Using a Tolerant Cartesian Vector Class

https://github.com/t-o-k/scikit-vectors (https://github.com/t-o-k/scikit-vectors)

In [1]:
```
from skvectors import create_class_Tolerant_Cartesian_Vector
```

In [2]:
```
# Create a 4-dimensional tolerant cartesian vector class

TCVC = create_class_Tolerant_Cartesian_Vector('TCVC', 'ABCD')

# Explicit alternative:
# TCVC = \
#     create_class_Tolerant_Cartesian_Vector(
#         name = 'TCVC',
#         component_names = [ 'A', 'B', 'C', 'D' ],
#         brackets = [ '<', '>' ],
#         sep = ', ',
#         cnull = 0,
#         cunit = 1,
#         functions = None,
#         abs_tol = 1e-12,
#         rel_tol = 1e-9
#     )
```

In [3]:
```
# Absolute tolerance for vector lengths
TCVC.abs_tol
```

Out[3]:
```
1e-12
```

In [4]:
```
# Relative tolerance for vector lengths
TCVC.rel_tol
```

Out[4]:
```
1e-09
```

In [5]:
```
# Calculate the tolerance for a vector based on its length
u = TCVC(0.0, 0.0, 0.0, 0.0)  # u.length() = 0.0
u.tolerance(), u.tol
```

Out[5]:
```
(1e-12, 1e-12)
```

In [6]:
```
# Calculate the tolerance for a vector based on its length
u = TCVC(-0.2, 0.4, 0.8, -0.4)  # u.length() = 1.0
u.tol, (1e6 * u).tol
```

Out[6]:
```
(1e-09, 0.001)
```

In [7]:
```
# Calculate the tolerance for a vector based on its length
u = TCVC(-1, 2, 4, -2)  # u.length() = 5.0
u.tol, (u / 1e3).tol, (u / 1e6).tol, (u / 1e9).tol
```

Out[7]:
```
(5e-09, 5.0000000000000005e-12, 1e-12, 1e-12)
```

In [8]:
```
# Calculate a common tolerance for a vector and another based on their lengths
u = TCVC(0, 0, 0, 0)
v = TCVC(0, 0, 0, 0)
u.tolerance_with(v)
```

Out[8]:
```
1e-12
```

In [9]:
```
# Calculate a common tolerance for a vector and another based on their lengths
u = TCVC(-0.2, 0.4, 0.8, -0.4)  # u.length() = 1.0
v = TCVC(-1.0, 2.0, 4.0, -2.0)  # v.length() = 5.0
u.tolerance_with(v), v.tolerance_with(u)
```

Out[9]:
```
(5e-09, 5e-09)
```

In [10]:
```
# Calculate a common tolerance for several vectors based on their lengths
u = TCVC(0, 0, 0, 0)
v = TCVC(0, 0, 0, 0)
some_vectors = [ u, v ]
TCVC.tolerance_all(some_vectors)
```

Out[10]: 1e-12

In [11]:
```
# Calculate a tolerance for no vectors
TCVC.tolerance_all([ ])
```

Out[11]: 1e-12

In [12]:
```
# Calculate a tolerance for one vector based on its length
u = TCVC(-1.0, 2.0, 4.0, -2.0)  # u.length() = 5.0
TCVC.tolerance_all([ u ])
```

Out[12]: 5e-09

In [13]:
```
# Calculate a common tolerance for several vectors based on their lengths
u = TCVC(-0.2, 0.4, 0.8, -0.4)  # u.length() = 1.0
v = TCVC(-1.0, 2.0, 4.0, -2.0)  # v.length() = 5.0
some_vectors = [ u, v, u - v, u + v ]
TCVC.tolerance_all(some_vectors), TCVC.tolerance_all(vector for vector in some_vectors)
```

Out[13]: (6.000000000000001e-09, 6.000000000000001e-09)

In [14]:
```
# Check if the length of a vector is equal to cnull (within a calculated tolerance)
nil = TCVC.abs_tol / 2
u = TCVC(0, nil, 0, 0)  # u.length() = 5e-13
u.is_zero_vector()
```

Out[14]: True

In [15]:
```
# Check if the length of a vector is equal to cnull (within a calculated tolerance)
not_nil = TCVC.abs_tol * 2
u = TCVC(0, not_nil, 0, 0)  # u.length() = 2e-12
u.is_zero_vector()
```

Out[15]: False

In [16]:
```
# Check if the length of a vector is equal to cunit (within a calculated tolerance)
u = TCVC(-0.2, 0.4, 0.8, -0.4)  # u.length() = 1.0
nil = TCVC.rel_tol / 2
v = (1 + nil) * u  # Make the length of v slightly longer than 1.0; v.length() = 1.0 + 5e-10
v.is_unit_vector()
```

Out[16]: True

In [17]:
```
# Check if the length of a vector is equal to cunit (within a calculated tolerance)
u = TCVC(-0.2, 0.4, 0.8, -0.4)  # u.length() = 1.0
not_nil = TCVC.rel_tol * 2
v = (1 + not_nil) * u  # Make the length of v longer than 1.0; v.length() = 1.0 + 2e-9
v.is_unit_vector()
```

Out[17]: False

In [18]:
```
# Check if a vector is equal to another (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
nil = u.tolerance() / 2
v = (1 + nil / u.length()) * u  # Make v slightly different from u
u == v
```

Out[18]: True

In [19]:
```
# Check if a vector is equal to another (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
not_nil = u.tolerance() * 2
v = (1 + not_nil / u.length()) * u  # Make v different from u
u == v
```

Out[19]: False

In [20]:
```
# Check if a vector is equal to any of some other vectors (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
nil = u.tolerance() / 2
v = (1 + nil / u.length()) * u  # Make v slightly different from u
w = TCVC(5, 4, 0, -3)
some_vectors = [ v, w ]
u in some_vectors
```

Out[20]: True

In [21]:
```
# Check if a vector is equal to other any of some other vectors (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
not_nil = u.tolerance() * 2
v = (1 + not_nil / u.length()) * u  # Make v different from u
w = TCVC(5, 4, 0, -3)
some_vectors = [ v, w ]
u in some_vectors
```

Out[21]: False

In [22]:
```
# Check if a vector is not equal to another (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
nil = u.tolerance() / 2
v = (1 + nil / u.length()) * u  # Make v slightly different from u
u != v
```

Out[22]: False

In [23]:
```
# Check if a vector is not equal to another (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
not_nil = u.tolerance() * 2
v = (1 + not_nil / u.length()) * u  # Make v different from u
u != v
```

Out[23]: True

In [24]:
```
# Check if a vector is not equal to any of some other vectors (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
nil = u.tolerance() / 2
v = (1 + nil / u.length()) * u  # Make v slightly different from u
w = TCVC(5, 4, 0, -3)
some_vectors = [ v, w ]
u not in some_vectors
```

Out[24]: False

In [25]:
```
# Check if a vector is not equal to any of some other vectors (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
not_nil = u.tolerance() * 2
v = (1 + not_nil / u.length()) * u  # Make v different from u
w = TCVC(5, 4, 0, -3)
some_vectors = [ v, w ]
u not in some_vectors
```

Out[25]: True

In [26]:
```
# Check if a vector has equal length to another (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
v = TCVC(-5, -4, 3, 0)
nil = u.tolerance_with(v) / 2
v *= (1 + nil / u.length())  # Make v slightly longer
u.equal_lengths(v)
```

Out[26]: True

In [27]:
```
# Check if a vector has equal length to another (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
v = TCVC(-5, -4, 3, 0)
not_nil = u.tolerance_with(v) * 2
v *= (1 + not_nil / u.length())  # Make v longer
u.equal_lengths(v)
```

Out[27]: False

In [28]:
```
# Check if a vector is shorter than another vector (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
v = TCVC(-5, -4, 3, 0)
nil = u.tolerance_with(v) / 2
u *= (1 - nil / u.length())  # Make u slightly shorter
u.shorter(v)
```

Out[28]: False

In [29]:
```
# Check if a vector is shorter than another vector (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
v = TCVC(-5, -4, 3, 0)
not_nil = u.tolerance_with(v) * 2
u *= (1 - not_nil / u.length())  # Make u shorter
u.shorter(v)
```

Out[29]: True

In [30]:
```
# Check if a vector is longer than another vector (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
v = TCVC(-5, -4, 3, 0)
nil = u.tolerance_with(v) / 2
u *= (1 + nil / u.length())  # Make u slightly longer
u.longer(v)
```

Out[30]: False

In [31]:
```
# Check if a vector is longer than another vector (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
v = TCVC(-5, -4, 3, 0)
not_nil = u.tolerance_with(v) * 2
u *= (1 + not_nil / u.length())  # Make u longer
u.longer(v)
```

Out[31]: True

In [32]:
```
# Check if a vector is orthogonal to another (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
v = TCVC(0, 0, 0, 0)
nil = TCVC.abs_tol / 2
v.A = nil
u.are_orthogonal(v)
```

Out[32]: True

In [33]:
```
# Check if a vector is orthogonal to another (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
v = TCVC(0, 0, 0, 0)
not_nil = TCVC.abs_tol * 2
v.A = not_nil
u.are_orthogonal(v)
```

Out[33]: False

In [34]:
```
# Check if a vector is orthogonal to another (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
v = TCVC(0, 5, 1, 3)
nil = 1e-12
v.A = nil
u.are_orthogonal(v), (u * 1e9).are_orthogonal(v / 1e9), (u / 1e9).are_orthogonal(v * 1e9)
```

Out[34]: (True, True, True)

In [35]:
```
# Check if a vector is orthogonal to another (within a calculated tolerance)
u = TCVC(4, -3, 0, 5)
v = TCVC(0, 5, 1, 3)
not_nil = 1e-10
v.A = not_nil
u.are_orthogonal(v), (u * 1e9).are_orthogonal(v / 1e9), (u / 1e9).are_orthogonal(v * 1e9)
```

Out[35]: (False, False, False)

In [36]:
```
# Create a vector by rounding the component values in a vector
u = TCVC(-1.000000004, 1.0, 3.999999996, 2.123456789)  #  u.tolerance() = circa 4.7e-9
u.round_components(), u.cround
```

Out[36]:
```
(TCVC(A=-1.0, B=1.0, C=4.0, D=2.12345679),
 TCVC(A=-1.0, B=1.0, C=4.0, D=2.12345679))
```