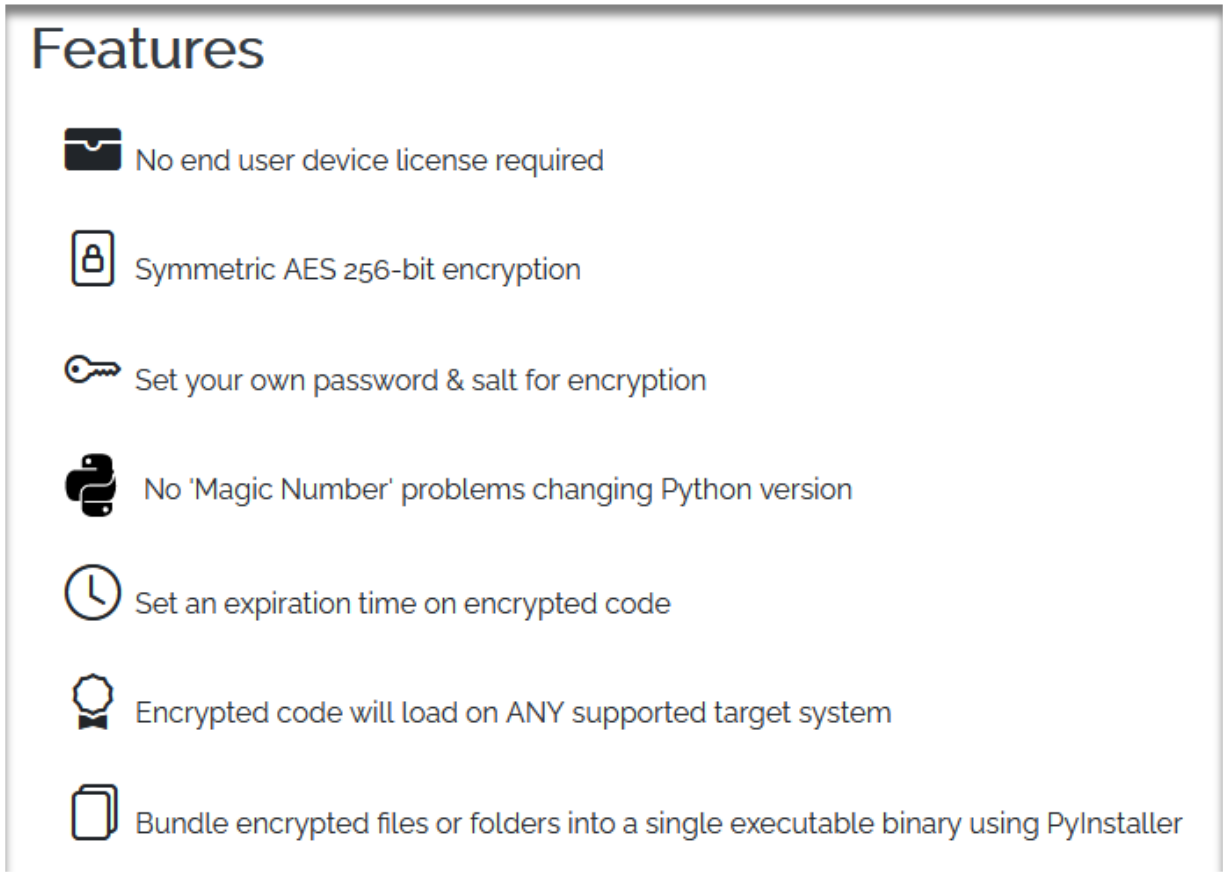
https://www.sourcedefender.co.uk/

- Commercial software (Free Trial available)

- Symmetric encryption of code with AES 256.
- Transparent integration
  with importer that loads *.pye files.
- Uses binary module
  available for broad range of platforms

- Basic licensing mechanism:
  - Can set expiration date
  - Tied to *.pye file → new translation each time

- Own distributable builder included



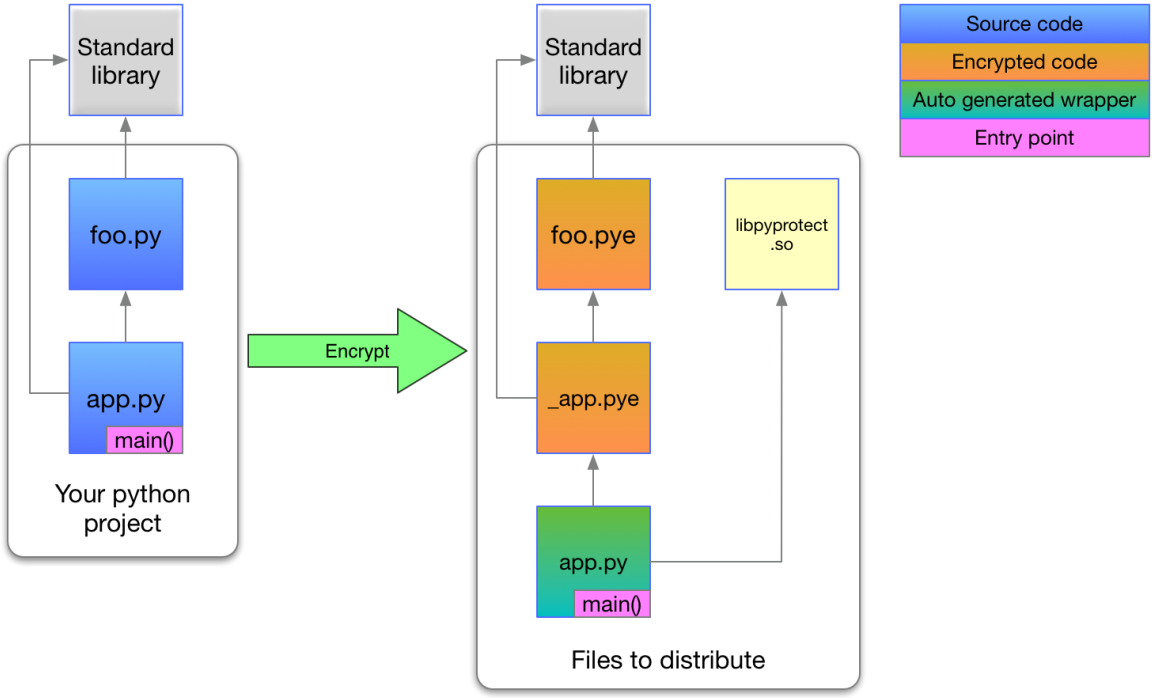
# pyprotect
## https://github.com/ga0/pyprotect

- Open Source solution (BSD)

- Based on pybind11
- Comes with custom AES implementation
  →No extra dependencies

- Builds a custom libpyprotect.so with custom importer
- Code is stored in *.pye files (different to SOURCEdefender)

- encrypt.py as simple Interface for building
- No built-in license mechanism



# pyconcrete
https://github.com/Falldog/pyconcrete

- Open Source (Apache 2.0)
  - … with honest disclaimer

- Uses binary module
  and still works with 2.7

- Transparent integration
  - Produces yet another „flavor“ of *.pye files

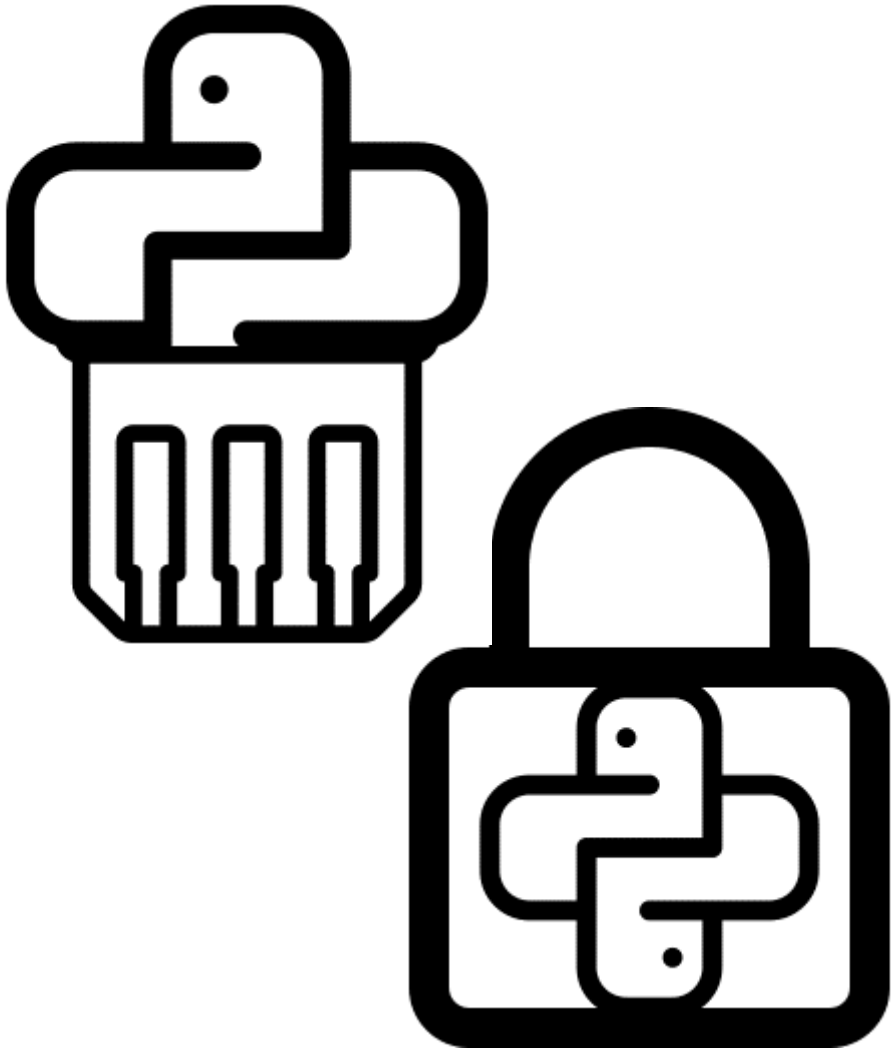
- pyconcrete-admin.py for building encrypted mods
- Key created at installation time
- No built-in license mechanism

# dongle/lockup

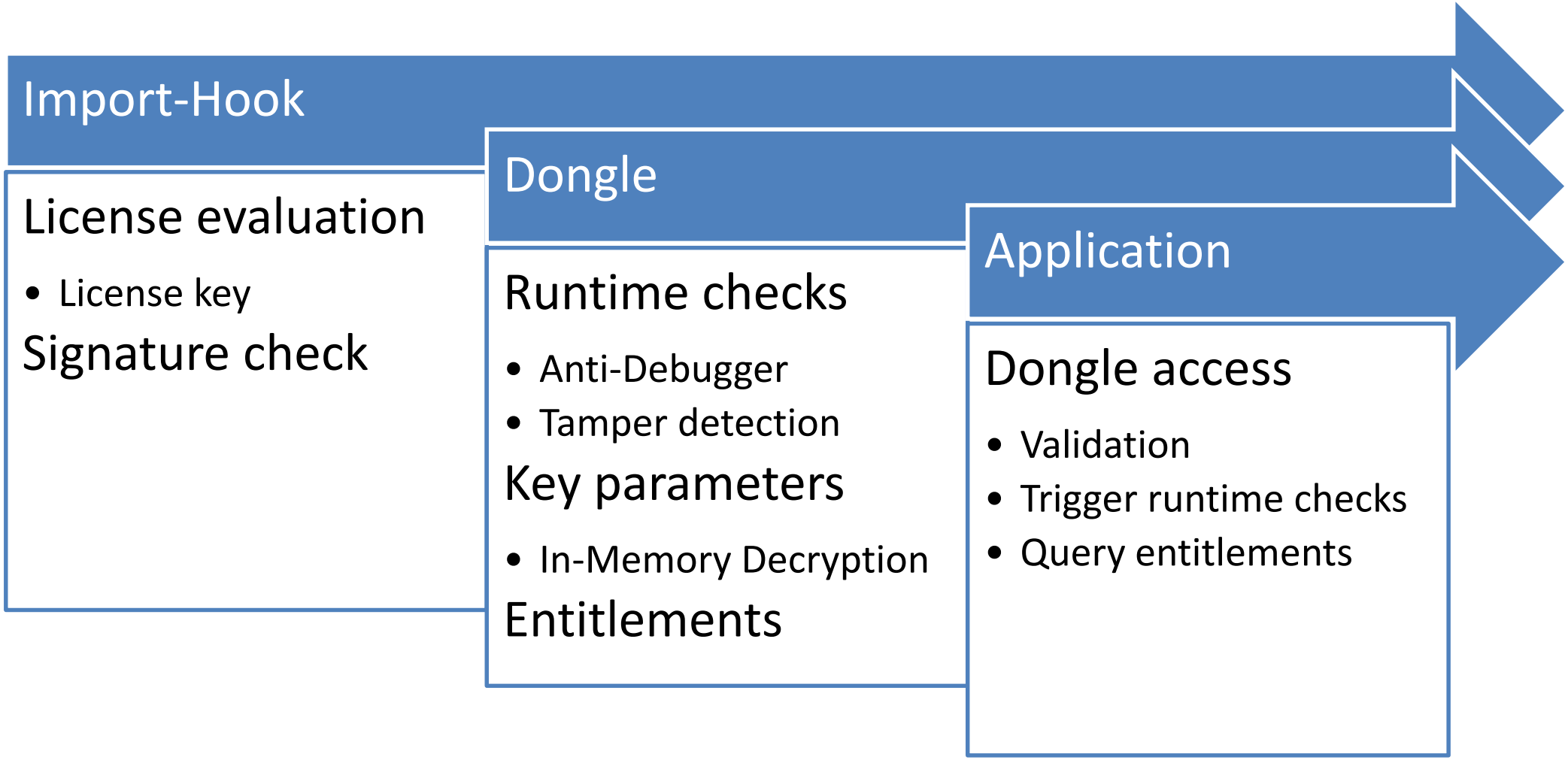
- Custom solution for DLR Technology Marketing

- Encrypted and/or signed modules
  - Possibly fully self-contained and transparent
  - License, independent of distributable
  - Implements different type of checks (extensible)
    - License conditions (node lock, expiration)
    - Environment (anti-debug, time tampering)
  - „Pure“ Python implementation
    (depends on „Cryptography“ package, though)

- Two parts:
  - dongle → Runtime: singed, Open Source (tbp)
  - lockup → Builder: licensed, Closed Source
    - Protected by … dongle ;)



# dongle Runtime Architecture

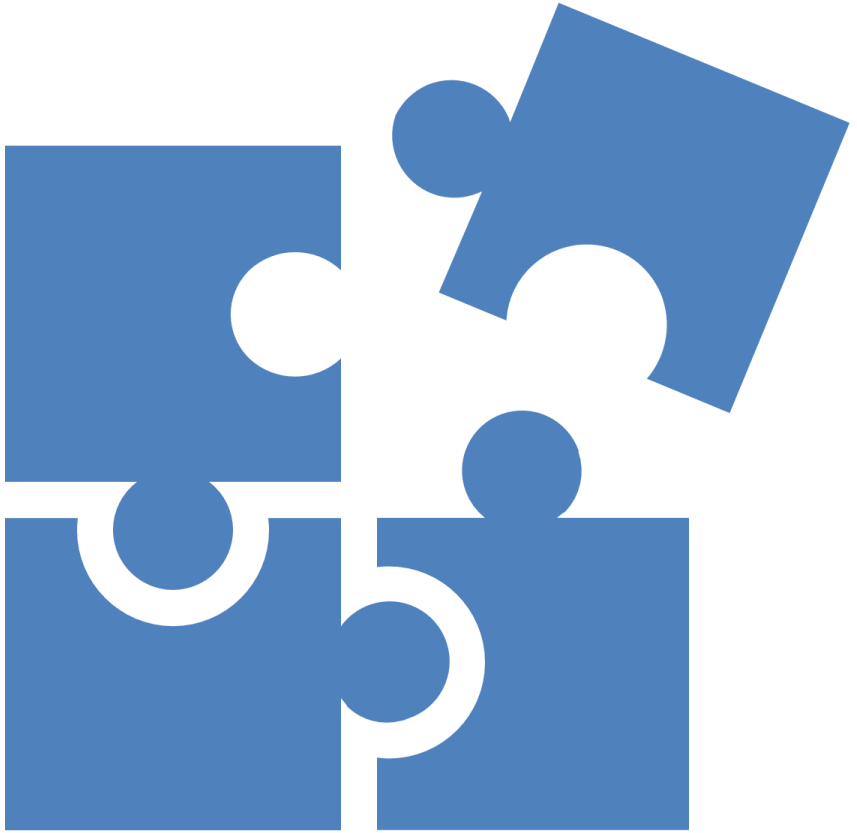


# dongle Runtime

- Public key based with ECC
  - Symmetric encryption with AES
  - Using Cryptography / OpenSSL
- License independent from distributable (using a tagging system)
  - Fully offline licensing possible
  - Enforce different rules in licenses
  - Selective package licensing
- Basic mechanisms to protect access to lower layer
- Fully transparent usage possible (*.py files)
- No build tools included

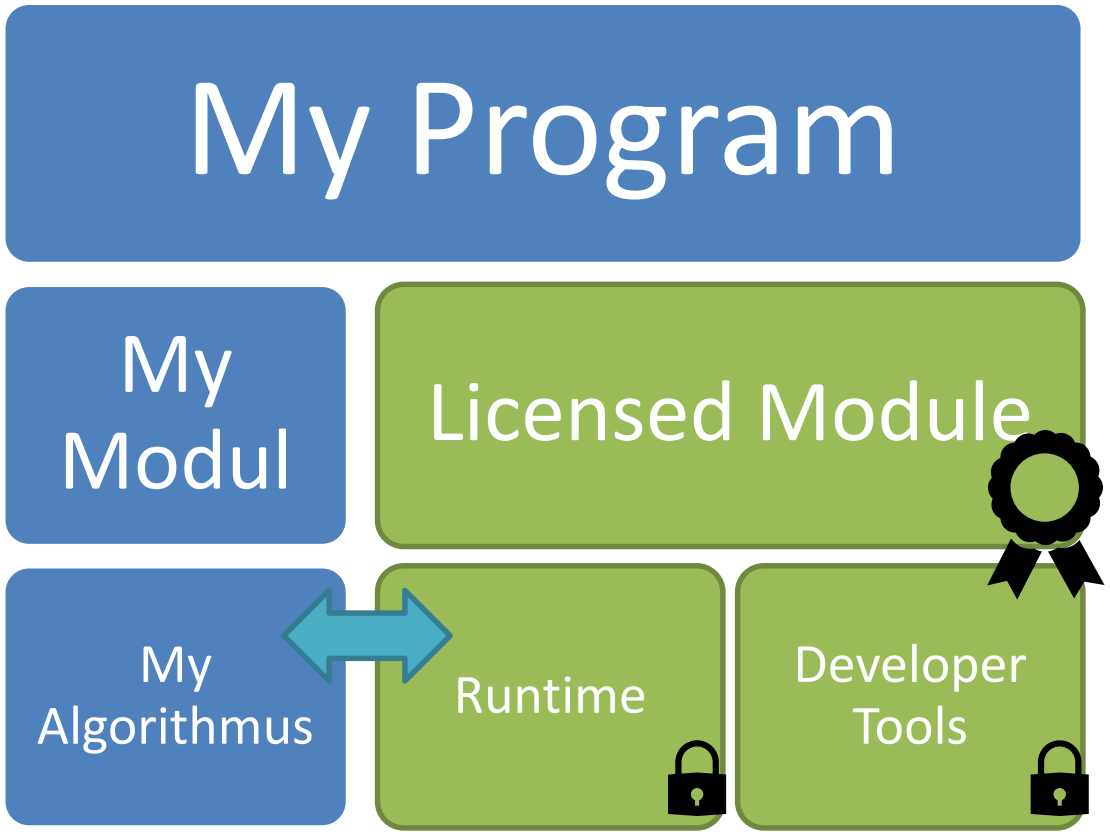
# lockup License Manager

- The „missing piece“…
- PEP 517 build system
  - drop-in replacement for setuptools
  - (WIP for poetry-based drop-in)
- License manager to generate licenses (CLI)
- Additional checks
  - Debugger detection
  - …
  - Sub-licensible (WIP)

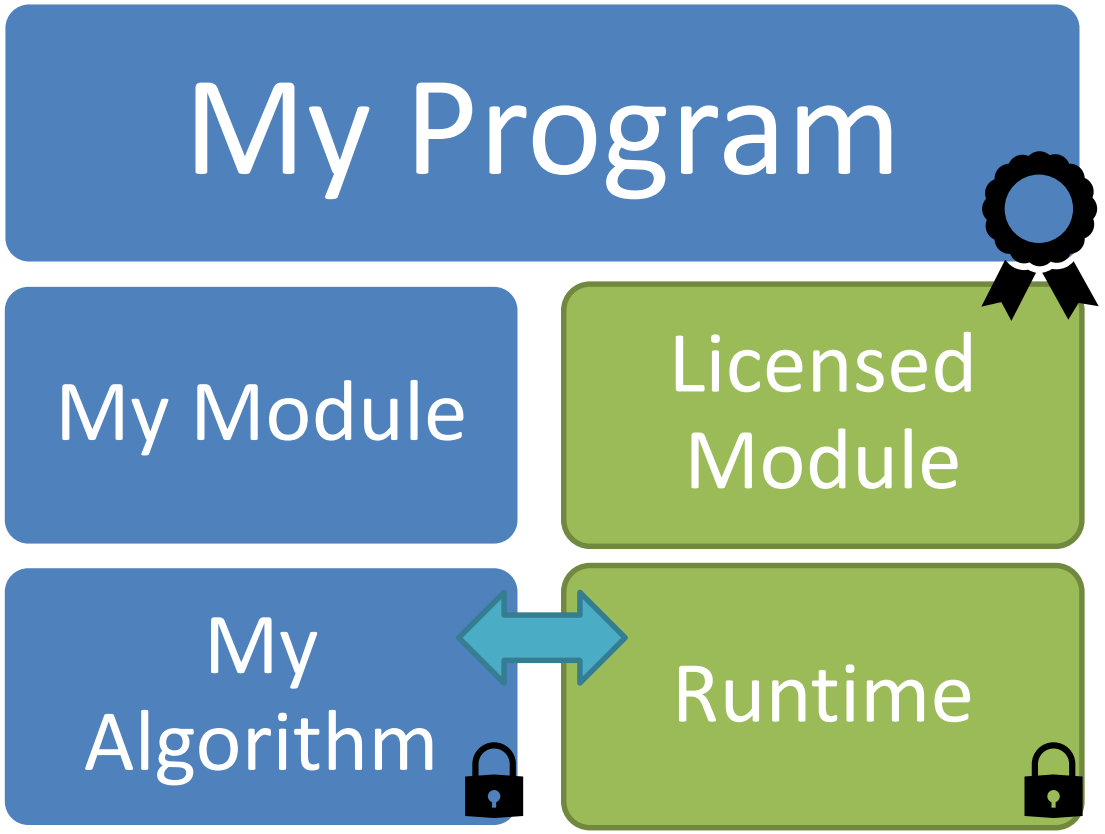


# „Sub-Licensing“
## Working concept

**Development**




**Customer**



# Roadmap

- Fix up to make it more PEPish
  - Signed wheels (PEP 491)
  - Resource loading
  - …
- Documentation
  - User documentation for dongle / lockup
  - Write Master Thesis
    (Analysis of the Crypto System)
  - Publish dongle als Open Source (license?)
- Better User Interface for lockup
- Get funding and further users!

# Question / Discussion

# The Final Slide

- This presentation does not aim to be complete or exhaustive in any way.
- dongle/lockup are developed by me at the German Aerospace Center. If you are interested in this software, feel free to contact me:

Michael Meinel <michael.meinel@dlr.de>

- Image Credit:
  - Chart 11: The logo and block diagram were taken from https://pyarmor.dashingsoft.com/
  - Chart 13: The feature list was taken from https://www.sourcedefender.co.uk/
  - Chart 14: The block diagram was taken from https://github.com/ga0/pyprotect