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# **josepy Documentation**

*Release 1.2.0.dev0*

**Let's Encrypt Project**

**Jan 14, 2019**



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Javascript Object Signing and Encryption (JOSE).

This package is a Python implementation of the standards developed by IETF Javascript Object Signing and Encryption (Active WG), in particular the following RFCs:

- [JSON Web Algorithms \(JWA\)](#)
- [JSON Web Key \(JWK\)](#)
- [JSON Web Signature \(JWS\)](#)

Originally developed as part of the [ACME](#) protocol implementation.



JOSE Base64 is defined as:

- URL-safe Base64
- padding stripped

`josepy.b64.b64decode` (*data*)  
JOSE Base64 decode.

**Parameters** `data` (*bytes* or *unicode*) – Base64 string to be decoded. If it's unicode, then only ASCII characters are allowed.

**Returns** Decoded data.

**Return type** `bytes`

**Raises**

- `TypeError` – if input is of incorrect type
- `ValueError` – if input is unicode with non-ASCII characters

`josepy.b64.b64encode` (*data*)  
JOSE Base64 encode.

**Parameters** `data` (*bytes*) – Data to be encoded.

**Returns** JOSE Base64 string.

**Return type** `bytes`

**Raises** `TypeError` – if `data` is of incorrect type





JOSE errors.

**exception** `josepy.errors.DeserializationError`

Bases: `josepy.errors.Error`

JSON deserialization error.

**exception** `josepy.errors.Error`

Bases: `exceptions.Exception`

Generic JOSE Error.

**exception** `josepy.errors.SerializationError`

Bases: `josepy.errors.Error`

JSON serialization error.

**exception** `josepy.errors.UnrecognizedTypeError` (*typ, jobj*)

Bases: `josepy.errors.DeserializationError`

Unrecognized type error.

#### Variables

- **typ** (*str*) – The unrecognized type of the JSON object.
- **jobj** – Full JSON object.



JOSE interfaces.

**class** josepy.interfaces.JSONDeSerializable

Bases: object

Interface for (de)serializable JSON objects.

Please recall, that standard Python library implements `json.JSONEncoder` and `json.JSONDecoder` that perform translations based on respective *conversion tables* that look pretty much like the one below (for complete tables see relevant Python documentation):

JSON	Python
object	dict
...	...

While the above **conversion table** is about translation of JSON documents to/from the basic Python types only, *JSONDeSerializable* introduces the following two concepts:

**serialization** Turning an arbitrary Python object into Python object that can be encoded into a JSON document. **Full serialization** produces a Python object composed of only basic types as required by the *conversion table*. **Partial serialization** (accomplished by `to_partial_json()`) produces a Python object that might also be built from other *JSONDeSerializable* objects.

**deserialization** Turning a decoded Python object (necessarily one of the basic types as required by the *conversion table*) into an arbitrary Python object.

Serialization produces **serialized object** (“partially serialized object” or “fully serialized object” for partial and full serialization respectively) and deserialization produces **deserialized object**, both usually denoted in the source code as `jobj`.

Wording in the official Python documentation might be confusing after reading the above, but in the light of those definitions, one can view `json.JSONDecoder.decode()` as decoder and deserializer of basic types, `json.JSONEncoder.default()` as serializer of basic types, `json.JSONEncoder.encode()` as serializer and encoder of basic types.

One could extend `json` to support arbitrary object (de)serialization either by:

- overriding `json.JSONDecoder.decode()` and `json.JSONEncoder.default()` in subclasses
- or passing `object_hook` argument (or `object_hook_pairs`) to `json.load()/json.loads()` or `default` argument for `json.dump()/json.dumps()`.

Interestingly, `default` is required to perform only partial serialization, as `json.dumps()` applies `default` recursively. This is the idea behind making `to_partial_json()` produce only partial serialization, while providing custom `json_dumps()` that dumps with `default` set to `json_dump_default()`.

To make further documentation a bit more concrete, please, consider the following imaginary implementation example:

```
class Foo(JSONDeSerializable):
    def to_partial_json(self):
        return 'foo'

    @classmethod
    def from_json(cls, jobj):
        return Foo()

class Bar(JSONDeSerializable):
    def to_partial_json(self):
        return [Foo(), Foo()]

    @classmethod
    def from_json(cls, jobj):
        return Bar()
```

**classmethod `from_json`** (*jobj*)

Deserialize a decoded JSON document.

**Parameters** *jobj* – Python object, composed of only other basic data types, as decoded from JSON document. Not necessarily `dict` (as decoded from “JSON object” document).

**Raises** `josepy.errors.DeserializationError` – if decoding was unsuccessful, e.g. in case of unparseable X509 certificate, or wrong padding in JOSE base64 encoded string, etc.

**classmethod `json_dump_default`** (*python\_object*)

Serialize Python object.

This function is meant to be passed as default to `json.dump()` or `json.dumps()`. They call `default(python_object)` only for non-basic Python types, so this function necessarily raises `TypeError` if *python\_object* is not an instance of `IJSONSerializable`.

Please read the class docstring for more information.

**`json_dumps`** (*\*\*kwargs*)

Dump to JSON string using proper serializer.

**Returns** JSON document string.

**Return type** `str`

**`json_dumps_pretty`** ()

Dump the object to pretty JSON document string.

**Return type** `str`

**classmethod `json_loads`** (*json\_string*)

Deserialize from JSON document string.

**to\_json()**

Fully serialize.

Again, following the example from before, **full serialization** means the following:

```
assert Bar().to_json() == ['foo', 'foo']
```

**Raises** *josepy.errors.SerializationError* – in case of any serialization error.

**Returns** Fully serialized object.

**to\_partial\_json()**

Partially serialize.

Following the example, **partial serialization** means the following:

```
assert isinstance(Bar().to_partial_json()[0], Foo)
assert isinstance(Bar().to_partial_json()[1], Foo)

# in particular...
assert Bar().to_partial_json() != ['foo', 'foo']
```

**Raises** *josepy.errors.SerializationError* – in case of any serialization error.

**Returns** Partially serializable object.



JSON (de)serialization framework.

The framework presented here is somewhat based on Go's "json" package (especially the `omitempty` functionality).

```
class josepy.json_util.Field(json_name, default=None, omitempty=False, decoder=None, encoder=None)
```

Bases: `object`

JSON object field.

*Field* is meant to be used together with *JSONObjectWithFields*.

`encoder` (`decoder`) is a callable that accepts a single parameter, i.e. a value to be encoded (decoded), and returns the serialized (deserialized) value. In case of errors it should raise *SerializationError* (*DeserializationError*).

Note, that `decoder` should perform partial serialization only.

### Variables

- **json\_name** (*str*) – Name of the field when encoded to JSON.
- **default** – Default value (used when not present in JSON object).
- **omitempty** (*bool*) – If `True` and the field value is empty, then it will not be included in the serialized JSON object, and `default` will be used for deserialization. Otherwise, if `False`, field is considered as required, value will always be included in the serialized JSON object, and it must also be present when deserializing.

```
classmethod _empty(value)
```

Is the provided value considered "empty" for this field?

This is useful for subclasses that might want to override the definition of being empty, e.g. for some more exotic data types.

```
decode(value)
```

Decode a value, optionally with context JSON object.

**decoder** (*fdec*)

Descriptor to change the decoder on JSON object field.

**classmethod default\_decoder** (*value*)

Default decoder.

Recursively deserialize into immutable types ( *josepy.util.frozendict* instead of *dict()*, *tuple()* instead of *list()*).

**classmethod default\_encoder** (*value*)

Default (passthrough) encoder.

**encode** (*value*)

Encode a value, optionally with context JSON object.

**encoder** (*fenc*)

Descriptor to change the encoder on JSON object field.

**omit** (*value*)

Omit the value in output?

**class** `josepy.json_util.JSONObjectWithFields` (\*\**kwargs*)

Bases: *josepy.util.ImmutableMap*, *josepy.interfaces.JSONDeSerializable*

JSON object with fields.

Example:

```
class Foo(JSONObjectWithFields):
    bar = Field('Bar')
    empty = Field('Empty', omitempty=True)

    @bar.encoder
    def bar(value):
        return value + 'bar'

    @bar.decoder
    def bar(value):
        if not value.endswith('bar'):
            raise errors.DeserializationError('No bar suffix!')
        return value[:-3]

assert Foo(bar='baz').to_partial_json() == {'Bar': 'bazbar'}
assert Foo.from_json({'Bar': 'bazbar'}) == Foo(bar='baz')
assert (Foo.from_json({'Bar': 'bazbar', 'Empty': '!'})
        == Foo(bar='baz', empty='!'))
assert Foo(bar='baz').bar == 'baz'
```

**classmethod \_defaults** ()

Get default fields values.

**encode** (*name*)

Encode a single field.

**Parameters** *name* (*str*) – Name of the field to be encoded.

**Raises**

- *errors.SerializationError* – if field cannot be serialized
- *errors.Error* – if field could not be found



**classmethod** `fields_from_json(jobj)`

Deserialize fields from JSON.

**fields\_to\_partial\_json()**

Serialize fields to JSON.

**classmethod** `from_json(jobj)`

Deserialize a decoded JSON document.

**Parameters** `jobj` – Python object, composed of only other basic data types, as decoded from JSON document. Not necessarily `dict` (as decoded from “JSON object” document).

**Raises** `josepy.errors.DeserializationError` – if decoding was unsuccessful, e.g. in case of unparseable X509 certificate, or wrong padding in JOSE base64 encoded string, etc.

**to\_partial\_json()**

Partially serialize.

Following the example, **partial serialization** means the following:

```
assert isinstance(Bar().to_partial_json()[0], Foo)
assert isinstance(Bar().to_partial_json()[1], Foo)

# in particular...
assert Bar().to_partial_json() != ['foo', 'foo']
```

**Raises** `josepy.errors.SerializationError` – in case of any serialization error.

**Returns** Partially serializable object.

**class** `josepy.json_util.JSONObjectWithFieldsMeta`

Bases: `abc.ABCMeta`

Metaclass for `JSONObjectWithFields` and its subclasses.

It makes sure that, for any class `cls` with `__metaclass__` set to `JSONObjectWithFieldsMeta`:

1. All fields (attributes of type `Field`) in the class definition are moved to the `cls._fields` dictionary, where keys are field attribute names and values are fields themselves.
2. `cls.__slots__` is extended by all field attribute names (i.e. not `Field.json_name`). Original `cls.__slots__` are stored in `cls._orig_slots`.

In a consequence, for a field attribute name `some_field`, `cls.some_field` will be a slot descriptor and not an instance of `Field`. For example:

```
some_field = Field('someField', default=())

class Foo(object):
    __metaclass__ = JSONObjectWithFieldsMeta
    __slots__ = ('baz',)
    some_field = some_field

assert Foo.__slots__ == ('some_field', 'baz')
assert Foo._orig_slots == ()
assert Foo.some_field is not Field

assert Foo._fields.keys() == ['some_field']
assert Foo._fields['some_field'] is some_field
```

As an implementation note, this metaclass inherits from `abc.ABCMeta` (and not the usual `type`) to mitigate the metaclass conflict (`ImmutableMap` and `JSONDeSerializable`, parents of `JSONObjectWithFields`, use `abc.ABCMeta` as its metaclass).

**class** `josepy.json_util.TypedJSONObjectWithFields` (\*\*kwargs)

Bases: `josepy.json_util.JSONObjectWithFields`

JSON object with type.

**classmethod** `from_json` (obj)

Deserialize ACME object from valid JSON object.

**Raises** `josepy.errors.UnrecognizedTypeError` – if type of the ACME object has not been registered.

**classmethod** `get_type_cls` (obj)

Get the registered class for obj.

**classmethod** `register` (type\_cls, typ=None)

Register class for JSON deserialization.

**to\_partial\_json** ()

Get JSON serializable object.

**Returns** Serializable JSON object representing ACME typed object. `validate()` will almost certainly not work, due to reasons explained in `josepy.interfaces.IJSONSerializable`.

**Return type** `dict`

`josepy.json_util.decode_b64jose` (data, size=None, minimum=False)

Decode JOSE Base-64 field.

**Parameters**

- **data** (`unicode`) –
- **size** (`int`) – Required length (after decoding).
- **minimum** (`bool`) – If True, then size will be treated as minimum required length, as opposed to exact equality.

**Return type** `bytes`

`josepy.json_util.decode_cert` (b64der)

Decode JOSE Base-64 DER-encoded certificate.

**Parameters** `b64der` (`unicode`) –

**Return type** `OpenSSL.crypto.X509` wrapped in `ComparableX509`

`josepy.json_util.decode_csr` (b64der)

Decode JOSE Base-64 DER-encoded CSR.

**Parameters** `b64der` (`unicode`) –

**Return type** `OpenSSL.crypto.X509Req` wrapped in `ComparableX509`

`josepy.json_util.decode_hex16` (value, size=None, minimum=False)

Decode hexlified field.

**Parameters**

- **value** (`unicode`) –
- **size** (`int`) – Required length (after decoding).

- **minimum** (*bool*) – If True, then `size` will be treated as minimum required length, as opposed to exact equality.

**Return type** `bytes`

`josepy.json_util.encode_b64jose` (*data*)  
Encode JOSE Base-64 field.

**Parameters** `data` (*bytes*) –

**Return type** `unicode`

`josepy.json_util.encode_cert` (*cert*)  
Encode certificate as JOSE Base-64 DER.

**Return type** `unicode`

`josepy.json_util.encode_csr` (*csr*)  
Encode CSR as JOSE Base-64 DER.

**Return type** `unicode`

`josepy.json_util.encode_hex16` (*value*)  
Hexlify.

**Parameters** `value` (*bytes*) –

**Return type** `unicode`



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## JSON Web Algorithms

---

JSON Web Algorithms.

<https://tools.ietf.org/html/draft-ietf-jose-json-web-algorithms-40>

**class** josepy.jwa.**JWA**  
Bases: *josepy.interfaces.JSONDeSerializable*  
JSON Web Algorithm.

**class** josepy.jwa.**JWSignature** (*name*)  
Bases: *josepy.jwa.JWA*, *\_abcoll.Hashable*  
Base class for JSON Web Signature Algorithms.

**classmethod** **from\_json** (*obj*)  
Deserialize a decoded JSON document.

**Parameters** *obj* – Python object, composed of only other basic data types, as decoded from JSON document. Not necessarily `dict` (as decoded from “JSON object” document).

**Raises** *josepy.errors.DeserializationError* – if decoding was unsuccessful, e.g. in case of unparseable X509 certificate, or wrong padding in JOSE base64 encoded string, etc.

**classmethod** **register** (*signature\_cls*)  
Register class for JSON deserialization.

**sign** (*key*, *msg*)  
Sign the msg using key.

**to\_partial\_json** ()  
Partially serialize.

Following the example, **partial serialization** means the following:

```
assert isinstance(Bar().to_partial_json()[0], Foo)
assert isinstance(Bar().to_partial_json()[1], Foo)
```

(continues on next page)

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```
# in particular...  
assert Bar().to_partial_json() != ['foo', 'foo']
```

**Raises** *josepy.errors.SerializationError* – in case of any serialization error.

**Returns** Partially serializable object.

**verify** (*key, msg, sig*)

Verify the *msg* and *sig* using *key*.

**class** josepy.jwa.\_JWAES (*name*)

Bases: *josepy.jwa.JWASignature*

**sign** (*key, msg*)

Sign the *msg* using *key*.

**verify** (*key, msg, sig*)

Verify the *msg* and *sig* using *key*.

**class** josepy.jwa.\_JWAHS (*name, hash\_*)

Bases: *josepy.jwa.JWASignature*

**kti**

alias of *josepy.jwk.JWKOct*

**sign** (*key, msg*)

Sign the *msg* using *key*.

**verify** (*key, msg, sig*)

Verify the *msg* and *sig* using *key*.

**class** josepy.jwa.\_JWAPS (*name, hash\_*)

Bases: *josepy.jwa.\_JWARSA*, *josepy.jwa.JWASignature*

**class** josepy.jwa.\_JWARS (*name, hash\_*)

Bases: *josepy.jwa.\_JWARSA*, *josepy.jwa.JWASignature*

JSON Web Key.

```
class josepy.jwk.JWK(**kwargs)
```

Bases: *josepy.json\_util.TypedJSONObjectWithFields*

JSON Web Key.

```
classmethod load(data, password=None, backend=None)
```

Load serialized key as JWK.

**Parameters**

- **data** (*str*) – Public or private key serialized as PEM or DER.
- **password** (*str*) – Optional password.
- **backend** – A *PEMSerializationBackend* and *DERSerializationBackend* provider.

**Raises** *errors.Error* – if unable to deserialize, or unsupported JWK algorithm

**Returns** JWK of an appropriate type.

**Return type** *JWK*

```
public_key()
```

Generate JWK with public key.

For symmetric cryptosystems, this would return `self`.

```
thumbprint(hash_function=<class 'cryptography.hazmat.primitives.hashes.SHA256'>)
```

Compute JWK Thumbprint.

<https://tools.ietf.org/html/rfc7638>

**Returns** bytes

```
class josepy.jwk.JWKES(**kwargs)
```

Bases: *josepy.jwk.JWK*

ES JWK.

**Warning:** This is not yet implemented!

**classmethod** `fields_from_json(jobj)`  
Deserialize fields from JSON.

**fields\_to\_partial\_json()**  
Serialize fields to JSON.

**public\_key()**  
Generate JWK with public key.

For symmetric cryptosystems, this would return `self`.

**class** `josepy.jwk.JWKOct(**kwargs)`  
Bases: `josepy.jwk.JWK`  
Symmetric JWK.

**classmethod** `fields_from_json(jobj)`  
Deserialize fields from JSON.

**fields\_to\_partial\_json()**  
Serialize fields to JSON.

**public\_key()**  
Generate JWK with public key.

For symmetric cryptosystems, this would return `self`.

**class** `josepy.jwk.JWKRSA(*args, **kwargs)`  
Bases: `josepy.jwk.JWK`  
RSA JWK.

**Variables** `key` – `RSAPrivateKey` or `RSAPublicKey` wrapped in `ComparableRSAKey`

**classmethod** `_decode_param(data)`  
Decode Base64urlUInt.

**classmethod** `_encode_param(data)`  
Encode Base64urlUInt.

**Return type** unicode

**classmethod** `fields_from_json(jobj)`  
Deserialize fields from JSON.

**fields\_to\_partial\_json()**  
Serialize fields to JSON.

**public\_key()**  
Generate JWK with public key.

For symmetric cryptosystems, this would return `self`.



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## JSON Web Signature

---

JSON Web Signature.

```
class josepy.jws.CLI
```

Bases: `object`

JWS CLI.

```
classmethod run(args=None)
```

Parse arguments and sign/verify.

```
classmethod sign(args)
```

Sign.

```
classmethod verify(args)
```

Verify.

```
class josepy.jws.Header(**kwargs)
```

Bases: `josepy.json_util.JSONObjectWithFields`

JOSE Header.

**Warning:** This class supports **only** Registered Header Parameter Names (as defined in section 4.1 of the protocol). If you need Public Header Parameter Names (4.2) or Private Header Parameter Names (4.3), you must subclass and override `from_json()` and `to_partial_json()` appropriately.

**Warning:** This class does not support any extensions through the “crit” (Critical) Header Parameter (4.1.11) and as a conforming implementation, `from_json()` treats its occurrence as an error. Please subclass if you seek for a different behaviour.

### Variables

- `x5tS256` – “x5t#S256”

- **typ**(*str*) – MIME Media Type, inc. `MediaType.PREFIX`.
- **cty**(*str*) – Content-Type, inc. `MediaType.PREFIX`.

**find\_key**()

Find key based on header.

---

**Todo:** Supports only “jwk” header parameter lookup.

---

**Returns** (Public) key found in the header.

**Return type** *JWK*

**Raises** *josepy.errors.Error* – if key could not be found

**not\_omitted**()

Fields that would not be omitted in the JSON object.

**class** `josepy.jws.JWS`(\*\**kwargs*)

Bases: *josepy.json\_util.JSONObjectWithFields*

JSON Web Signature.

**Variables**

- **payload**(*str*) – JWS Payload.
- **signature**(*str*) – JWS Signatures.

**classmethod** `from_compact`(*compact*)

Compact deserialization.

**Parameters** `compact`(*bytes*) –

**classmethod** `from_json`(*obj*)

Deserialize a decoded JSON document.

**Parameters** `obj` – Python object, composed of only other basic data types, as decoded from JSON document. Not necessarily `dict` (as decoded from “JSON object” document).

**Raises** *josepy.errors.DeserializationError* – if decoding was unsuccessful, e.g. in case of unparseable X509 certificate, or wrong padding in JOSE base64 encoded string, etc.

**classmethod** `sign`(*payload*, \*\**kwargs*)

Sign.

**signature**

Get a singleton signature.

**Return type** *JWS.signature\_cls*

**signature\_cls**

alias of *Signature*

**to\_compact**()

Compact serialization.

**Return type** *bytes*

**to\_partial\_json** (*flat=True*)

Partially serialize.

Following the example, **partial serialization** means the following:

```
assert isinstance(Bar().to_partial_json()[0], Foo)
assert isinstance(Bar().to_partial_json()[1], Foo)

# in particular...
assert Bar().to_partial_json() != ['foo', 'foo']
```

**Raises** `josepy.errors.SerializationError` – in case of any serialization error.

**Returns** Partially serializable object.

**verify** (*key=None*)

Verify.

**class** `josepy.jws.MediaType`

Bases: `object`

MediaType field encoder/decoder.

**classmethod** `decode` (*value*)

Decoder.

**classmethod** `encode` (*value*)

Encoder.

**class** `josepy.jws.Signature` (*\*\*kwargs*)

Bases: `josepy.json_util.JSONObjectWithFields`

JWS Signature.

**Variables**

- **combined** – Combined Header (protected and unprotected, `Header`).
- **protected** (*unicode*) – JWS protected header (Jose Base-64 decoded).
- **header** – JWS Unprotected Header (`Header`).
- **signature** (*str*) – The signature.

**classmethod** `fields_from_json` (*obj*)

Deserialize fields from JSON.

**fields\_to\_partial\_json** ()

Serialize fields to JSON.

**header\_cls**

alias of `Header`

**classmethod** `sign` (*payload, key, alg, include\_jwk=True, protect=frozenset()*, *\*\*kwargs*)

Sign.

**Parameters** **key** (`JWK`) – Key for signature.

**verify** (*payload, key=None*)

Verify.

**Parameters** **key** (`JWK`) – Key used for verification.



JOSE utilities.

**class** josepy.util.ComparableKey (*wrapped*)

Bases: `object`

Comparable wrapper for cryptography keys.

See <https://github.com/pyca/cryptography/issues/2122>.

**public\_key** ()

Get wrapped public key.

**class** josepy.util.ComparableRSAKey (*wrapped*)

Bases: `josepy.util.ComparableKey`

Wrapper for cryptography RSA keys.

Wraps around:

- `RSAPrivateKey`
- `RSAPublicKey`

**class** josepy.util.ComparableX509 (*wrapped*)

Bases: `object`

Wrapper for `OpenSSL.crypto.X509**` objects that supports `__eq__`.

**Variables wrapped** – Wrapped certificate or certificate request.

**\_dump** (*filetype=2*)

Dumps the object into a buffer with the specified encoding.

**Parameters filetype** (*int*) – The desired encoding. Should be one of `OpenSSL.crypto.FILETYPE_ASN1`, `OpenSSL.crypto.FILETYPE_PEM`, or `OpenSSL.crypto.FILETYPE_TEXT`.

**Returns** Encoded X509 object.

**Return type** `str`

```
class josepy.util.ImmutableMap (**kwargs)
    Bases: _abcoll.Mapping, _abcoll.Hashable
```

Immutable key to value mapping with attribute access.

```
update (**kwargs)
    Return updated map.
```

```
class josepy.util.abstractclassmethod (target)
    Bases: classmethod
```

Descriptor for an abstract classmethod.

It augments the `abc` framework with an abstract classmethod. This is implemented as `abc.abstractclassmethod` in the standard Python library starting with version 3.2.

This particular implementation, allegedly based on Python 3.3 source code, is stolen from <http://stackoverflow.com/questions/11217878/python-2-7-combine-abc-abstractmethod-and-classmethod>.

```
class josepy.util.frozendict (*args, **kwargs)
    Bases: _abcoll.Mapping, _abcoll.Hashable
```

Frozen dictionary.

### 9.1 1.1.0 (2018-04-13)

- Deprecated support for Python 2.6 and 3.3.
- Use the `sign` and `verify` methods when they are available in `cryptography` instead of the deprecated methods `signer` and `verifier`.

### 9.2 1.0.1 (2017-10-25)

Stop installing `mock` as part of the default but only as part of the testing dependencies.

### 9.3 1.0.0 (2017-10-13)

First release after moving the `josepy` package into a standalone library.





# CHAPTER 10

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## Indices and tables

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