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ASN.1 library for Python

```
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```

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```

Abstract Syntax Notation One (ASN.1)

<http://en.wikipedia.org/wiki/Abstract_Syntax_Notation_1x>`_) is a technology for exchanging structured data in a universally understood, hardware agnostic way. Many industrial, security and telephony applications heavily rely on ASN.1.

The `pyasn1 <<https://pypi.org/project/pyasn1/>>`_ library implements ASN.1 support in pure-Python.

What is ASN.1

```
-----
```

ASN.1 is a large, arguably over-engineered and extremely old data modelling and serialisation tool. It is probably among the first serialisation protocols in the history of computer science and technology.

ASN.1 started its life over 30 years ago as a serialisation mechanism for the first electronic mail (known as X.400). Later on it was split off the e-mail application and became a stand-alone tech still being actively supported by its designers and

widely used in industry and technology.

Since then ASN.1 is sort of haunted by its relations with the OSI model -- the first, unsuccessful, version of the Internet. You can read many interesting discussions <<https://news.ycombinator.com/item?id=8871453>> on that topic.

In the following years, generations of software engineers tackled the serialisation problem many times. We can see that in Google's `ProtoBuffers` <<https://developers.google.com/protocol-buffers/>> or `FlatBuffers` <<https://google.github.io/flatbuffers/>>, for example. Interestingly, many new takes on binary protocol design do not depart far from ASN.1 from technical perspective. It's more of a matter of striking a balance between processing overhead, wire format overhead and human readability.

Looking at what ASN.1 has to offer, it has three loosely coupled parts:

- * Data types: the standard introduces a collection of basic data types (integers, bits, strings, arrays and records) that can be used for describing arbitrarily complex, nested data structures.
- * Serialisation protocols: the above data structures could be converted into a series of octets for storage or transmission over the wire as well as recovered back into their structured form. The system is fully agnostic to hardware architectures differences.
- * Schema language: ASN.1 data structures could be described in terms of a schema language for ASN.1 compiler to turn it into platform-specific implementation.

ASN.1 applications

Being an old and generally successful standard, ASN.1 is widely adopted for many uses. To give you an example, these technologies use ASN.1 for their data exchange needs:

- * Signaling standards for the public switched telephone network (SS7 family)
- * Network management standards (SNMP, CMIP)
- * Directory standards (X.500 family, LDAP)
- * Public Key Infrastructure standards (X.509, etc.)
- * PBX control (CSTA)
- * IP-based Videoconferencing (H.323 family)
- * Biometrics (BIP, CBEFF, ACBio)
- * Intelligent transportation (SAE J2735)
- * Cellular telephony (GSM, GPRS/EDGE, UMTS, LTE)

ASN.1 gotchas

Apparently, ASN.1 is hard to implement properly. Quality open-source ASN.1 tools are rare, but ad-hoc implementations are numerous. Judging from the ``statistics <http://cve.mitre.org/cgi-bin/cvekey.cgi?keyword=ASN.1>`_` on discovered security vulnerabilities, many people have implemented ASN.1 parsers and oftentimes fell victim to its edge cases.

On the bright side, ASN.1 has been around for a long time, it is well understood and security reviewed.

Documentation

```
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```

[/pyasn1/contents](#)

Use case

```
.. toctree::  
    :maxdepth: 2
```

[/example-use-case](#)

Download & Install

```
.. toctree::  
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```

[/download](#)

Changes

All changes and release history is maintained in changelog. There you could also download the latest unreleased pyasn1 tarball containing the latest fixes and improvements.

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```

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```

[/changelog](#)

License

The PyASN1 software is distributed under 2-clause BSD License.

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```

```
/license
```

Getting help

Please, file your `issues` <<https://github.com/etingof/pyasn1/issues>>` _
and `PRs` <<https://github.com/etingof/pyasn1/pulls>>` _ at GitHub.
Alternatively, you could ask for help at
`Stack Overflow` <<http://stackoverflow.com/questions/tagged/pyasn1>>` _
or search
`pyasn1-users` <<https://lists.sourceforge.net/lists/listinfo/pyasn1-users>>` _
mailing list archive.

Books on ASN.1

The pyasn1 implementation is largely based on reading up the following awesome books:

- * `ASN.1 - Communication between heterogeneous systems` <<http://www.oss.com/asn1/dubuisson.html>>` _ by Olivier Dubuisson
- * `ASN.1 Complete` <<http://www.oss.com/asn1/resources/books-whitepapers-pubs/larmouth-asn1-book.pdf>>` _ by Prof John Larmouth

Here you can get the official standards which is hard to read:

- * `ITU standards`
<<http://www.itu.int/ITU-T/studygroups/com17/languages/X.680-X.693-0207w.zip>>` _

On the other end of the readability spectrum, here is a quick and sweet write up:

- * `A Layman's Guide to a Subset of ASN.1, BER, and DER` <<ftp://ftp.rsasecurity.com/pub/pkcs/ascii/layman.asc>>` _ by Burton S. Kaliski

If you are working with ASN.1, we'd highly recommend reading a proper book on the subject.

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pyasn1-70c1bbd/docs/source/contents.rst

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ASN.1 library for Python

[![PyPI](https://img.shields.io/pypi/v/pyasn1.svg?maxAge=2592000)](https://pypi.org/project/pyasn1)
[![Python Versions](https://img.shields.io/pypi/pyversions/pyasn1.svg)](https://pypi.org/project/pyasn1/)
[![Build status](https://travis-ci.org/etingof/pyasn1.svg?branch=master)](https://secure.travis-ci.org/etingof/pyasn1)
[![Coverage Status](https://img.shields.io/codecov/c/github/etingof/pyasn1.svg)](https://codecov.io/github/etingof/pyasn1)
[![GitHub license](https://img.shields.io/badge/license-BSD-blue.svg)](https://raw.githubusercontent.com/etingof/pyasn1/master/LICENSE.txt)

This is a free and open source implementation of ASN.1 types and codecs as a Python package. It has been first written to support particular protocol (SNMP) but then generalized to be suitable for a wide range of protocols based on

[ASN.1 specification](https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-X.208-198811-W!!PDF-E&type=items).

Features

*

Generic implementation of ASN.1 types (X.208)

* Standards compliant BER/CER/DER codecs

* Dumps/loads ASN.1 structures from Python types

* 100% Python, works with Python 2.4 up to Python 3.7

* MT-safe

* Contributed ASN.1 compiler [Asn1ate](https://github.com/kimgr/asn1ate)

Why using pyasn1

ASN.1 solves the data serialisation problem. This solution was designed long ago by the wise Ancients. Back then, they did not have the luxury of wasting bits. That is why ASN.1 is designed to serialise data structures of unbounded complexity into something compact and efficient when it comes to processing the data.

That probably explains why many network protocols and file formats still rely on the 30+ years old technology. Including a number of high-profile Internet protocols and file formats.

Quite a number of books cover the topic of ASN.1.

[Communication between heterogeneous systems](http://www.oss.com/asn1/dubuisson.html)

by

Olivier Dubuisson is one of those high quality books freely available on the Internet.

The pyasn1 package is designed to help Python programmers tackling network protocols and file formats at the comfort of their Python prompt. The tool struggles to capture all aspects of a rather complicated ASN.1 system and to represent it on the Python terms.

How to use pyasn1

With pyasn1 you can build Python objects from ASN.1 data structures. For example, the following ASN.1 data structure:

```
```bash
Record ::= SEQUENCE {
 id INTEGER,
```

```

room [0] INTEGER OPTIONAL,
house [1] INTEGER DEFAULT 0
}
...

```

Could be expressed in pyasn1 like this:

```

```python
class Record(Sequence):
    componentType = NamedTypes(
        NamedType('id', Integer()),
        OptionalNamedType(
            'room', Integer().subtype(
                implicitTag=Tag(tagClassContext, tagFormatSimple, 0)
            )
        ),
        DefaultedNamedType(
            'house',
            Integer(0).subtype(
                implicitTag=Tag(tagClassContext, tagFormatSimple, 1)
            )
        )
    )
...

```

It is in the spirit of ASN.1 to take abstract data description and turn it into a programming language specific form. Once you have your ASN.1 data structure expressed in Python, you can use it along the lines of similar Python type (e.g. ASN.1 `SET` is similar to Python `dict`, `SET OF` to `list`):

```

```python
>>> record = Record()
>>> record['id'] = 123
>>> record['room'] = 321
>>> str(record)
Record:
id=123
room=321
>>>
...

```

Part of the power of ASN.1 comes from its serialisation features. You can serialise your data structure and send it over the network.

```

```python
>>> from pyasn1.codec.der.encoder import encode
>>> substrate = encode(record)

```



```
>>> hexdump(substrate)
00000: 30 07 02 01 7B 80 02 01 41
...
```

Conversely, you can turn serialised ASN.1 content, as received from network or read from a file, into a Python object which you can introspect, modify, encode and send back.

```
```python
>>> from pyasn1.codec.der.decoder import decode
>>> received_record, rest_of_substrate = decode(substrate, asn1Spec=Record())
>>>
>>> for field in received_record:
>>> print('{} is {}'.format(field, received_record[field]))
id is 123
room is 321
house is 0
>>>
>>> record == received_record
True
>>> received_record.update(room=123)
>>> substrate = encode(received_record)
>>> hexdump(substrate)
00000: 30 06 02 01 7B 80 01 7B
...

```

The pyasn1 classes struggle to emulate their Python prototypes (e.g. int, list, dict etc.). But ASN.1 types exhibit more complicated behaviour. To make life easier for a Pythonista, they can turn their pyasn1 classes into Python built-ins:

```
```python
>>> from pyasn1.codec.native.encoder import encode
>>> encode(record)
{'id': 123, 'room': 321, 'house': 0}
...

```

Or vice-versa -- you can initialize an ASN.1 structure from a tree of Python objects:

```
```python
>>> from pyasn1.codec.native.decoder import decode
>>> record = decode({'id':
123, 'room': 321, 'house': 0}, asn1Spec=Record())
>>> str(record)
Record:
id=123

```

room=321

>>>

...

With ASN.1 design, serialisation codecs are decoupled from data objects, so you could turn every single ASN.1 object into many different serialised forms. As of this moment, pyasn1 supports BER, DER, CER and Python built-ins codecs. The extremely compact PER encoding is expected to be introduced in the upcoming pyasn1 release.

More information on pyasn1 APIs can be found in the [documentation](<http://snmplabs.com/pyasn1/>), compiled ASN.1 modules for different protocols and file formats could be found in the pyasn1-modules [repo](<https://github.com/etingof/pyasn1-modules>).

How to get pyasn1

-----

The pyasn1 package is distributed under terms and conditions of 2-clause BSD [license](<http://snmplabs.com/pyasn1/license.html>). Source code is freely available as a GitHub [repo](<https://github.com/etingof/pyasn1>).

You could `pip install pyasn1` or download it from [PyPI](<https://pypi.org/project/pyasn1>).

If

something does not work as expected,

[open an issue](<https://github.com/etingof/pyasn1/issues>) at GitHub or

post your question [on Stack Overflow](<https://stackoverflow.com/questions/ask>)

or try browsing pyasn1

[mailing list archives](<https://sourceforge.net/p/pyasn1/mailman/pyasn1-users/>).

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## 1.13 pyparsing 3.0.0a2

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## 1.14 twisted\_connect\_proxy 1.0.0

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## 1.15 typing-extensions 4.3.0

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#### A. HISTORY OF THE SOFTWARE

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Python was created in the early 1990s by Guido van Rossum at Stichting Mathematisch Centrum (CWI, see <http://www.cwi.nl>) in the Netherlands as a successor of a language called ABC. Guido remains Python's principal author, although it includes many contributions from others.

In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <http://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations (now Zope Corporation, see <http://www.zope.com>). In 2001, the Python Software Foundation (PSF, see <http://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation is a sponsoring member of the PSF.

All Python releases are Open Source (see <http://www.opensource.org> for the Open Source Definition). Historically, most, but not all, Python releases have also been GPL-compatible; the table below summarizes the various releases.

Release	Derived	Year	Owner	GPL-
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	from			compatible? (1)
0.9.0 thru 1.2		1991-1995	CWI	yes
1.3 thru 1.5.2	1.2	1995-1999	CNRI	yes
1.6	1.5.2	2000	CNRI	no
2.0	1.6	2000	BeOpen.com	no
1.6.1	1.6	2001	CNRI	yes (2)
2.1	2.0+1.6.1	2001	PSF	no
2.0.1	2.0+1.6.1	2001	PSF	yes
2.1.1	2.1+2.0.1	2001	PSF	yes
2.1.2	2.1.1	2002	PSF	yes
2.1.3	2.1.2	2002	PSF	yes
2.2 and above				
2.1.1	2001-now	PSF		yes

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## 1.24 python-setuptools 68.2.2

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In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <https://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

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1.3 thru 1.5.2	1.2	1995-1999	CNRI	yes
1.6	1.5.2	2000	CNRI	no
2.0	1.6	2000	BeOpen.com	no
1.6.1	1.6	2001	CNRI	yes (2)

2.1	2.0+1.6.1	2001	PSF	no
2.0.1	2.0+1.6.1	2001	PSF	yes
2.1.1	2.1+2.0.1	2001	PSF	yes
2.1.2	2.1.1	2002	PSF	yes
2.1.3	2.1.2	2002	PSF	yes
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1.6.1	1.6	2001	CNRI	yes (2)
2.1	2.0+1.6.1	2001	PSF	no
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## 1.33 openssl-fips 3.0.9

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```
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Gnomovision comes with ABSOLUTELY NO WARRANTY; for details type `show w'.
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```

The hypothetical commands `show w' and `show c' should show the  
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commands you use may be called something other than `show w' and `show  
c'; they could even be mouse-clicks or menu items--whatever suits your  
program.

You should also get your employer (if you work as a programmer) or your  
school, if any, to sign a "copyright disclaimer" for the program, if  
necessary. Here a sample; alter  
the names:

```
Yoyodyne, Inc., hereby disclaims all copyright interest in the
program `Gnomovision' (a program to direct compilers to make passes
```

at assemblers) written by James Hacker.

<signature of Ty Coon>, 1 April 1989  
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That's all there is to it!

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## 1.34 cachetools 4.1.1

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