cbenchmark_vector

June 30, 2023

1 Use of PYBIND11_MAKE_OPAQUE

pybind11 automatically converts `std::vector` into python list. That's convenient but not necessarily efficient depending on how it is used after that. PYBIND11_MAKE_OPAQUE is used to create a capsule to hold a pointer on the C++ object.

[1]:
```
from jyquickhelper import add_notebook_menu
add_notebook_menu()
```

[1]:
```
<IPython.core.display.HTML object>
```

[2]:
```
%matplotlib inline
```

1.1 Two identical classes

Both of then creates random vectors equivalent to `std::vector<Tensor>`, and `Tensor ~ std::vector<float>`. The first one returns a capsule due `PYBIND11_MAKE_OPAQUE(std::vector<OneTensorFloat>)` inserted into the C++ code. The other one is returning a list.

[3]:
```
from cpyquickhelper.examples.vector_container_python import (
    RandomTensorVectorFloat, RandomTensorVectorFloat2)

rnd = RandomTensorVectorFloat(10, 10)
result = rnd.get_tensor_vector()
print(result)
```

```
<cpyquickhelper.examples.vector_container_python.OneTensorVector object at
0x000002B144FB5470>
```

[4]:
```
result_ref = rnd.get_tensor_vector_ref()
print(result_ref)
```

```
<cpyquickhelper.examples.vector_container_python.TensorVectorConstReferencePoint
er object at 0x000002B13BB8DD70>
```

[5]:
```
rnd2 = RandomTensorVectorFloat2(10, 10)
result2 = rnd2.get_tensor_vector()
print(result2)
```

```
[<cpyquickhelper.examples.vector_container_python.OneTensor2 object at
0x000002B144BC4330>, <cpyquickhelper.examples.vector_container_python.OneTensor2
object at 0x000002B144BC2BF0>,
<cpyquickhelper.examples.vector_container_python.OneTensor2 object at
0x000002B144BC2E30>, <cpyquickhelper.examples.vector_container_python.OneTensor2
object at 0x000002B144BC2C30>,
<cpyquickhelper.examples.vector_container_python.OneTensor2 object at
0x000002B144BC2FB0>, <cpyquickhelper.examples.vector_container_python.OneTensor2
object at 0x000002B144BC2970>,
<cpyquickhelper.examples.vector_container_python.OneTensor2 object at
0x000002B144BC26F0>, <cpyquickhelper.examples.vector_container_python.OneTensor2
object at 0x000002B144BC22B0>,
<cpyquickhelper.examples.vector_container_python.OneTensor2 object at
0x000002B144BC21B0>, <cpyquickhelper.examples.vector_container_python.OneTensor2
object at 0x000002B144BC20F0>]
```

[6]:
```
result2_ref = rnd2.get_tensor_vector_ref()
print(result2_ref)
```

```
<cpyquickhelper.examples.vector_container_python.TensorVectorConstReferencePoint
er2 object at 0x000002B144EE0C30>
```

[7]:
```
%timeit rnd.get_tensor_vector()
```

```
3.13 µs ± 60.6 ns per loop (mean ± std. dev. of 7 runs, 100,000 loops each)
```

[8]:
```
%timeit rnd.get_tensor_vector_ref()
```

```
1.21 µs ± 38.4 ns per loop (mean ± std. dev. of 7 runs, 1,000,000 loops each)
```

[9]:
```
%timeit rnd2.get_tensor_vector()
```

```
10.4 µs ± 138 ns per loop (mean ± std. dev. of 7 runs, 100,000 loops each)
```

[10]:
```
%timeit rnd2.get_tensor_vector_ref()
```

```
1.19 µs ± 18.1 ns per loop (mean ± std. dev. of 7 runs, 1,000,000 loops each)
```

1.2 Scenarii

Three possibilities:

- **list**: `std::vector<Tensor>` is converted into a list of copied Tensors
- **capsule**: `std::vector<Tensor>` is converted into a capsule on a copied `std::vector<Tensor>`, the capsule still holds the pointer and is responsible to the deletion.
- **ref**: `std::vector<Tensor>` is just return as a pointer. The cost of getting the pointer does not depend on the content size. It is somehow the low limit.

1.3 Plots

[11]:
```
import itertools
from cpyquickhelper.numbers.speed_measure import measure_time
from tqdm import tqdm
import pandas

data = []
sizes = [1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 5000, 10000]
sizes = list(itertools.product(sizes, sizes))
for i, j in tqdm(sizes):
    if j >= 1000:
        if i > 1000:
            continue
    if i * j >= 1e6:
        repeat, number = 3, 3
    else:
        repeat, number = 10, 10
    rnd = RandomTensorVectorFloat(i, j)
    obs = measure_time(lambda: rnd.get_tensor_vector(), repeat=repeat, number=number,␣
 ↪div_by_number=True)
    obs['name'] = 'capsule'
    obs['n_vectors'] = i
    obs['size'] = j
    data.append(obs)

    rnd2 = RandomTensorVectorFloat2(i, j)
    obs = measure_time(lambda: rnd2.get_tensor_vector(), repeat=repeat, number=number,␣
 ↪div_by_number=True)
    obs['name'] = 'list'
    obs['n_vectors'] = i
    obs['size'] = j
    data.append(obs)

    obs = measure_time(lambda: rnd2.get_tensor_vector_ref(), repeat=repeat,␣
 ↪number=number, div_by_number=True)
    obs['name'] = 'ref'
    obs['n_vectors'] = i
    obs['size'] = j
    data.append(obs)

df = pandas.DataFrame(data)
df.tail()
```

```
100%|¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿␣
 ↪¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿ ¿
¿ ¿ ¿ ¿ ¿ | 144/144 [00:19<00:00,  7.43it/s]
```

[11]:

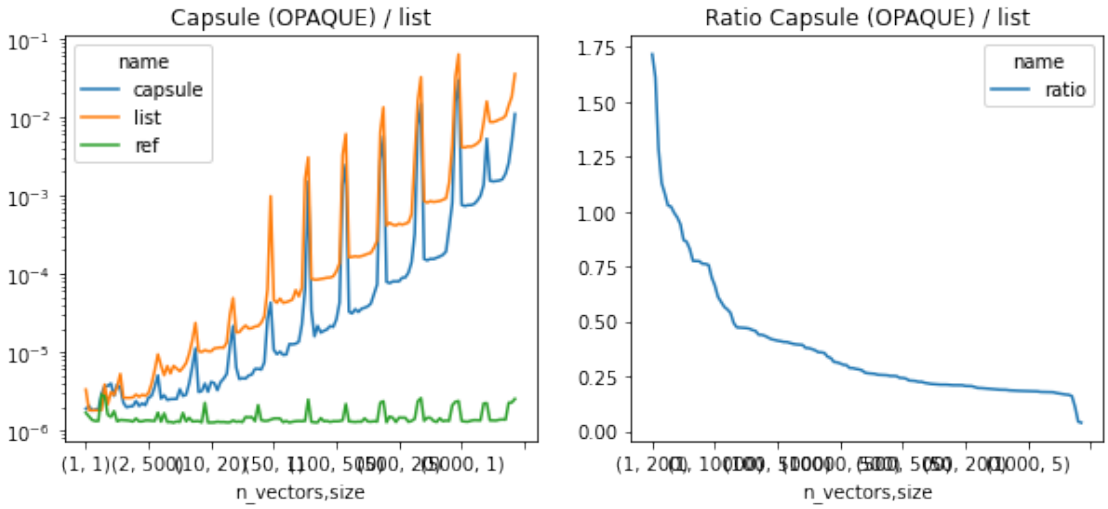
	average	deviation	min_exec	max_exec	repeat	number	ttime	\
409	0.018321	0.000367	0.018026	0.018838	3	3	0.054962	
410	0.000002	0.000001	0.000001	0.000004	3	3	0.000007	
411	0.010974	0.000492	0.010512	0.011656	3	3	0.032923	
412	0.035484	0.000900	0.034286	0.036456	3	3	0.106451	
413	0.000003	0.000002	0.000001	0.000005	3	3	0.000008	

```
     context_size     name  n_vectors  size
409            64     list      10000   200
410            64      ref      10000   200
411            64  capsule      10000   500
412            64     list      10000   500
413            64      ref      10000   500
```

[12]:
```
piv = pandas.pivot_table(df, index=['n_vectors', 'size'], columns=['name'],␣
  ↪values='average')
piv['ratio'] = piv['capsule'] / piv['list']
piv.tail()
```

[12]:
```
name                 capsule      list       ref     ratio
n_vectors size
10000     20    0.001611  0.009616  0.000001  0.167512
          50    0.001892  0.010399  0.000001  0.181907
          100   0.002597  0.014054  0.000002  0.184789
          200   0.004847  0.018321  0.000002  0.264565
          500   0.010974  0.035484  0.000003  0.309278
```

[13]:
```
import matplotlib.pyplot as plt
fig, ax = plt.subplots(1, 2, figsize=(10, 4))
piv[['capsule', 'list', 'ref']].plot(logy=True, ax=ax[0], title='Capsule (OPAQUE) /␣
  ↪list')
piv.sort_values('ratio', ascending=False)[['ratio']].plot(ax=ax[1], title='Ratio␣
  ↪Capsule (OPAQUE) / list');
```



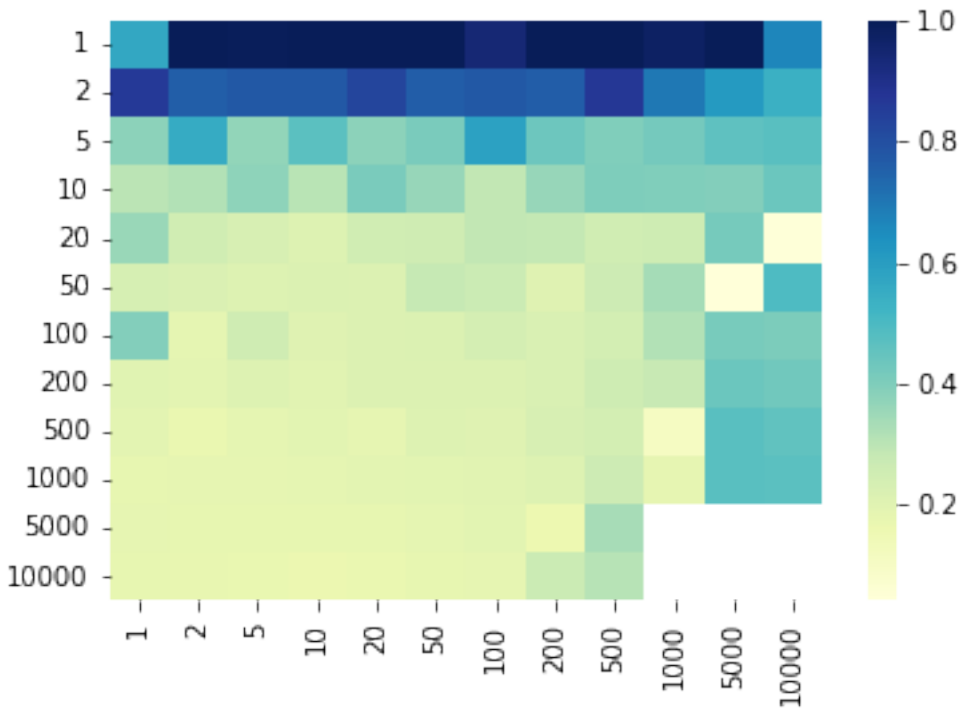
[14]:
```
flat = piv.reset_index(drop=False)[['n_vectors', 'size', 'ratio']]
flat_piv = flat.pivot('n_vectors', 'size', 'ratio')
flat_piv
```

[14]:
```
size             1         2         5         10        20        50      \
n_vectors
1          0.566917  1.130723  0.995022  1.023320  1.028793  1.612390
```

```
2          0.862783  0.757669  0.775862  0.775123  0.829735  0.763393
5          0.379608  0.555293  0.368967  0.470159  0.378897  0.410572
10         0.301479  0.316046  0.374528  0.303198  0.407169  0.359681
20         0.356484  0.251247  0.230067  0.210293  0.252366  0.255456
50         0.231620  0.220888  0.210009  0.216061  0.214163  0.282138
100        0.394659  0.189204  0.256503  0.206615  0.214958  0.218592
200        0.201795  0.189723  0.211110  0.197427  0.212577  0.212658
500        0.189678  0.169699  0.188959  0.193446  0.184101  0.209909
1000       0.181940  0.183248  0.183335  0.186856  0.191277  0.195801
5000       0.183440  0.179145  0.178354  0.179633  0.178630  0.185844
10000      0.178259  0.174690  0.172229  0.166271  0.167512  0.181907

size          100       200       500       1000      5000      10000
n_vectors
1          0.943035  1.717130  1.284653  0.973898  1.083473  0.663566
2          0.776532  0.762319  0.871343  0.699622  0.612026  0.539308
5          0.589214  0.434686  0.395905  0.419958  0.461235  0.473515
10         0.288451  0.360526  0.402298  0.398315  0.393545  0.439519
20         0.288205  0.284486  0.252392  0.257864  0.416393  0.043764
50         0.266862  0.206823  0.263674  0.339590  0.039424  0.493669
100        0.240267  0.225569  0.243605  0.314168  0.412960  0.406809
200        0.212798  0.225500  0.257274  0.277588  0.439891  0.427631
500        0.205913  0.229271  0.243023  0.110660  0.472577  0.456907
1000       0.197123  0.209983  0.262004  0.184530  0.471995  0.467629
5000       0.194558  0.160261  0.334000       NaN       NaN       NaN
10000      0.184789  0.264565  0.309278       NaN       NaN       NaN
```

[15]:
```
import numpy
import seaborn
seaborn.heatmap(numpy.minimum(flat_piv.values, 1), cmap="YlGnBu",
                xticklabels=list(flat_piv.index), yticklabels=list(flat_piv.columns));
```



[16]:

[17]: