```
!pip install biopython
import Bio
print(Bio.__version__)

from Bio.Seq import Seq
from Bio.Alphabet import IUPAC
from Bio.SeqRecord import SeqRecord
```

```
> class ModifiedOligo: ···
```

Usage

1. Creating a `ModifiedOligo` object

A `ModifiedOligo` object has two atttributes: a sequence of DNA alphabet and a dictionary mapping the modified base(s) to its position.

The DNA alphabet is created from Biopython's `Bio.SeqRecord` object as follows:

```
# construct IUPAC DNA object
dna = Seq("ATCGAGTTTACCATATCTAGAATGCAT", IUPAC.unambiguous_dna)

# construct SeqRecord object
seq_rec = SeqRecord(dna)
```

While it is not necessary to specify `IUPAC.unambiguous_dna`, doing so enforces the fact that the created `Bio.Seq` object is a DNA alphabet (and not, for example, a peptide).

Now create dictionary of the form {(symbol, name):(positions)} to map modified bases to their positions. Note the base numbering system is **zero-based**.

```
# define modified bases, their symbol representations, and their positions in the oligo
mods = {('#', 'dU'):(1, 26),
        ('^', "mC5"):(11, 24),
        ('$', "Super G"):(19, )}   # singletone tuple MUST end with comma
```

Create ModifiedOligo object

```
# create ModifiedOligo object
oligo = ModifiedOligo(seq_rec, modifications=mods)
```

2. Viewing

To view the `ModifiedOligo` object, use `view53()` and wrap it within a `print()` statement. Below, we view the unmodified oligo by setting `modified=False`.

```
# view the unmodified oligo
print(oligo.view53(modified=False))
```

```
5' ATCGAGTTTACCATATCTAGAATGCAT 3'
```

Notice the oligo has been padded with `5'` and `3'`.

To view the modified version by setting `modified=True` (default). Add the legend.

```
# view modified version, along with legend
print(oligo.view53(showLegend=True))
```

```
# = dU
^ = mC5
$ = Super G
5' A#CGAGTTTAC^ATATCTA$AATG^A# 3'
```

Notice the symbols **#** (at 1st and 26th bases), **^** (at 11th and 24th bases), and **$** (at 19th base) appear in the proper (zero-based) positions specified in the dictionary.

Notice also they are color-matched to the canonical base which they represent. For example,

- # = T = blue
- ^ = C = yellow
- $ = G = green

Sometimes, it is desirable to view the oligo in the 3' to 5' orientation (NOT reverse complement. Just reverse!).

```
# view unmodified oligo in 3'->5', with legend
print(oligo.view35(modified=False, showLegend=True))

# view modified oligo in 3'->5', without legend
print(oligo.view35(modified=True))
```

```
# = dU
^ = mC5
$ = Super G
3' TACGTAAGATCTATACCATTTGAGCTA 5'
3' #A^GTAA$ATCTATA^CATTTGAGC#A 5'
```