A) number of objectives = 2, number of variables = 10, pareto front = degenerate, algorithm = RVEA

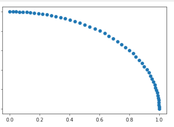
In [ ]:
```
from desdeo_problem.testproblems.TestProblems import test_problem_builder
from desdeo_emo.EAs.RVEA import RVEA
from desdeo_emo.EAs.NSGAIII import NSGAIII
import matplotlib.pyplot as plt
import desdeo_tools.utilities.quality_indicator as indicator
from scipy.stats import gmc
```

In [ ]:
```
dtlz5 = test_problem_builder("DTLZ5", n_of_objectives= 2, n_of_variables=10)
evolver = RVEA(dtlz5, n_gen_per_iter=100, n_iterations=10)
while evolver.continue_evolution():
    evolver.iterate()
```

In [ ]:
```
objs= evolver.population.objectives
```

I'dont understand what this "objs[:,0], objs[:,1]" means

In [ ]:
```
plt.scatter(objs[:,0], objs[:,1])
plt.show()
```



In [ ]:
```
hv = indicator.hypervolume_indicator(objs, [1.1, 1.1])
print(hv)
```

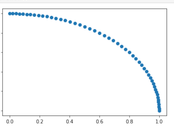
```
0.41382417568502994
```

B) number of objectives = 2, number of variables = 10, pareto front = degenerate, algorithm = NSGA-III

In [ ]:
```
dtlz5 = test_problem_builder("DTLZ5", n_of_objectives= 2, n_of_variables=10)
evolver = NSGAIII(dtlz5, n_gen_per_iter=100, n_iterations=10)
while evolver.continue_evolution():
    evolver.iterate()
```

In [ ]:
```
objs= evolver.population.objectives
```

In [ ]:
```
plt.scatter(objs[:,0], objs[:,1])
plt.show()
```



In [ ]:
```
hv = indicator.hypervolume_indicator(objs, [1.1, 1.1])
print(hv)
```

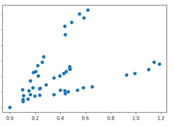
```
0.41553563199092264
```

C) number of objectives = 5, number of variables = 10, pareto front = degenerate, algorithm = RVEA

In [ ]:
```
dtlz5 = test_problem_builder("DTLZ5", n_of_objectives= 5, n_of_variables=10)
evolver = RVEA(dtlz5, n_gen_per_iter=100, n_iterations=10)
while evolver.continue_evolution():
    evolver.iterate()
```

In [ ]:
```
objs= evolver.population.objectives
```

In [ ]:
```
plt.scatter(objs[:,0], objs[:,1])
plt.show()
```



In [ ]:
```
hv = indicator.hypervolume_indicator(objs, [1.1, 1.1, 1.1, 1.1, 1.1])
print(hv)
```

```
0.2985849759100363
```

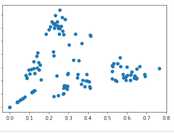
D) number of objectives = 5, number of variables = 10, pareto front = degenerate, algorithm = NSGA-III

In [ ]:
```
dtlz5 = test_problem_builder("DTLZ5", n_of_objectives= 5, n_of_variables=10)
evolver = NSGAIII(dtlz5, n_gen_per_iter=100, n_iterations=10)
while evolver.continue_evolution():
    evolver.iterate()
```

```
/Users/eerolantto/Documents/JYU/venvironment/lib/python3.8/site-packages/desdeo_emo/selection/NSGAIII_select.py:166: RuntimeWarning:

divide by zero encountered in true_divide

/Users/eerolantto/Documents/JYU/venvironment/lib/python3.8/site-packages/desdeo_emo/selection/NSGAIII_select.py:166: RuntimeWarning:

divide by zero encountered in true_divide
```

In [ ]:
```
objs= evolver.population.objectives
```

In [ ]:
```
plt.scatter(objs[:,0], objs[:,1])
plt.show()
```



In [ ]:
```
hv = indicator.hypervolume_indicator(objs, [1.1, 1.1, 1.1, 1.1, 1.1])
print(hv)
```

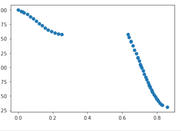
```
0.3772995378492706
```

E) number of objectives = 2, number of variables = 10, pareto front = disconnected, algorithm = NSGA-III

In [ ]:
```
dtlz7 = test_problem_builder("DTLZ7", n_of_objectives= 2, n_of_variables=10)
evolver = NSGAIII(dtlz7, n_gen_per_iter=100, n_iterations=10)
while evolver.continue_evolution():
    evolver.iterate()
```

In [ ]:
```
objs= evolver.population.objectives
```

In [ ]:
```
plt.scatter(objs[:,0], objs[:,1])
plt.show()
```



In [ ]:
```
hv = indicator.hypervolume_indicator(objs, [1.1, 1.1])
print(hv)
```

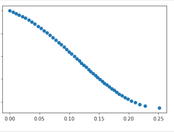
```
0.0
```

F) number of objectives = 2, number of variables = 10, pareto front = disconnected, algorithm = RVEA

In [ ]:
```
dtlz7 = test_problem_builder("DTLZ7", n_of_objectives= 2, n_of_variables=10)
evolver = RVEA(dtlz7, n_gen_per_iter=100, n_iterations=10)
while evolver.continue_evolution():
    evolver.iterate()
```

In [ ]:
```
objs= evolver.population.objectives
```

In [ ]:
```
plt.scatter(objs[:,0], objs[:,1])
plt.show()
```



In [ ]:
```
hv = indicator.hypervolume_indicator(objs, [1.1, 1.1])
print(hv)
```

```
0.0
```

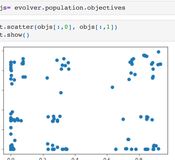
G) number of objectives = 5, number of variables = 10, pareto front = disconnected, algorithm = NSGA-III

In [ ]:
```
dtlz7 = test_problem_builder("DTLZ7", n_of_objectives= 5, n_of_variables=10)
evolver = NSGAIII(dtlz7, n_gen_per_iter=100, n_iterations=10)
while evolver.continue_evolution():
    evolver.iterate()
```

```
/Users/eerolantto/Documents/JYU/venvironment/lib/python3.8/site-packages/desdeo_emo/selection/NSGAIII_select.py:166: RuntimeWarning:

divide by zero encountered in true_divide
```

In [ ]:
```
objs= evolver.population.objectives
```

In [ ]:
```
plt.scatter(objs[:,0], objs[:,1])
plt.show()
```



In [ ]:
```
hv = indicator.hypervolume_indicator(objs, [1.1, 1.1, 1.1, 1.1, 1.1])
print(hv)
```

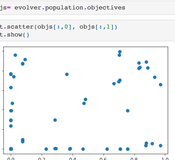
```
0.0
```

H) number of objectives = 5, number of variables = 10, pareto front = disconnected, algorithm = RVEA

In [ ]:
```
dtlz7 = test_problem_builder("DTLZ7", n_of_objectives= 5, n_of_variables=10)
evolver = RVEA(dtlz7, n_gen_per_iter=100, n_iterations=10)
while evolver.continue_evolution():
    evolver.iterate()
```

In [ ]:
```
objs= evolver.population.objectives
```

In [ ]:
```
plt.scatter(objs[:,0], objs[:,1])
plt.show()
```



In [ ]:
```
hv = indicator.hypervolume_indicator(objs, [1.1, 1.1, 1.1, 1.1, 1.1])
print(hv)
```

```
0.0
```

Pareto front type	Objectives (K)	Decision variables (n)	Hypervolume	
			RVEA	NSGA-III
Degenerate	2	10	0.4151825793	0.4155356319
Degenerate	5	10	0.2985849759	0.3772995378
Disconnected	2	10	0	0
Disconnected	5	10	0	0