
Python CWT

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Python CWT is a CBOR Web Token (CWT) and CBOR Object Signing and Encryption (COSE) implementation compliant with:

- [RFC8392: CBOR Web Token \(CWT\)](#)
- [RFC8152: CBOR Object Signing and Encryption \(COSE\)](#)

It is designed to make users who already know about [JSON Web Token \(JWT\)](#) be able to use it in ease. Little knowledge of [CBOR](#), [COSE](#), and [CWT](#) is required to use it.

You can install Python CWT with pip:

```
$ pip install cwt
```

And then, you can use it as follows:

```
import cwt
from cwt import COSEKey

key = COSEKey.from_symmetric_key(alg="HMAC 256/256")
token = cwt.encode({"iss": "https://as.example", "sub": "dajiaji", "cti": "123"}, key)
decoded = cwt.decode(token, key)
```


1.1 Installation

You can install Python CWT with pip:

```
$ pip install cwt
```

1.2 CWT Usage Examples

The following is a simple sample code for command line console.

```
>>> import cwt
>>> from cwt import Claims, COSEKey
>>> key = COSEKey.from_symmetric_key(alg="HS256")
>>> token = cwt.encode({"iss": "coaps://as.example", "sub": "dajiaji", "cti": "123"},
↳key)
>>> token.hex()
'd18443a10105a05835a60172636f6170733a2f2f61732e6578616d706c65026764616a69616a69'
'0743313233041a609097b7051a609089a7061a609089a758201fad9b0a76803194bd11ca9b9b3c'
'bbf1028005e15321665a768994f38c7127f7'
>>> decoded = cwt.decode(token, key)
>>> decoded
{1: 'coaps://as.example', 2: 'dajiaji', 7: b'123',
 4: 1620088759, 5: 1620085159, 6: 1620085159}
>>> readable = Claims.new(decoded)
>>> readable.iss
'coaps://as.example'
>>> readable.sub
'dajiaji'
>>> readable.exp
1620088759
```

This page shows various examples to use this library. Specific examples are as follows:

- *MACed CWT*
- *Signed CWT*
- *Encrypted CWT*

- *Nested CWT*
- *CWT with User-Defined Claims*
- *CWT with PoP key*

1.2.1 MACed CWT

Create a MACed CWT, verify and decode it as follows:

```
import cwt
from cwt import COSEKey

try:
    key = COSEKey.from_symmetric_key(alg="HS256")
    token = cwt.encode(
        {"iss": "coaps://as.example", "sub": "dajiaji", "cti": "123"},
        key,
    )
    decoded = cwt.decode(token, key)
except Exception as err:
    # All the other examples in this document omit error handling but this CWT library
    # can throw following errors:
    # ValueError: Invalid arguments.
    # EncodeError: Failed to encode.
    # VerifyError: Failed to verify.
    # DecodeError: Failed to decode.
    print(err)
```

CBOR-like structure (Dict[int, Any]) can also be used as follows:

```
import cwt
from cwt import COSEKey

key = COSEKey.from_symmetric_key(alg="HS256")
token = cwt.encode({1: "coaps://as.example", 2: "dajiaji", 7: b"123"}, key)
decoded = cwt.decode(token, key)
```

Algorithms other than HS256 are listed in [Supported COSE Algorithms](#).

1.2.2 Signed CWT

Create an Ed25519 (Ed25519 for use w/ EdDSA only) key pair:

```
$ openssl genpkey -algorithm ed25519 -out private_key.pem
$ openssl pkey -in private_key.pem -pubout -out public_key.pem
```

Create a Signed CWT, verify and decode it with the key pair as follows:

```
import cwt
from cwt import COSEKey
```

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```

with open("./private_key.pem") as key_file:
    private_key = COSEKey.from_pem(key_file.read(), kid="01")
with open("./public_key.pem") as key_file:
    public_key = COSEKey.from_pem(key_file.read(), kid="01")

token = cwt.encode(
    {"iss": "coaps://as.example", "sub": "dajiaji", "cti": "123"}, private_key
)

decoded = cwt.decode(token, public_key)

```

JWKs can also be used instead of the PEM-formatted keys as follows:

```

import cwt
from cwt import COSEKey

private_key = COSEKey.from_jwk(
    {
        "kty": "OKP",
        "d": "L8JS08VsFZoZxGa9JvzYmCW0wg7zaKcei3KZmYsj7dc",
        "use": "sig",
        "crv": "Ed25519",
        "kid": "01",
        "x": "2E6dX83gqD_D0eAmqnaHe1TC1xuld6iAKXfw2OVATr0",
        "alg": "EdDSA",
    }
)

public_key = COSEKey.from_jwk(
    {
        "kty": "OKP",
        "use": "sig",
        "crv": "Ed25519",
        "kid": "01",
        "x": "2E6dX83gqD_D0eAmqnaHe1TC1xuld6iAKXfw2OVATr0",
    }
)

token = cwt.encode(
    {"iss": "coaps://as.example", "sub": "dajiaji", "cti": "123"}, private_key
)

decoded = cwt.decode(token, public_key)

```

Algorithms other than Ed25519 are also supported. The following is an example of ES256:

```

$ openssl ecparam -genkey -name prime256v1 -noout -out private_key.pem
$ openssl ec -in private_key.pem -pubout -out public_key.pem

```

```

import cwt
from cwt import COSEKey

with open("./private_key.pem") as key_file:

```

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```

private_key = COSEKey.from_pem(key_file.read(), kid="01")
with open("./public_key.pem") as key_file:
    public_key = COSEKey.from_pem(key_file.read(), kid="01")

token = cwt.encode(
    {"iss": "coaps://as.example", "sub": "dajiaji", "cti": "123"}, private_key
)

decoded = cwt.decode(token, public_key)

```

Other supported algorithms are listed in [Supported COSE Algorithms](#).

1.2.3 Encrypted CWT

Create an encrypted CWT with ChaCha20/Poly1305 (ChaCha20/Poly1305 w/ 256-bit key, 128-bit tag), and decrypt it as follows:

```

import cwt
from cwt import COSEKey

enc_key = COSEKey.from_symmetric_key(alg="ChaCha20/Poly1305")
token = cwt.encode(
    {"iss": "coaps://as.example", "sub": "dajiaji", "cti": "123"}, enc_key
)
decoded = cwt.decode(token, enc_key)

```

Algorithms other than ChaCha20/Poly1305 are also supported. The following is an example of AES-CCM-16-64-256:

```

import cwt
from cwt import COSEKey

enc_key = COSEKey.from_symmetric_key(alg="AES-CCM-16-64-256")
token = cwt.encode(
    {"iss": "coaps://as.example", "sub": "dajiaji", "cti": "123"}, enc_key
)
decoded = cwt.decode(token, enc_key)

```

Other supported algorithms are listed in [Supported COSE Algorithms](#).

1.2.4 Nested CWT

Create a signed CWT and encrypt it, and then decrypt and verify the nested CWT as follows.

```

import cwt
from cwt import COSEKey

with open("./private_key.pem") as key_file:
    private_key = COSEKey.from_pem(key_file.read(), kid="01")
with open("./public_key.pem") as key_file:
    public_key = COSEKey.from_pem(key_file.read(), kid="01")

```

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```

# Creates a CWT with ES256 signing.
token = cwt.encode(
    {"iss": "coaps://as.example", "sub": "dajiaji", "cti": "123"}, private_key
)

# Encrypts the signed CWT.
enc_key = COSEKey.from_symmetric_key(alg="ChaCha20/Poly1305")
nested = cwt.encode(token, enc_key)

# Decrypts and verifies the nested CWT.
decoded = cwt.decode(nested, [enc_key, public_key])

```

1.2.5 CWT with User-Defined Claims

You can use your own claims as follows:

Note that such user-defined claim's key should be less than -65536.

```

import cwt
from cwt import COSEKey

with open("./private_key.pem") as key_file:
    private_key = COSEKey.from_pem(key_file.read(), kid="01")
with open("./public_key.pem") as key_file:
    public_key = COSEKey.from_pem(key_file.read(), kid="01")
token = cwt.encode(
    {
        1: "coaps://as.example", # iss
        2: "dajiaji", # sub
        7: b"123", # cti
        -70001: "foo",
        -70002: ["bar"],
        -70003: {"baz": "qux"},
        -70004: 123,
    },
    private_key,
)
raw = cwt.decode(token, public_key)
# raw[-70001] == "foo"
# raw[-70002][0] == "bar"
# raw[-70003]["baz"] == "qux"
# raw[-70004] == 123
readable = Claims.new(raw)
# readable.get(-70001) == "foo"
# readable.get(-70002)[0] == "bar"
# readable.get(-70003)["baz"] == "qux"
# readable.get(-70004) == 123

```

User-defined claims can also be used with JSON-based claims as follows:

```
import cwt
from cwt import Claims, COSEKey

with open("./private_key.pem") as key_file:
    private_key = COSEKey.from_pem(key_file.read(), kid="01")
with open("./public_key.pem") as key_file:
    public_key = COSEKey.from_pem(key_file.read(), kid="01")

cwt.set_private_claim_names(
    {
        "ext_1": -70001,
        "ext_2": -70002,
        "ext_3": -70003,
        "ext_4": -70004,
    }
)
token = cwt.encode(
    {
        "iss": "coaps://as.example",
        "sub": "dajiaji",
        "cti": b"123",
        "ext_1": "foo",
        "ext_2": ["bar"],
        "ext_3": {"baz": "qux"},
        "ext_4": 123,
    },
    private_key,
)
claims.set_private_claim_names()
raw = cwt.decode(token, public_key)
readable = Claims.new(
    raw,
    private_claim_names={
        "ext_1": -70001,
        "ext_2": -70002,
        "ext_3": -70003,
        "ext_4": -70004,
    },
)
# readable.get("ext_1") == "foo"
# readable.get("ext_2")[0] == "bar"
# readable.get("ext_3")["baz"] == "qux"
# readable.get("ext_4") == 123
```

1.2.6 CWT with PoP key

Create a CWT which has a PoP key as follows:

On the issuer side:

```
import cwt
from cwt import COSEKey

# Prepares a signing key for CWT in advance.
with open("./private_key_of_issuer.pem") as key_file:
    private_key = COSEKey.from_pem(key_file.read(), kid="issuer-01")

# Sets the PoP key to a CWT for the presenter.
token = cwt.encode(
    {
        "iss": "coaps://as.example",
        "sub": "dajiaji",
        "cti": "123",
        "cnf": {
            "jwk": { # Provided by the CWT presenter.
                "kty": "OKP",
                "use": "sig",
                "crv": "Ed25519",
                "kid": "01",
                "x": "2E6dX83gqD_D0eAmqnaHe1TC1xuld6iAKXfw2OVATr0",
                "alg": "EdDSA",
            },
        },
    },
    private_key,
)

# Issues the token to the presenter.
```

On the CWT presenter side:

```
import cwt
from cwt import COSEKey

# Prepares a private PoP key in advance.
with open("./private_pop_key.pem") as key_file:
    pop_key_private = COSEKey.from_pem(key_file.read(), kid="01")

# Receives a message (e.g., nonce) from the recipient.
msg = b"could-you-sign-this-message?" # Provided by recipient.

# Signs the message with the private PoP key.
sig = pop_key_private.sign(msg)

# Sends the msg and the sig with the CWT to the recipient.
```

On the CWT recipient side:

```
import cwt
from cwt import Claims, COSEKey

# Prepares the public key of the issuer in advance.
with open("./public_key_of_issuer.pem") as key_file:
    public_key = COSEKey.from_pem(key_file.read(), kid="issuer-01")

# Verifies and decodes the CWT received from the presenter.
raw = cwt.decode(token, public_key)
decoded = Claims.new(raw)

# Extracts the PoP key from the CWT.
extracted_pop_key = COSEKey.new(decoded.cnf) # = raw[8][1]

# Then, verifies the message sent by the presenter
# with the signature which is also sent by the presenter as follows:
extracted_pop_key.verify(msg, sig)
```

In case of another PoP confirmation method Encrypted_COSE_Key:

```
import cwt
from cwt import Claims, COSEKey, EncryptedCOSEKey

with open("./private_key.pem") as key_file:
    private_key = COSEKey.from_pem(key_file.read(), kid="issuer-01")

enc_key = COSEKey.from_symmetric_key(
    "a-client-secret-of-cwt-recipient", # Just 32 bytes!
    alg="ChaCha20/Poly1305",
)
pop_key = COSEKey.from_symmetric_key(
    "a-client-secret-of-cwt-presenter",
    alg="HMAC 256/256",
)

token = cwt.encode(
    {
        "iss": "coaps://as.example",
        "sub": "dajiaji",
        "cti": "123",
        "cnf": {
            # 'eck'(Encrypted Cose Key) is a keyword defined by this library.
            "eck": EncryptedCOSEKey.from_cose_key(pop_key, enc_key),
        },
    },
    private_key,
)

with open("./public_key.pem") as key_file:
    public_key = COSEKey.from_pem(key_file.read(), kid="issuer-01")
raw = cwt.decode(token, public_key)
decoded = Claims.new(raw)
extracted_pop_key = EncryptedCOSEKey.to_cose_key(decoded.cnf, enc_key)
```

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```
# extracted_pop_key.verify(message, signature)
```

In case of another PoP confirmation method kid:

```
import cwt
from cwt import Claims, COSEKey

with open("./private_key.pem") as key_file:
    private_key = COSEKey.from_pem(key_file.read(), kid="issuer-01")

token = cwt.encode(
    {
        "iss": "coaps://as.example",
        "sub": "dajiaji",
        "cti": "123",
        "cnf": {
            "kid": "pop-key-id-of-cwt-presenter",
        },
    },
    private_key,
)

with open("./public_key.pem") as key_file:
    public_key = COSEKey.from_pem(key_file.read(), kid="issuer-01")
raw = cwt.decode(token, public_key)
decoded = Claims.new(raw)
# decoded.cnf[8][3] is kid.
```

1.3 COSE Usage Examples

The following is a simple sample code for command line console.

```
>>> from cwt import COSE, COSEKey
>>> ctx = COSE.new(alg_auto_inclusion=True, kid_auto_inclusion=True)
>>> mac_key = COSEKey.from_symmetric_key(alg="HS256", kid="01")
>>> encoded = ctx.encode_and_mac(b"Hello world!", mac_key)
>>> encoded.hex()

↪ 'd18443a10105a1044230314c48656c6c6f20776f726c642158205d0b144add282ccaac32a02e0d5eec76928ccadf3623271e'
↪ '
>>> ctx.decode(encoded, mac_key)
b'Hello world!'
```

This page shows various examples to use COSE API in this library. Specific examples are as follows:

- *COSE MAC0*
- *COSE MAC*
- *COSE Encrypt0*

- *COSE Encrypt*
- *COSE Signature1*
- *COSE Signature*

1.3.1 COSE MAC0

Create a COSE MAC0 message, verify and decode it as follows:

```
from cwt import COSE, COSEKey

mac_key = COSEKey.from_symmetric_key(alg="HS256", kid="01")
ctx = COSE.new(alg_auto_inclusion=True, kid_auto_inclusion=True)
encoded = ctx.encode_and_mac(b"Hello world!", mac_key)
decoded = ctx.decode(encoded, mac_key)
```

Algorithms other than HS256 are listed in [Supported COSE Algorithms](#) .

Following two samples are other ways of writing the above example:

```
from cwt import COSE, COSEKey

mac_key = COSEKey.from_symmetric_key(alg="HS256", kid="01")
ctx = COSE.new()
encoded = ctx.encode_and_mac(
    b"Hello world!",
    mac_key,
    protected={"alg": "HS256"},
    unprotected={"kid": "01"},
)
decoded = ctx.decode(encoded, mac_key)
```

```
from cwt import COSE, COSEKey

mac_key = COSEKey.from_symmetric_key(alg="HS256", kid="01")
ctx = COSE.new()
encoded = ctx.encode_and_mac(
    b"Hello world!",
    mac_key,
    protected={1: 5},
    unprotected={4: b"01"},
)
decoded = ctx.decode(encoded, mac_key)
```


1.3.2 COSE MAC

Create a COSE MAC message, verify and decode it as follows:

```
from cwt import COSE, COSEKey

recipient = Recipient.from_json({"alg": "direct", "kid": "01"})
mac_key = COSEKey.from_symmetric_key(alg="HS512", kid="01")
ctx = COSE.new()
encoded = ctx.encode_and_mac(b"Hello world!", mac_key, recipients=[recipient])
decoded = ctx.decode(encoded, mac_key)
```

Algorithms other than HS512 are listed in [Supported COSE Algorithms](#).

Following sample is another way of writing the above example:

```
from cwt import COSE, COSEKey

recipient = Recipient.new(unprotected={"alg": "direct", "kid": "01"})
mac_key = COSEKey.from_symmetric_key(alg="HS512", kid="01")
ctx = COSE.new()
encoded = ctx.encode_and_mac(b"Hello world!", mac_key, recipients=[recipient])
decoded = ctx.decode(encoded, mac_key)
```

1.3.3 COSE Encrypt0

Create a COSE Encrypt0 message, verify and decode it as follows:

```
from cwt import COSE, COSEKey

enc_key = COSEKey.from_symmetric_key(alg="ChaCha20/Poly1305", kid="01")
ctx = COSE.new(alg_auto_inclusion=True, kid_auto_inclusion=True)
encoded = ctx.encode_and_encrypt(b"Hello world!", enc_key)
decoded = ctx.decode(encoded, enc_key)
```

Algorithms other than ChaCha20/Poly1305 are listed in [Supported COSE Algorithms](#).

Following two samples are other ways of writing the above example:

```
from cwt import COSE, COSEKey

enc_key = COSEKey.from_symmetric_key(alg="ChaCha20/Poly1305", kid="01")
ctx = COSE.new()
encoded = ctx.encode_and_encrypt(
    b"Hello world!",
    enc_key,
    nonce=nonce,
    protected={"alg": "ChaCha20/Poly1305"},
    unprotected={"kid": "01"},
)
decoded = ctx.decode(encoded, enc_key)
```

```
from cwt import COSE, COSEKey

enc_key = COSEKey.from_symmetric_key(alg="ChaCha20/Poly1305", kid="01")
ctx = COSE.new()
encoded = ctx.encode_and_encrypt(
    b"Hello world!",
    enc_key,
    nonce=nonce,
    protected={1: 24},
    unprotected={4: b"01"},
)
decoded = ctx.decode(encoded, enc_key)
```

1.3.4 COSE Encrypt

Create a COSE Encrypt message, verify and decode it as follows:

```
from cwt import COSE, COSEKey

recipient = Recipient.from_json({"alg": "direct", "kid": "01"})
enc_key = COSEKey.from_symmetric_key(alg="ChaCha20/Poly1305", kid="01")
ctx = COSE.new()
encoded = ctx.encode_and_encrypt(
    b"Hello world!",
    enc_key,
    recipients=[recipient],
)
decoded = ctx.decode(encoded, enc_key)
```

Following sample is another way of writing the above example:

```
from cwt import COSE, COSEKey

recipient = Recipient.new(unprotected={"alg": "direct", "kid": "01"})
enc_key = COSEKey.from_symmetric_key(alg="ChaCha20/Poly1305", kid="01")
ctx = COSE.new()
encoded = ctx.encode_and_mac(b"Hello world!", enc_key, recipients=[recipient])
decoded = ctx.decode(encoded, enc_key)
```

1.3.5 COSE Signature1

Create a COSE Signature1 message, verify and decode it as follows:

```
from cwt import COSE, COSEKey

sig_key = COSEKey.from_jwk(
    {
        "kty": "EC",
        "kid": "01",
        "crv": "P-256",
```

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```

        "x": "usWxHK2PmfHkWXPS54m0kTcGJ90UiglWiGahtagnv8",
        "y": "IBOL-C3BttVivg-lSreASjpkttcsz-1rb7btKlv8EX4",
        "d": "V8kgd2ZBRuh2dgyVINBUqpPDr7BOMGcF22CQMIUHtNM",
    }
)
ctx = COSE.new(alg_auto_inclusion=True, kid_auto_inclusion=True)
encoded = ctx.encode_and_sign(b"Hello world!", sig_key)
decoded = ctx.decode(encoded, sig_key)

```

Following two samples are other ways of writing the above example:

```

from cwt import COSE, COSEKey

sig_key = COSEKey.from_jwk(
    {
        "kty": "EC",
        "kid": "01",
        "crv": "P-256",
        "x": "usWxHK2PmfHkWXPS54m0kTcGJ90UiglWiGahtagnv8",
        "y": "IBOL-C3BttVivg-lSreASjpkttcsz-1rb7btKlv8EX4",
        "d": "V8kgd2ZBRuh2dgyVINBUqpPDr7BOMGcF22CQMIUHtNM",
    }
)
ctx = COSE.new()
encoded = ctx.encode_and_sign(
    b"Hello world!",
    sig_key,
    protected={"alg": "ES256"},
    unprotected={"kid": "01"},
)
decoded = ctx.decode(encoded, sig_key)

```

```

from cwt import COSE, COSEKey

sig_key = COSEKey.from_jwk(
    {
        "kty": "EC",
        "kid": "01",
        "crv": "P-256",
        "x": "usWxHK2PmfHkWXPS54m0kTcGJ90UiglWiGahtagnv8",
        "y": "IBOL-C3BttVivg-lSreASjpkttcsz-1rb7btKlv8EX4",
        "d": "V8kgd2ZBRuh2dgyVINBUqpPDr7BOMGcF22CQMIUHtNM",
    }
)
ctx = COSE.new()
encoded = ctx.encode_and_sign(
    b"Hello world!",
    sig_key,
    protected={1: -7},
    unprotected={4: b"01"},
)
decoded = ctx.decode(encoded, sig_key)

```

1.3.6 COSE Signature

Create a COSE Signature message, verify and decode it as follows:

```
from cwt import COSE, Signer

signer = Signer.from_jwk(
    {
        "kty": "EC",
        "kid": "01",
        "crv": "P-256",
        "x": "usWxHK2PmfnHKwXPS54m0kTcGJ90UiglWiGahtagnv8",
        "y": "IBOL-C3BttVivg-lSreASjpkttcsz-1rb7btKLv8EX4",
        "d": "V8kgd2ZBRuh2dgyVINBUqpPDr7BOMGcF22CQMIUHtNM",
    },
)
ctx = COSE.new()
encoded = ctx.encode_and_sign(b"Hello world!", signers=[signer])
decoded = ctx.decode(encoded, signer.cose_key)
```

Following two samples are other ways of writing the above example:

```
from cwt import COSE, COSEKey, Signer

signer = Signer.new(
    cose_key=COSEKey.from_jwk(
        {
            "kty": "EC",
            "kid": "01",
            "crv": "P-256",
            "x": "usWxHK2PmfnHKwXPS54m0kTcGJ90UiglWiGahtagnv8",
            "y": "IBOL-C3BttVivg-lSreASjpkttcsz-1rb7btKLv8EX4",
            "d": "V8kgd2ZBRuh2dgyVINBUqpPDr7BOMGcF22CQMIUHtNM",
        }
    ),
    protected={"alg": "ES256"},
    unprotected={"kid": "01"},
)
ctx = COSE.new()
encoded = ctx.encode_and_sign(b"Hello world!", signers=[signer])
decoded = ctx.decode(encoded, signer.cose_key)
```

```
from cwt import COSE, COSEKey, Signer

signer = Signer.new(
    cose_key=COSEKey.from_jwk(
        {
            "kty": "EC",
            "kid": "01",
            "crv": "P-256",
            "x": "usWxHK2PmfnHKwXPS54m0kTcGJ90UiglWiGahtagnv8",
            "y": "IBOL-C3BttVivg-lSreASjpkttcsz-1rb7btKLv8EX4",
            "d": "V8kgd2ZBRuh2dgyVINBUqpPDr7BOMGcF22CQMIUHtNM",
```

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```

    }
    ),
    protected={1: -7},
    unprotected={4: b"01"},
)
ctx = COSE.new()
encoded = ctx.encode_and_sign(b"Hello world!", signers=[signer])
decoded = ctx.decode(encoded, signer.cose_key)

```

1.4 API Reference

A Python implementation of CWT/COSE <<https://python-cwt.readthedocs.io>>

`cwt.encode`(*claims*: Union[cwt.claims.Claims, Dict[str, Any], Dict[int, Any], bytes], *key*: cwt.cose_key_interface.COSEKeyInterface, *nonce*: bytes = b'', *recipients*: Optional[List[cwt.recipient_interface.RecipientInterface]] = None, *signers*: List[cwt.signer.Signer] = [], *tagged*: bool = False) → bytes

Encodes CWT with MAC, signing or encryption. This is a wrapper function of the following functions for easy use:

- `encode_and_mac`
- `encode_and_sign`
- `encode_and_encrypt`

Therefore, it must be clear whether the use of the specified key is for MAC, signing, or encryption. For this purpose, the key must have the `key_ops` parameter set to identify the usage.

Parameters

- **claims** (Union[Claims, Dict[str, Any], Dict[int, Any], bytes]) – A CWT claims object, or a JWT claims object, text string or byte string.
- **key** (COSEKeyInterface) – A COSE key used to generate a MAC for the claims.
- **recipients** (List[RecipientInterface]) – A list of recipient information structures.
- **tagged** (bool) – An indicator whether the response is wrapped by CWT tag(61) or not.

Returns A byte string of the encoded CWT.

Return type bytes

Raises

- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to encode the claims.

`cwt.encode_and_mac`(*claims*: Union[cwt.claims.Claims, Dict[int, Any], bytes], *key*: cwt.cose_key_interface.COSEKeyInterface, *recipients*: Optional[List[cwt.recipient_interface.RecipientInterface]] = None, *tagged*: bool = False) → bytes

Encodes with MAC.

Parameters

- **claims** (*Union[Claims, Dict[int, Any], bytes]*) – A CWT claims object or byte string.
- **key** (*COSEKeyInterface*) – A COSE key used to generate a MAC for the claims.
- **recipients** (*List[RecipientInterface]*) – A list of recipient information structures.
- **tagged** (*bool*) – An indicator whether the response is wrapped by CWT tag(61) or not.

Returns A byte string of the encoded CWT.

Return type bytes

Raises

- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to encode the claims.

`cwt.encode_and_sign(claims: Union[cwt.claims.Claims, Dict[int, Any], bytes], key: Optional[cwt.cose_key_interface.COSEKeyInterface] = None, signers: List[cwt.signer.Signer] = [], tagged: bool = False) → bytes`

Encodes CWT with signing.

Parameters

- **claims** (*Claims, Union[Dict[int, Any], bytes]*) – A CWT claims object or byte string.
- **key** (*Optional[COSEKeyInterface]*) – A COSE key or a list of the keys used to sign claims. When the **signers** parameter is set, this **key** parameter will be ignored and should not be set.
- **signers** (*List[Signer]*) – A list of signer information objects for multiple signer cases.
- **tagged** (*bool*) – An indicator whether the response is wrapped by CWT tag(61) or not.

Returns A byte string of the encoded CWT.

Return type bytes

Raises

- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to encode the claims.

`cwt.encode_and_encrypt(claims: Union[cwt.claims.Claims, Dict[int, Any], bytes], key: cwt.cose_key_interface.COSEKeyInterface, nonce: bytes = b'', recipients: Optional[List[cwt.recipient_interface.RecipientInterface]] = None, tagged: bool = False) → bytes`

Encodes CWT with encryption.

Parameters

- **claims** (*Claims, Union[Dict[int, Any], bytes]*) – A CWT claims object or byte string.
- **key** (*COSEKeyInterface*) – A COSE key used to encrypt the claims.
- **nonce** (*bytes*) – A nonce for encryption.
- **recipients** (*List[RecipientInterface]*) – A list of recipient information structures.
- **tagged** (*bool*) – An indicator whether the response is wrapped by CWT tag(61) or not.

Returns A byte string of the encoded CWT.

Return type bytes

Raises

- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to encode the claims.

`cwt.decode(data: bytes, key: Union[cwt.cose_key_interface.COSEKeyInterface, List[cwt.cose_key_interface.COSEKeyInterface]], no_verify: bool = False) → Union[Dict[int, Any], bytes]`

Verifies and decodes CWT.

Parameters

- **data** (bytes) – A byte string of an encoded CWT.
- **key** (Union[COSEKeyInterface, List[COSEKeyInterface]]) – A COSE key or a list of the keys used to verify and decrypt the encoded CWT.
- **no_verify** (bool) – An indicator whether token verification is skipped or not.

Returns A byte string of the decoded CWT.

Return type Union[Dict[int, Any], bytes]

Raises

- **ValueError** – Invalid arguments.
- **DecodeError** – Failed to decode the CWT.
- **VerifyError** – Failed to verify the CWT.

`cwt.set_private_claim_names(claim_names: Dict[str, int])`

Sets private claim definitions. The definitions will be used in [encode](#) when it is called with JSON-based claims.

Parameters **claim_names** (Dict[str, int]) – A set of private claim definitions which consist of a readable claim name(str) and a claim key(int). The claim key should be less than -65536 but you can use the numbers other than pre-registered numbers listed in [IANA Registry](#).

Raises **ValueError** – Invalid arguments.

`class cwt.CWT(expires_in: int = 3600, leeway: int = 60)`

Bases: `cwt.cbor_processor.CBORProcessor`

A CWT (CBOR Web Token) Implementaion, which is built on top of [COSE](#)

`cwt.cwt` is a global object of this class initialized with default settings.

CBOR_TAG = 61

`classmethod new(expires_in: int = 3600, leeway: int = 60)`

Constructor.

Parameters

- **expires_in** (int) – The default lifetime in seconds of CWT (default value: 3600).
- **leeway** (int) – The default leeway in seconds for validating `exp` and `nbft` (default value: 60).

Examples

```
>>> from cwt import CWT, COSEKey
>>> ctx = CWT.new(expires_in=3600*24, leeway=10)
>>> key = COSEKey.from_symmetric_key(alg="HS256")
>>> token = ctx.encode(
...     {"iss": "coaps://as.example", "sub": "dajiaji", "cti": "123"},
...     key,
... )
```

property expires_in: `int`

The default lifetime in seconds of CWT. If *exp* is not found in claims, this value will be used with current time.

property leeway: `int`

The default leeway in seconds for validating *exp* and *nbfi*.

encode(claims: Union[cwt.claims.Claims, Dict[str, Any], Dict[int, Any], bytes], key: cwt.cose_key_interface.COSEKeyInterface, nonce: bytes = b'', recipients: Optional[List[cwt.recipient_interface.RecipientInterface]] = None, signers: List[cwt.signer.Signer] = [], tagged: bool = False) → bytes

Encodes CWT with MAC, signing or encryption. This is a wrapper function of the following functions for easy use:

- [encode_and_mac](#)
- [encode_and_sign](#)
- [encode_and_encrypt](#)

Therefore, it must be clear whether the use of the specified key is for MAC, signing, or encryption. For this purpose, the key must have the *key_ops* parameter set to identify the usage.

Parameters

- **claims** (Union[Claims, Dict[str, Any], Dict[int, Any], bytes]) – A CWT claims object, or a JWT claims object, text string or byte string.
- **key** (COSEKeyInterface) – A COSE key used to generate a MAC for the claims.
- **recipients** (List[RecipientInterface]) – A list of recipient information structures.
- **tagged** (bool) – An indicator whether the response is wrapped by CWT tag(61) or not.

Returns A byte string of the encoded CWT.

Return type bytes

Raises

- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to encode the claims.

encode_and_mac(claims: Union[cwt.claims.Claims, Dict[int, Any], bytes], key: cwt.cose_key_interface.COSEKeyInterface, recipients: Optional[List[cwt.recipient_interface.RecipientInterface]] = None, tagged: bool = False) → bytes

Encodes with MAC.

Parameters

- **claims** (*Union[Claims, Dict[int, Any], bytes]*) – A CWT claims object or byte string.
- **key** (*COSEKeyInterface*) – A COSE key used to generate a MAC for the claims.
- **recipients** (*List[RecipientInterface]*) – A list of recipient information structures.
- **tagged** (*bool*) – An indicator whether the response is wrapped by CWT tag(61) or not.

Returns A byte string of the encoded CWT.

Return type bytes

Raises

- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to encode the claims.

encode_and_sign(*claims: Union[cwt.claims.Claims, Dict[int, Any], bytes], key: Optional[cwt.cose_key_interface.COSEKeyInterface] = None, signers: List[cwt.signer.Signer] = [], tagged: bool = False*) → bytes

Encodes CWT with signing.

Parameters

- **claims** (*Claims, Union[Dict[int, Any], bytes]*) – A CWT claims object or byte string.
- **key** (*Optional[COSEKeyInterface]*) – A COSE key or a list of the keys used to sign claims. When the **signers** parameter is set, this **key** parameter will be ignored and should not be set.
- **signers** (*List[Signer]*) – A list of signer information objects for multiple signer cases.
- **tagged** (*bool*) – An indicator whether the response is wrapped by CWT tag(61) or not.

Returns A byte string of the encoded CWT.

Return type bytes

Raises

- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to encode the claims.

encode_and_encrypt(*claims: Union[cwt.claims.Claims, Dict[int, Any], bytes], key: cwt.cose_key_interface.COSEKeyInterface, nonce: bytes = b'', recipients: Optional[List[cwt.recipient_interface.RecipientInterface]] = None, tagged: bool = False*) → bytes

Encodes CWT with encryption.

Parameters

- **claims** (*Claims, Union[Dict[int, Any], bytes]*) – A CWT claims object or byte string.
- **key** (*COSEKeyInterface*) – A COSE key used to encrypt the claims.
- **nonce** (*bytes*) – A nonce for encryption.
- **recipients** (*List[RecipientInterface]*) – A list of recipient information structures.
- **tagged** (*bool*) – An indicator whether the response is wrapped by CWT tag(61) or not.

Returns A byte string of the encoded CWT.

Return type bytes

Raises

- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to encode the claims.

decode(*data*: bytes, *key*: Union[cwt.cose_key_interface.COSEKeyInterface, List[cwt.cose_key_interface.COSEKeyInterface]], *no_verify*: bool = False) → Union[Dict[int, Any], bytes]

Verifies and decodes CWT.

Parameters

- **data** (bytes) – A byte string of an encoded CWT.
- **key** (Union[COSEKeyInterface, List[COSEKeyInterface]]) – A COSE key or a list of the keys used to verify and decrypt the encoded CWT.
- **no_verify** (bool) – An indicator whether token verification is skipped or not.

Returns A byte string of the decoded CWT.

Return type Union[Dict[int, Any], bytes]

Raises

- **ValueError** – Invalid arguments.
- **DecodeError** – Failed to decode the CWT.
- **VerifyError** – Failed to verify the CWT.

set_private_claim_names(*claim_names*: Dict[str, int])

Sets private claim definitions. The definitions will be used in [encode](#) when it is called with JSON-based claims.

Parameters **claim_names** (Dict[str, int]) – A set of private claim definitions which consist of a readable claim name(str) and a claim key(int). The claim key should be less than -65536 but you can use the numbers other than pre-registered numbers listed in [IANA Registry](#).

Raises **ValueError** – Invalid arguments.

class cwt.COSE(*alg_auto_inclusion*: int = False, *kid_auto_inclusion*: int = False)

Bases: cwt.cbor_processor.CBORProcessor

A COSE (CBOR Object Signing and Encryption) Implementaion built on top of [cbor2](#).

classmethod **new**(*alg_auto_inclusion*: int = False, *kid_auto_inclusion*: int = False)

Constructor.

Parameters

- **alg_auto_inclusion** (bool) – The indicator whether alg parameter is included in a proper header bucket automatically or not.
- **kid_auto_inclusion** (bool) – The indicator whether kid parameter is included in a proper header bucket automatically or not.

encode_and_mac(*payload*: bytes, *key*: cwt.cose_key_interface.COSEKeyInterface, *protected*: Optional[Union[dict, bytes]] = None, *unprotected*: Optional[dict] = None, *recipients*: Optional[List[cwt.recipient_interface.RecipientInterface]] = None, *external_aad*: bytes = b'', *out*: str = '') → Union[bytes, _cbor2.CBORTag]

Encodes data with MAC.

Parameters

- **payload** (*bytes*) – A content to be MACed.
- **key** (*COSEKeyInterface*) – A COSE key as a MAC Authentication key.
- **protected** (*Optional[Union[dict, bytes]]*) – Parameters that are to be cryptographically protected.
- **unprotected** (*Optional[dict]*) – Parameters that are not cryptographically protected.
- **recipients** (*Optional[List[RecipientInterface]]*) – A list of recipient information structures.
- **external_aad** (*bytes*) – External additional authenticated data supplied by application.
- **out** (*str*) – An output format. Only "cbor2/CBORTag" can be used. If "cbor2/CBORTag" is specified. This function will return encoded data as *cbor2*'s CBORTag object. If any other value is specified, it will return encoded data as bytes.

Returns A byte string of the encoded COSE or a *cbor2*.CBORTag object.

Return type Union[bytes, CBORTag]

Raises

- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to encode data.

encode_and_sign(*payload: bytes, key: Optional[cwt.cose_key_interface.COSEKeyInterface] = None, protected: Optional[Union[dict, bytes]] = None, unprotected: Optional[dict] = None, signers: List[cwt.signer.Signer] = [], external_aad: bytes = b'', out: str = ''*) → Union[bytes, _cbor2.CBORTag]

Encodes data with signing.

Parameters

- **payload** (*bytes*) – A content to be signed.
- **key** (*COSEKeyInterface*) – A signing key for single signer cases. When the *signers* parameter is set, this *key* will be ignored and should not be set.
- **protected** (*Optional[Union[dict, bytes]]*) – Parameters that are to be cryptographically protected.
- **unprotected** (*Optional[dict]*) – Parameters that are not cryptographically protected.
- **signers** (*Optional[List[Signer]]*) – A list of signer information objects for multiple signer cases.
- **external_aad** (*bytes*) – External additional authenticated data supplied by application.
- **out** (*str*) – An output format. Only "cbor2/CBORTag" can be used. If "cbor2/CBORTag" is specified. This function will return encoded data as *cbor2*'s CBORTag object. If any other value is specified, it will return encoded data as bytes.

Returns A byte string of the encoded COSE or a *cbor2*.CBORTag object.

Return type Union[bytes, CBORTag]

Raises

- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to encode data.

encode_and_encrypt(*payload: bytes*, *key: cwt cose_key_interface.COSEKeyInterface*, *protected: Optional[Union[dict, bytes]] = None*, *unprotected: Optional[dict] = None*, *nonce: bytes = b''*, *recipients: Optional[List[cwt.recipient_interface.RecipientInterface]] = None*, *external_aad: bytes = b''*, *out: str = ''*) → bytes

Encodes data with encryption.

Parameters

- **payload** (*bytes*) – A content to be encrypted.
- **key** (*COSEKeyInterface*) – A COSE key as an encryption key.
- **protected** (*Optional[Union[dict, bytes]]*) – Parameters that are to be cryptographically protected.
- **unprotected** (*Optional[dict]*) – Parameters that are not cryptographically protected.
- **nonce** (*bytes*) – A nonce for encryption.
- **recipients** (*Optional[List[RecipientInterface]]*) – A list of recipient information structures.
- **external_aad** (*bytes*) – External additional authenticated data supplied by application.
- **out** (*str*) – An output format. Only "cbor2/CBORTag" can be used. If "cbor2/CBORTag" is specified. This function will return encoded data as `cbor2`'s CBORTag object. If any other value is specified, it will return encoded data as bytes.

Returns A byte string of the encoded COSE or a `cbor2.CBORTag` object.

Return type Union[bytes, CBORTag]

Raises

- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to encode data.

decode(*data: Union[bytes, _cbor2.CBORTag]*, *key: Optional[Union[cwt cose_key_interface.COSEKeyInterface, List[cwt cose_key_interface.COSEKeyInterface]]] = None*, *materials: Optional[List[dict]] = None*, *external_aad: bytes = b''*) → bytes

Verifies and decodes COSE data.

Parameters

- **data** (*Union[bytes, CBORTag]*) – A byte string or `cbor2.CBORTag` of an encoded data.
- **key** (*Optional[Union[COSEKeyInterface, List[COSEKeyInterface]]]*) – A COSE key to verify and decrypt the encoded data.
- **materials** (*Optional[List[dict]]*) – A list of key materials to be used to derive an encryption key.
- **external_aad** (*bytes*) – External additional authenticated data supplied by application.

Returns A byte string of decoded payload.

Return type bytes

Raises

- **ValueError** – Invalid arguments.
- **DecodeError** – Failed to decode data.
- **VerifyError** – Failed to verify data.

class `cwt.COSEKey`

Bases: `object`

A COSEKeyInterface Builder.

static new(*cose_key: Dict[int, Any]*) → *cwt.cose_key_interface.COSEKeyInterface*

Create a COSE key from a CBOR-like dictionary with numeric keys.

Parameters *cose_key* (*Dict[int, Any]*) – A CBOR-like dictionary with numeric keys of a COSE key.

Returns A COSE key object.

Return type *COSEKeyInterface*

Raises **ValueError** – Invalid arguments.

classmethod from_symmetric_key(*key: Union[bytes, str] = b'', alg: Union[int, str] = 'HMAC 256/256', kid: Union[bytes, str] = b'', key_ops: Optional[Union[List[int], List[str]]] = None*) → *cwt.cose_key_interface.COSEKeyInterface*

Create a COSE key from a symmetric key.

Parameters

- **key** (*Union[bytes, str]*) – A key bytes or string.
- **alg** (*Union[int, str]*) – An algorithm label(int) or name(str). Supported alg are listed in [Supported COSE Algorithms](#).
- **kid** (*Union[bytes, str]*) – A key identifier.
- **key_ops** (*Union[List[int], List[str]]*) – A list of key operation values. Following values can be used: 1("sign"), 2("verify"), 3("encrypt"), 4("decrypt"), 5("wrap key"), 6("unwrap key"), 7("derive key"), 8("derive bits"), 9("MAC create"), 10("MAC verify")

Returns A COSE key object.

Return type *COSEKeyInterface*

Raises **ValueError** – Invalid arguments.

classmethod from_bytes(*key_data: bytes*) → *cwt.cose_key_interface.COSEKeyInterface*

Create a COSE key from CBOR-formatted key data.

Parameters *key_data* (*bytes*) – CBOR-formatted key data.

Returns A COSE key object.

Return type *COSEKeyInterface*

Raises

- **ValueError** – Invalid arguments.
- **DecodeError** – Failed to decode the key data.

classmethod from_jwk(*data: Union[str, bytes, Dict[str, Any]]*) → *cwt.cose_key_interface.COSEKeyInterface*

Create a COSE key from JWK (JSON Web Key).

Parameters *jwk* (*Union[str, bytes, Dict[str, Any]]*) – JWK-formatted key data.

Returns A COSE key object.

Return type *COSEKeyInterface*

Raises

- **ValueError** – Invalid arguments.
- **DecodeError** – Failed to decode the key data.

```
classmethod from_pem(key_data: Union[str, bytes], alg: Union[int, str] = "", kid: Union[bytes, str] = b",  
                    key_ops: Optional[Union[List[int], List[str]]] = None) →  
                    cwt.cose_key_interface.COSEKeyInterface
```

Create a COSE key from PEM-formatted key data.

Parameters

- **key_data** (*bytes*) – A PEM-formatted key data.
- **alg** (*Union[int, str]*) – An algorithm label(int) or name(str). Different from `::func::cwt.COSEKey.from_symmetric_key`, it is only used when an algorithm cannot be specified by the PEM data, such as RSA family algorithms.
- **kid** (*Union[bytes, str]*) – A key identifier.
- **key_ops** (*Union[List[int], List[str]]*) – A list of key operation values. Following values can be used: 1("sign"), 2("verify"), 3("encrypt"), 4("decrypt"), 5("wrap key"), 6("unwrap key"), 7("derive key"), 8("derive bits"), 9("MAC create"), 10("MAC verify")

Returns A COSE key object.

Return type *COSEKeyInterface*

Raises

- **ValueError** – Invalid arguments.
- **DecodeError** – Failed to decode the key data.

```
class cwt.EncryptedCOSEKey
```

Bases: `cwt.cbor_processor.CBORProcessor`

An encrypted COSE key.

```
static from_cose_key(key: cwt.cose_key_interface.COSEKeyInterface, encryption_key:  
                    cwt.cose_key_interface.COSEKeyInterface, nonce: bytes = b", tagged: bool =  
                    False) → Union[List[Any], bytes]
```

Returns an encrypted COSE key formatted to COSE_Encrypt0 structure.

Parameters

- **key** – *COSEKeyInterface*: A key to be encrypted.
- **encryption_key** – *COSEKeyInterface*: An encryption key to encrypt the target COSE key.
- **nonce** (*bytes*) – A nonce for encryption.

Returns A COSE_Encrypt0 structure of the target COSE key.

Return type *List[Any]*

Raises

- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to encrypt the COSE key.

static to_cose_key(key: List[Any], encryption_key: cwt.cose_key_interface.COSEKeyInterface) → cwt.cose_key_interface.COSEKeyInterface

Returns an decrypted COSE key.

Parameters

- **key** – COSEKeyInterface: A key formatted to COSE_Encrypt0 structure to be decrypted.
- **encryption_key** – COSEKeyInterface: An encryption key to decrypt the target COSE key.

Returns A key decrypted.

Return type COSEKeyInterface

Raises

- **ValueError** – Invalid arguments.
- **DecodeError** – Failed to decode the COSE key.
- **VerifyError** – Failed to verify the COSE key.

class cwt.Claims(claims: Dict[int, Any], claim_names: Dict[str, int] = {'EAT-FDO': -257, 'EATMAROEPrefix': -258, 'EUPHNonce': -259, 'aud': 3, 'cnf': 8, 'cti': 7, 'dbgstat': 16, 'eat_profile': 18, 'exp': 4, 'hcert': -260, 'iat': 6, 'iss': 1, 'location': 17, 'nbf': 5, 'nonce': 10, 'oemid': 13, 'secboot': 15, 'secllevel': 14, 'sub': 2, 'submods': 20, 'ueid': 11})

Bases: object

A class for handling CWT Claims like JWT claims.

classmethod new(claims: Dict[int, Any], private_claim_names: Dict[str, int] = {})

Create a Claims object from a CBOR-like(Dict[int, Any]) claim object.

Parameters

- **claims** (Dict[str, Any]) – A CBOR-like(Dict[int, Any]) claim object.
- **private_claim_names** (Dict[str, int]) – A set of private claim definitions which consist of a readable claim name(str) and a claim key(int). The claim key should be less than -65536 but you can use the numbers other than pre-registered numbers listed in [IANA Registry](#).

Returns A CWT claims object.

Return type Claims

Raises **ValueError** – Invalid arguments.

classmethod from_json(claims: Union[str, bytes, Dict[str, Any]], private_claim_names: Dict[str, int] = {})

Converts a JWT claims object into a CWT claims object which has numeric keys. If a key string in JSON data cannot be mapped to a numeric key, it will be skipped.

Parameters

- **claims** (Union[str, bytes, Dict[str, Any]]) – A JWT claims object to be converted.
- **private_claim_names** (Dict[str, int]) – A set of private claim definitions which consist of a readable claim name(str) and a claim key(int). The claim key should be less than -65536 but you can use the numbers other than pre-registered numbers listed in [IANA Registry](#).

Returns A CWT claims object.

Return type *Claims*

Raises **ValueError** – Invalid arguments.

classmethod **validate**(*claims: Dict[int, Any]*)

Validates a CWT claims object.

Parameters **claims** (*Dict[int, Any]*) – A CWT claims object to be validated.

Raises **ValueError** – Failed to verify.

property **iss**: *Optional[str]*

property **sub**: *Optional[str]*

property **aud**: *Optional[str]*

property **exp**: *Optional[int]*

property **nbf**: *Optional[int]*

property **iat**: *Optional[int]*

property **cti**: *Optional[str]*

property **cnf**: *Optional[Union[Dict[int, Any], List[Any], str]]*

get(*key: Union[str, int]*) → *Any*

Gets a claim value with a claim key.

Parameters **key** (*Union[str, int]*) – A claim key.

Returns The value of the claim.

Return type *Any*

to_dict() → *Dict[int, Any]*

class **cwt.Recipient**

Bases: *object*

A RecipientInterface Builder.

classmethod **new**(*protected: dict = {}, unprotected: dict = {}, ciphertext: bytes = b'', recipients: List[Any] = [], key_ops: List[int] = [], key: bytes = b''*) → *cwt.recipient_interface.RecipientInterface*

Create a recipient from a CBOR-like dictionary with numeric keys.

Parameters

- **protected** (*dict*) – Parameters that are to be cryptographically protected.
- **unprotected** (*dict*) – Parameters that are not cryptographically protected.

Returns A recipient object.

Return type *RecipientInterface*

Raises **ValueError** – Invalid arguments.

classmethod **from_json**(*data: Union[str, bytes, Dict[str, Any]]*) → *cwt.recipient_interface.RecipientInterface*

Create a recipient from JSON-formatted recipient data.

Parameters **data** (*Union[str, bytes, Dict[str, Any]]*) – JSON-formatted recipient data.

Returns A recipient object.

Return type *RecipientInterface*

Raises

- **ValueError** – Invalid arguments.
- **DecodeError** – Failed to decode the key data.

```
class cwt.Signer(cose_key: cwt.cose_key_interface.COSEKeyInterface, protected: Union[Dict[int, Any], bytes],
                 unprotected: Dict[int, Any], signature: bytes = b"")
```

Bases: cwt.cbor_processor.CBORProcessor

A Signer information.

property cose_key: cwt.cose_key_interface.COSEKeyInterface

The COSE key for the signer.

property protected: bytes

The parameters that are to be cryptographically protected.

property unprotected: Dict[int, Any]

The parameters that are not cryptographically protected.

property signature: bytes

The signature that the signer signed.

```
classmethod new(cose_key: cwt.cose_key_interface.COSEKeyInterface, protected: Union[dict, bytes] = {},
               unprotected: dict = {}, signature: bytes = b"")
```

Create a signer information object (COSE_Signature).

Parameters

- **key** (COSEKey) – A signature key for the signer.
- **protected** (Union[dict, bytes]) – Parameters that are to be cryptographically protected.
- **unprotected** (dict) – Parameters that are not cryptographically protected.
- **signature** (bytes) – A signature as bytes.

Returns A signer information object.

Return type *Signer*

Raises **ValueError** – Invalid arguments.

```
classmethod from_jwk(data: Union[str, bytes, Dict[str, Any]])
```

Create a signer information object (COSE_Signature) from JWK. The alg in the JWK will be included in the protected header, and the kid in the JWT will be include in the unprotected header. If you want to include any other parameters in the protected/unprotected header, you have to use *Signer.new*.

Parameters **data** (Union[str, bytes, Dict[str, Any]]) – A JWK.

Returns A signer information object.

Return type *Signer*

Raises

- **ValueError** – Invalid arguments.
- **DecodeError** – Failed to decode the key data.

```
classmethod from_pem(data: Union[str, bytes], alg: Union[int, str] = "", kid: Union[bytes, str] = b"")
```

Create a signer information object (COSE_Signature) from PEM-formatted key. The alg in the JWK will be included in the protected header, and the kid in the JWT will be include in the unprotected header. If you want to include any other parameters in the protected/unprotected header, you have to use *Signer.new*.

Parameters

- **data** (*Union[str, bytes]*) – A PEM-formatted key.
- **alg** (*Union[int, str]*) – An algorithm label(int) or name(str). It is only used when an algorithm cannot be specified by the PEM data, such as RSA family algorithms.
- **kid** (*Union[bytes, str]*) – A key identifier.

Returns A signer information object.

Return type *Signer*

Raises

- **ValueError** – Invalid arguments.
- **DecodeError** – Failed to decode the key data.

sign(*msg: bytes*)

Returns a digital signature for the specified message using the specified key value.

Parameters **msg** (*bytes*) – A message to be signed.

Raises

- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to sign the message.

verify(*msg: bytes*)

Verifies that the specified digital signature is valid for the specified message.

Parameters **msg** (*bytes*) – A message to be verified.

Raises

- **ValueError** – Invalid arguments.
- **VerifyError** – Failed to verify.

exception `cwt.CWTErrror`

Bases: `Exception`

Base class for all exceptions.

exception `cwt.EncodeError`

Bases: `cwt.exceptions.CWTErrror`

An Exception occurred when a CWT/COSE encoding process failed.

exception `cwt.DecodeError`

Bases: `cwt.exceptions.CWTErrror`

An Exception occurred when a CWT/COSE decoding process failed.

exception `cwt.VerifyError`

Bases: `cwt.exceptions.CWTErrror`

An Exception occurred when a verification process failed.

class `cwt.cose_key_interface.COSEKeyInterface`(*params: Dict[int, Any]*)

Bases: `cwt.cbor_processor.CBORProcessor`

The interface class for a COSE Key used for MAC, signing/verifying and encryption/decryption.

__init__(*params: Dict[int, Any]*)

Constructor.

Parameters **params** (*Dict[int, Any]*) – A COSE key common parameter object formatted to CBOR-like structure ((Dict[int, Any])).

property kty: **int**

The identifier of the key type.

property kid: **Optional[bytes]**

The key identifier.

property alg: **Optional[int]**

The algorithm that is used with the key.

property key_ops: **List[int]**

A set of permissible operations that the key is to be used for.

property base_iv: **Optional[bytes]**

Base IV to be xor-ed with Partial IVs.

property key: **bytes**

The body of the key as bytes.

to_dict() → *Dict[int, Any]*

Returns the CBOR-like structure (*Dict[int, Any]*) of the COSE key.

Returns The CBOR-like structure of the COSE key.

Return type *Dict[int, Any]*

generate_nonce() → *bytes*

Returns a nonce with the size suitable for the algorithm. This function will be called internally in *CWT* when no nonce is specified by the application. This function adopts *secrets.token_bytes()* to generate a nonce. If you do not want to use it, you should explicitly set a nonce to *CWT* functions (e.g., *encode_and_encrypt*).

Returns A byte string of the generated nonce.

Return type *bytes*

Raises **NotImplementedError** – Not implemented.

sign(msg: bytes) → *bytes*

Returns a digital signature for the specified message using the specified key value.

Parameters **msg** (*bytes*) – A message to be signed.

Returns The byte string of the encoded CWT.

Return type *bytes*

Raises

- **NotImplementedError** – Not implemented.
- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to sign the message.

verify(msg: bytes, sig: bytes)

Verifies that the specified digital signature is valid for the specified message.

Parameters

- **msg** (*bytes*) – A message to be verified.
- **sig** (*bytes*) – A digital signature of the message.

Returns The byte string of the encoded CWT.

Return type bytes

Raises

- **NotImplementedError** – Not implemented.
- **ValueError** – Invalid arguments.
- **VerifyError** – Failed to verify.

encrypt (*msg: bytes, nonce: bytes, aad: bytes*) → bytes

Encrypts the specified message.

Parameters

- **msg** (*bytes*) – A message to be encrypted.
- **nonce** (*bytes*) – A nonce for encryption.
- **aad** (*bytes*) – Additional authenticated data.

Returns The byte string of encrypted data.

Return type bytes

Raises

- **NotImplementedError** – Not implemented.
- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to encrypt the message.

decrypt (*msg: bytes, nonce: bytes, aad: bytes*) → bytes

Decrypts the specified message.

Parameters

- **msg** (*bytes*) – An encrypted message.
- **nonce** (*bytes*) – A nonce for encryption.
- **aad** (*bytes*) – Additional authenticated data.

Returns The byte string of the decrypted data.

Return type bytes

Raises

- **NotImplementedError** – Not implemented.
- **ValueError** – Invalid arguments.
- **DecodeError** – Failed to decrypt the message.

```
class cwt.recipient_interface.RecipientInterface(protected: Optional[Dict[int, Any]] = None,  
                                              unprotected: Optional[Dict[int, Any]] = None,  
                                              ciphertext: bytes = b'', recipients: List[Any] = [],  
                                              key_ops: List[int] = [], key: bytes = b'')
```

Bases: [cwt.cose_key_interface.COSEKeyInterface](#)

The interface class for a COSE Recipient.

```
__init__ (protected: Optional[Dict[int, Any]] = None, unprotected: Optional[Dict[int, Any]] = None,  
         ciphertext: bytes = b'', recipients: List[Any] = [], key_ops: List[int] = [], key: bytes = b'')
```

Constructor.

Parameters

- **protected** (*Optional[Dict[int, Any]]*) – Parameters that are to be cryptographically protected.
- **unprotected** (*Optional[Dict[int, Any]]*) – Parameters that are not cryptographically protected.
- **ciphertext** – A ciphertext encoded as bytes.
- **recipients** – A list of recipient information structures.
- **key_ops** – A list of operations that the key is to be used for.
- **key** – A body of the key as bytes.

property key: bytes

The body of the key as bytes.

property protected: Dict[int, Any]

The parameters that are to be cryptographically protected.

property unprotected: Dict[int, Any]

The parameters that are not cryptographically protected.

property ciphertext: bytes

The ciphertext encoded as bytes

property recipients: Optional[List[Any]]

The list of recipient information structures.

to_list() → List[Any]

Returns the recipient information as a COSE recipient structure.

Returns The recipient structure.

Return type List[Any]

set_key(*key: bytes*)

Sets a key.

Parameters **key** (*bytes*) – The key as bytes.

derive_key(*material: bytes, context: Union[List[Any], Dict[str, Any]]*) →

cwt.cose_key_interface.COSEKeyInterface

Derives a key from a key material.

Parameters

- **material** (*bytes*) – A key material.
- **context** (*Union[List[Any], Dict[str, Any]]*) – Context information structure.

Returns A COSE key derived.

Return type *COSEKeyInterface*

Raises

- **NotImplementedError** – Not implemented.
- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to derive key.

verify_key(*material: bytes, expected_key: bytes, context: Union[List[Any], Dict[str, Any]]*)

Verifies a key with a key material and an expected key.

Parameters

- **material** (*bytes*) – A key material.
- **expected_key** (*bytes*) – A byte string of the expected key.
- **context** (*Union[List[Any], Dict[str, Any]]*) – Context information structure.

Raises

- **NotImplementedError** – Not implemented.
- **ValueError** – Invalid arguments.
- **VerifyError** – Failed to verify the key.

wrap_key(*key_to_wrap: bytes*)

Wraps a key and keeps it internally as the ciphertext.

Parameters **key_to_wrap** (*bytes*) – A key to be wrapped.**Raises**

- **NotImplementedError** – Not implemented.
- **ValueError** – Invalid arguments.
- **EncodeError** – Failed to encode(wrap) key.

unwrap_key(*alg: int*) → *cwt.cose_key_interface.COSEKeyInterface*

Unwraps the key stored as the ciphertext.

Parameters **alg** (*int*) – The algorithm of the wrapped key.**Returns** An unwrapped key.**Return type** *COSEKeyInterface***Raises**

- **NotImplementedError** – Not implemented.
- **ValueError** – Invalid arguments.
- **DecodeError** – Failed to decode(unwrap) the key.

1.5 Supported CWT Claims

[IANA Registry for CWT Claims](#) lists all of registered CWT claims. This section shows the claims which this library currently supports. In particular, class `CWT` can validate the type of the claims and `Claims.from_json` can convert the following `Names(str)` into `Values(int)`.

1.5.1 CBOR Web Token (CWT) Claims

Name	Status	Value	Description
hcert		-260	Health Certificate
EUPHNonce		-259	Challenge Nonce defined in FIDO Device Onboarding
EATMAROEPrefix		-258	Signing prefix for multi-app restricted operating environments
EAT-FDO		-257	EAT-FDO may contain related to FIDO Device Onboarding
iss		1	Issuer
sub		2	Subject
aud		3	Audience
exp		4	Expiration Time
nbf		5	Not Before
iat		6	Issued At
cti		7	CWT ID
cnf		8	Confirmation
nonce		10	Nonce
ueid		11	Universal Entity ID Claim
oemid		13	OEM Identification by IEEE
secllevel		14	Security Level
secboot		15	Secure Boot
dbgstat		16	Debug Status
location		17	Location
eat_profile		18	EAT Profile
submods		20	The Submodules Part of a Token

1.5.2 CWT Confirmation Methods

Name	Status	Value	Description
COSE_Key		1	COSE_Key Representing Public Key
Encrypted_COSE_Key		2	Encrypted COSE_Key
kid		3	Key Identifier

1.6 Supported COSE Algorithms

[IANA Registry for COSE](#) lists many cryptographic algorithms for MAC, signing, and encryption. This section shows the algorithms which this library currently supports.

- : Supported.
- : No plan to support.

1.6.1 COSE Key Types

Name	Status	Value	Description
OKP		1	Octet Key Pair
EC2		2	Elliptic Curve Keys w/ x- and y-coordinate pair
RSA		3	RSA Key
Symmetric		4	Symmetric Keys
HSS-LMS		5	Public key for HSS/LMS hash-based digital signature
WalnutDSA		6	WalnutDSA public key

1.6.2 COSE Algorithms

Name	Status	Value	Description
RS1		-65535	RSASSA-PKCS1-v1_5 using SHA-1
WalnutDSA		-260	WalnutDSA signature
RS512		-259	RSASSA-PKCS1-v1_5 using SHA-512
RS384		-258	RSASSA-PKCS1-v1_5 using SHA-384
RS256		-257	RSASSA-PKCS1-v1_5 using SHA-256
ES256K		-47	ECDSA using secp256k1 curve and SHA-256
HSS-LMS		-46	HSS/LMS hash-based digital signature
SHAKE256		-45	SHAKE-256 512-bit Hash Value
SHA-512		-44	SHA-2 512-bit Hash
SHA-384		-43	SHA-2 384-bit Hash
RSAES-OAEP w/ SHA-512		-42	RSAES-OAEP w/ SHA-512
RSAES-OAEP w/ SHA-256		-41	RSAES-OAEP w/ SHA-256
RSAES-OAEP w/ RFC 8017 default parameters		-40	RSAES-OAEP w/ SHA-1

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Name	Status	Value	Description
PS512		-39	RSASSA-PSS w/ SHA-512
PS384		-38	RSASSA-PSS w/ SHA-384
PS256		-37	RSASSA-PSS w/ SHA-256
ES512		-36	ECDSA w/ SHA-512
ES384		-35	ECDSA w/ SHA-384
ECDH-SS + A256KW		-34	ECDH SS w/ Concat KDF and AES Key Wrap w/ 256-bit key
ECDH-SS + A192KW		-33	ECDH SS w/ Concat KDF and AES Key Wrap w/ 192-bit key
ECDH-SS + A128KW		-32	ECDH SS w/ Concat KDF and AES Key Wrap w/ 128-bit key
ECDH-ES + A256KW		-31	ECDH ES w/ Concat KDF and AES Key Wrap w/ 256-bit key
ECDH-ES + A192KW		-30	ECDH ES w/ Concat KDF and AES Key Wrap w/ 192-bit key
ECDH-ES + A128KW		-29	ECDH ES w/ Concat KDF and AES Key Wrap w/ 128-bit key
ECDH-SS + HKDF-512		-28	ECDH SS w/ HKDF - generate key directly
ECDH-SS + HKDF-256		-27	ECDH SS w/ HKDF - generate key directly
ECDH-ES + HKDF-512		-26	ECDH ES w/ HKDF - generate key directly

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Name	Status	Value	Description
ECDH-ES + HKDF-256		-25	ECDH ES w/ HKDF - generate key directly
SHAKE128		-18	SHAKE-128 256-bit Hash Value
SHA-512/256		-17	SHA-2 512-bit Hash truncated to 256-bits
SHA-256		-16	SHA-2 256-bit Hash
SHA-256/64		-15	SHA-2 256-bit Hash truncated to 64-bits
SHA-1		-14	SHA-1 Hash
direct+HKDF-AES-256		-13	Shared secret w/ AES-MAC 256-bit key
direct+HKDF-AES-128		-12	Shared secret w/ AES-MAC 128-bit key
direct+HKDF-SHA-512		-11	Shared secret w/ HKDF and SHA-512
direct+HKDF-SHA-256		-10	Shared secret w/ HKDF and SHA-256
EdDSA		-8	EdDSA
ES256		-7	ECDSA w/ SHA-256
direct		-6	Direct use of CEK
A256KW		-5	AES Key Wrap w/ 256-bit key
A192KW		-4	AES Key Wrap w/ 192-bit key
A128KW		-3	AES Key Wrap w/ 128-bit key
A128GCM		1	AES-GCM mode w/ 128-bit key, 128-bit tag
A192GCM		2	AES-GCM mode w/ 192-bit key, 128-bit tag
A256GCM		3	AES-GCM mode w/ 256-bit key, 128-bit tag
HMAC 256/64		4	HMAC w/ SHA-256 truncated to 64 bits
HMAC 256/256 ("HS256" can also be used.)		5	HMAC w/ SHA-256
HMAC 384/384 ("HS384" can also be used.)		6	HMAC w/ SHA-384

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Name	Status	Value	Description
HMAC 512/512 (“HS512” can also be used.)		7	HMAC w/ SHA-512
AES-CCM-16-64-128		10	AES-CCM mode 128-bit key, 64-bit tag, 13-byte nonce
AES-CCM-16-64-256		11	AES-CCM mode 256-bit key, 64-bit tag, 13-byte nonce
AES-CCM-64-64-128		12	AES-CCM mode 128-bit key, 64-bit tag, 7-byte nonce
AES-CCM-64-64-256		13	AES-CCM mode 256-bit key, 64-bit tag, 7-byte nonce
AES-MAC 128/64		14	AES-MAC 128-bit key, 64-bit tag
AES-MAC 256/64		15	AES-MAC 256-bit key, 64-bit tag
ChaCha20/Poly1305		24	ChaCha20/Poly1305 w/ 256-bit key, 128-bit tag
AES-MAC 128/128		25	AES-MAC 128-bit key, 128-bit tag
AES-MAC 128/128		26	AES-MAC 256-bit key, 128-bit tag
AES-CCM-16-128-128		30	AES-CCM mode 128-bit key, 128-bit tag, 13-byte nonce
AES-CCM-16-128-256		31	AES-CCM mode 256-bit key, 128-bit tag, 13-byte nonce

continues on next page

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Name	Status	Value	Description
AES-CCM-64-128-128		32	AES-CCM mode 128-bit key, 128-bit tag, 7-byte nonce
AES-CCM-64-128-256		33	AES-CCM mode 256-bit key, 128-bit tag, 7-byte nonce

1.6.3 COSE Elliptic Curves

Name	Status	Value	Description
P-256		1	NIST P-256 also known as secp256r1
P-384		2	NIST P-384 also known as secp384r1
P-521		3	NIST P-521 also known as secp521r1
X25519		4	X25519 for use w/ ECDH only
X448		5	X448 for use w/ ECDH only
Ed25519		6	Ed25519 for use w/ EdDSA only
Ed448		7	Ed448 for use w/ EdDSA only
secp256k1		8	SECG secp256k1 curve

1.7 Referenced Specifications

This library is (partially) compliant with following specifications:

- [RFC8152: CBOR Object Signing and Encryption \(COSE\)](#)
- [RFC8230: Using RSA Algorithms with COSE Messages](#)
- [RFC8392: CBOR Web Token \(CWT\)](#)
- [RFC8747: Proof-of-Possession Key Semantics for CBOR Web Tokens \(CWTs\)](#)
- [RFC8812: COSE and JOSE Registrations for Web Authentication \(WebAuthn\) Algorithms](#)

1.8 Changes

1.8.1 Unreleased

1.8.2 Version 0.9.0

Released 2021-06-04

- Introduce `new()` into CWT/COSE. [#115](#)
- Rename `Claims.from_dict` to `Claims.new`. [#115](#)

- Rename COSEKey.from_dict to COSEKey.new. #115
- Rename Recipient.from_dict to Recipient.new. #115
- Add Signer for encode_and_sign function. #114
- Divide CWT options into independent parameters. #113

1.8.3 Version 0.8.1

Released 2021-05-31

- Add JSON support for COSE. #109
- Devite a COSE options parameter into independent parameters. #109
- Refine COSE default mode. #108
- Refine the order of parameters for CWT functions. #107
- Fix example in docstring. #107
- Make interface docstring public. #106

1.8.4 Version 0.8.0

Released 2021-05-30

- Refine EncryptedCOSEKey interface. #104
- Merge RecipientsBuilder into Recipients. #103
- Rename Key to COSEKeyInterface. #102
- Rename RecipientBuilder to Recipient. #101
- Make Key private. #100
- Merge ClaimsBuilder into Claims. #98
- Rename KeyBuilder to COSEKey. #97
- Rename COSEKey to Key. #97
- Add support for external AAD. #94
- Make unwrap_key return COSEKey. #93
- Fix default HMAC key size. #91
- Add support for AES key wrap. #89
- Add support for direct+HKDF-SHA256 and SHA512. #87

1.8.5 Version 0.7.1

Released 2021-05-11

- Add alg validation and fix related bug. [#77](#)
- Update protected/unprotected default value from {} to None. [#76](#)

1.8.6 Version 0.7.0

Released 2021-05-09

- Add support for bytes-formatted protected header. [#73](#)
- Derive alg from kty and crv on from_jwk. [#73](#)
- Add alg_auto_inclusion. [#73](#)
- Move nonce generation from CWT to COSE. [#73](#)
- Re-order arguments of COSE API. [#73](#)
- Add support for COSE algorithm names for KeyBuilder.from_jwk. [#72](#)
- Add tests based on COSE WG examples. [#72](#)
- Move parameter auto-gen function from CWT to COSE. [#72](#)
- Refine COSE API to make the type of payload parameter be bytes only. [#71](#)
- Simplify samples on docs. [#69](#)

1.8.7 Version 0.6.1

Released 2021-05-08

- Add test for error handling of encoding/decoding. [#67](#)
- Fix low level error message. [#67](#)
- Add support for multiple aud. [#65](#)
- Relax the condition of the acceptable private claim value. [#64](#)
- Fix doc version. [#63](#)

1.8.8 Version 0.6.0

Released 2021-05-04

- Make decode accept multiple keys. [#61](#)
- Add set_private_claim_names to ClaimsBuilder and CWT. [#60](#)
- Add sample of CWT with user-defined claims to docs. [#60](#)

1.8.9 Version 0.5.0

Released 2021-05-04

- Make ClaimsBuilder return Claims. [#56](#)
- Add support for JWK keyword of alg and key_ops. [#55](#)
- Add from_jwk. [#53](#)
- Add support for PoP key (cnf claim). [#50](#)
- Add to_dict to COSEKey. [#50](#)
- Add crv property to COSEKey. [#50](#)
- Add key property to COSEKey. [#50](#)
- Add support for RSASSA-PSS. [#49](#)
- Add support for RSASSA-PKCS1-v1_5. [#48](#)

1.8.10 Version 0.4.0

Released 2021-04-30

- Add CWT.encode. [#46](#)
- Fix bug on KeyBuilder.from_dict. [#45](#)
- Add support for key_ops. [#44](#)
- Add support for ChaCha20/Poly1305. [#43](#)
- Make nonce optional for CWT.encode_and_encrypt. [#42](#)
- Add support for AES-GCM (A128GCM, A192GCM and A256GCM). [#41](#)
- Make key optional for KeyBuilder.from_symmetric_key. [#41](#)

1.8.11 Version 0.3.0

Released 2021-04-29

- Add docstring to COSE, KeyBuilder and more. [#39](#)
- Add support for COSE_Encrypt structure. [#36](#)
- Add support for COSE_Signature structure. [#35](#)
- Change protected_header type from bytes to dict. [#34](#)
- Add support for COSE_Mac structure. [#32](#)
- Add test for CWT. [#29](#)

1.8.12 Version 0.2.3

Released 2021-04-23

- Add test for cose_key and fix bugs. #21
- Add support for exp, nbf and iat. #18

1.8.13 Version 0.2.2

Released 2021-04-19

- Add support for Ed448, ES384 and ES512. #13
- Add support for EncodeError and DecodeError. #13
- Add test for supported algorithms. #13
- Update supported algorithms and claims on docs. #13

1.8.14 Version 0.2.1

Released 2021-04-18

- Add VerifyError. #11
- Fix HMAC alg names. #11
- Make COSEKey public. #11
- Add tests for HMAC. #11

1.8.15 Version 0.2.0

Released 2021-04-18

- Add docs for CWT. #9
- Rename exceptions. #9

1.8.16 Version 0.1.1

Released 2021-04-18

- Fix description of installation.

1.8.17 Version 0.1.0

Released 2021-04-18

- First public preview release.

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