Screenshot of `kubectl get nodes`

```
student@ds-student20:~/NTHU-Scheduler-Plugin$ kubectl get nodes
NAME                STATUS   ROLES           AGE   VERSION
kind-control-plane  Ready    control-plane   26d   v1.29.2
kind-worker         Ready    <none>          26d   v1.29.2
kind-worker2        Ready    <none>          26d   v1.29.2
```

Screenshot of passing unit tests

```
go: downloading k8s.io/cloud-provider v0.27.1
go: downloading k8s.io/dynamic-resource-allocation v0.27.1
go: downloading k8s.io/csi-translation-lib v0.27.1
go: downloading github.com/josharian/intern v1.0.0
go: downloading github.com/go-logr/stdr v1.2.2
go: downloading github.com/asaskevich/govalidator v0.0.0-20190424111038-f61b66f89f4a
go: downloading github.com/mitchellh/mapstructure v1.4.1
go: downloading go.etcd.io/etcd/api/v3 v3.5.7
go: downloading github.com/cenkalti/backoff/v4 v4.1.3
go: downloading go.uber.org/atomic v1.7.0
go: downloading go.uber.org/multierr v1.6.0
go: downloading github.com/antlr/antlr4/runtime/Go/antlr v1.4.10
go: downloading github.com/grpc-ecosystem/grpc-gateway/v2 v2.7.0
go: downloading github.com/docker/distribution v2.8.1+incompatible
go: downloading k8s.io/controller-manager v0.27.1
go: downloading github.com/opencontainers/selinux v1.10.0
go: downloading k8s.io/mount-utils v0.27.1
go: downloading github.com/coreos/go-semver v0.3.0
go: downloading github.com/opencontainers/go-digest v1.0.0
go: downloading github.com/moby/sys/mountinfo v0.6.2
root@c2e0a8c109a0:/go/src/app# go test -v ./...
?       my-scheduler-plugins/cmd/scheduler      [no test files]
=== RUN   TestCustomScheduler_PreFilter
=== RUN   TestCustomScheduler_PreFilter/pod_is_accepted
finish adding2024/05/28 08:06:35 Pod  is in Prefilter phase.
=== RUN   TestCustomScheduler_PreFilter/pod_is_just_accepted
finish adding2024/05/28 08:06:35 Pod  is in Prefilter phase.
=== RUN   TestCustomScheduler_PreFilter/pod_is_rejected
finish adding2024/05/28 08:06:35 Pod  is in Prefilter phase.
--- PASS: TestCustomScheduler_PreFilter (0.01s)
    --- PASS: TestCustomScheduler_PreFilter/pod_is_accepted (0.01s)
    --- PASS: TestCustomScheduler_PreFilter/pod_is_just_accepted (0.00s)
    --- PASS: TestCustomScheduler_PreFilter/pod_is_rejected (0.00s)
=== RUN   TestCustomScheduler_Score
=== RUN   TestCustomScheduler_Score/least_mode
2024/05/28 08:06:35 Custom scheduler runs with the mode: Least.
2024/05/28 08:06:35 Pod  is in Score phase. Calculate the score of Node m1.
2024/05/28 08:06:35 Pod  is in Score phase. Calculate the score of Node m2.
=== RUN   TestCustomScheduler_Score/most_mode
2024/05/28 08:06:35 Custom scheduler runs with the mode: Least.
2024/05/28 08:06:35 Pod  is in Score phase. Calculate the score of Node m1.
2024/05/28 08:06:35 Pod  is in Score phase. Calculate the score of Node m2.
--- PASS: TestCustomScheduler_Score (0.00s)
    --- PASS: TestCustomScheduler_Score/least_mode (0.00s)
    --- PASS: TestCustomScheduler_Score/most_mode (0.00s)
=== RUN   TestCustomScheduler_NormalizeScore
=== RUN   TestCustomScheduler_NormalizeScore/scores_in_range
=== RUN   TestCustomScheduler_NormalizeScore/scores_out_of_range
=== RUN   TestCustomScheduler_NormalizeScore/negative_score
--- PASS: TestCustomScheduler_NormalizeScore (0.00s)
    --- PASS: TestCustomScheduler_NormalizeScore/scores_in_range (0.00s)
    --- PASS: TestCustomScheduler_NormalizeScore/scores_out_of_range (0.00s)
    --- PASS: TestCustomScheduler_NormalizeScore/negative_score (0.00s)
PASS
ok      my-scheduler-plugins/pkg/plugins        0.162s
root@c2e0a8c109a0:/go/src/app#
```

Node resources

```
Addresses:
  InternalIP:  172.19.0.2
  Hostname:    kind-worker
Capacity:
  cpu:                  6
  ephemeral-storage:    50620216Ki
  hugepages-2Mi:        0
  memory:               6063048Ki
  pods:                 110
Allocatable:
  cpu:                  6
  ephemeral-storage:    50620216Ki
  hugepages-2Mi:        0
  memory:               1344456Ki
  pods:                 110
```

```
Addresses:
  InternalIP:  172.19.0.4
  Hostname:    kind-worker2
Capacity:
  cpu:                  6
  ephemeral-storage:    50620216Ki
  hugepages-2Mi:        0
  memory:               6063048Ki
  pods:                 110
Allocatable:
  cpu:                  6
  ephemeral-storage:    50620216Ki
  hugepages-2Mi:        0
  memory:               1868744Ki
  pods:                 110
```

5 scenarios

1. pod–spec1.yaml with Least mode

```
1    apiVersion: v1
2    kind: Pod
3    metadata:
4      name: nginx
5      labels:
6        podGroup: "A"
7        minAvailable: "2"
8    spec:
9      schedulerName: my-scheduler
10     containers:
11     - name: nginx
12       image: nginx:1.14.2
13       ports:
14       - containerPort: 80
15       resources:
16         requests:
17           memory: "100Mi"
18         limits:
19           memory: "100Mi"
```

```
student@ds-student20:~/NTHU-Scheduler-Plugin$ kubectl get po -o wide
NAME                             READY   STATUS      RESTARTS      AGE     IP           NODE           NOMINATED NODE   READINESS GATES
mnist-inference-599dc8b56-ftlbq  1/1     Running     1 (18d ago)   25d     10.244.1.2   kind-worker    <none>           <none>
mnist-inference-599dc8b56-sfqx5  1/1     Running     1 (18d ago)   25d     10.244.2.3   kind-worker2   <none>           <none>
mnist-train                      0/1     Completed   0             25d     <none>       kind-worker2   <none>           <none>
my-scheduler-69cfc986c7-6692c    1/1     Running     0             8m29s   10.244.2.5   kind-worker2   <none>           <none>
nginx                            0/1     Pending     0             3m33s   <none>       <none>         <none>           <none>
```

```
I0528 12:11:44.953921     1 log.go:194] Pod nginx is in Prefilter phase.
I0528 12:11:44.960534     1 schedule_one.go:867] "Unable to schedule pod; no fit; waiting" pod="default/nginx" err="0/3 nodes are available: preemption: 0/3 nodes are available: 3 No preemption victi
ms found for incoming pod.."
```

★因為minAvailable改成2，所以只創一個pod的情況下會過不了prefilter

2. pod-spec2.yaml with Least mode

```yaml
1   apiVersion: v1
2   kind: Pod
3   metadata:
4     name: nginx
5     labels:
6       podGroup: "A"
7       minAvailable: "2"
8   spec:
9     schedulerName: my-scheduler
10    containers:
11    - name: nginx
12      image: nginx:1.14.2
13      ports:
14      - containerPort: 80
15      resources:
16        requests:
17          memory: "100Mi"
18        limits:
19          memory: "100Mi"
20  ---
21  apiVersion: v1
22  kind: Pod
23  metadata:
24    name: nginx2
25    labels:
26      podGroup: "A"
27      minAvailable: "2"
28  spec:
29    schedulerName: my-scheduler
30    containers:
31    - name: nginx2
32      image: nginx:1.14.2
33      ports:
34      - containerPort: 80
35      resources:
36        requests:
37          memory: "100Mi"
38        limits:
39          memory: "100Mi"
40
```

```
student@ds-student20:~/NTHU-Scheduler-Plugin$ kubectl delete po nginx
pod "nginx" deleted
student@ds-student20:~/NTHU-Scheduler-Plugin$ kubectl create -f pod-spec1-2.yaml
pod/nginx created
pod/nginx2 created
```

```
student@ds-student20:~/NTHU-Scheduler-Plugin$ kubectl get po -o wide
NAME                              READY   STATUS      RESTARTS      AGE   IP           NODE          NOMINATED NODE   READINESS GATES
mnist-inference-599dc8b56-ftlbq   1/1     Running     1 (18d ago)   25d   10.244.1.2   kind-worker   <none>           <none>
mnist-inference-599dc8b56-sfqx5   1/1     Running     1 (18d ago)   25d   10.244.2.3   kind-worker2  <none>           <none>
mnist-train                       0/1     Completed   0             25d   <none>       kind-worker2  <none>           <none>
my-scheduler-69cfc986c7-6692c     1/1     Running     0             34m   10.244.2.5   kind-worker2  <none>           <none>
nginx                             1/1     Running     0             19m   10.244.1.5   kind-worker   <none>           <none>
nginx2                            1/1     Running     0             19m   10.244.1.4   kind-worker   <none>           <none>
```

★因為kind-worker的memory比kind-worker的memory小,所以在Least mode底下會優先選擇 kind-worker

3. pod–spec2.yaml with Most mode

```
▶ student@ds-student20:~/NTHU-Scheduler-Plugin$ kubectl get po -o wide
NAME                              READY   STATUS      RESTARTS      AGE    IP           NODE          NOMINATED NODE   READINESS GATES
mnist-inference-599dc8b56-ftlbq   1/1     Running     1 (18d ago)   25d    10.244.1.2   kind-worker   <none>           <none>
mnist-inference-599dc8b56-sfqx5   1/1     Running     1 (18d ago)   25d    10.244.2.3   kind-worker2  <none>           <none>
mnist-train                       0/1     Completed   0             26d    <none>       kind-worker2  <none>           <none>
my-scheduler-69cfc986c7-zhx6g     1/1     Running     0             7m8s   10.244.2.6   kind-worker2  <none>           <none>
nginx                             1/1     Running     0             5m34s  10.244.2.8   kind-worker2  <none>           <none>
nginx2                            1/1     Running     0             5m34s  10.244.2.7   kind-worker2  <none>           <none>
```

```
I0528 11:56:14.674825       1 log.go:194] Pod nginx2 is in Prefilter phase.
I0528 11:56:14.675817       1 log.go:194] Pod nginx2 is in Score phase. Calculate the score of Node kind-worker.
I0528 11:56:14.675840       1 log.go:194] Pod nginx2 is in Score phase. Calculate the score of Node kind-worker2.
I0528 11:56:14.724823       1 schedule_one.go:252] "Successfully bound pod to node" pod="default/nginx2" node="kind-worker2" evaluatedNodes=3 feasibleNodes=2
I0528 12:01:16.987000       1 log.go:194] Pod nginx is in Prefilter phase.
I0528 12:01:16.988044       1 log.go:194] Pod nginx is in Score phase. Calculate the score of Node kind-worker2.
I0528 12:01:16.988089       1 log.go:194] Pod nginx is in Score phase. Calculate the score of Node kind-worker.
I0528 12:01:17.005471       1 schedule_one.go:252] "Successfully bound pod to node" pod="default/nginx" node="kind-worker2" evaluatedNodes=3 feasibleNodes=2
```

★因為kind–worker2的memory比kind–worker的memory大，所以在Most mode底下會優先選擇 kind–worker2

4. pod–spec2.yaml with Least mode and one additional replication for scheduler

```
I0528 12:26:11.306663       1 log.go:194] Pod nginx2 is in Prefilter phase.
I0528 12:26:11.307994       1 log.go:194] Pod nginx2 is in Score phase. Calculate the score of Node kind-worker2.
I0528 12:26:11.308047       1 log.go:194] Pod nginx2 is in Score phase. Calculate the score of Node kind-worker.
I0528 12:26:11.327029       1 schedule_one.go:252] "Successfully bound pod to node" pod="default/nginx2" node="kind-worker" evaluatedNodes=3 feasibleNodes=2
```

其中一個scheduler先把nginx2指定給kind–worker

```
I0528 12:26:11.308244       1 log.go:194] Pod nginx2 is in Prefilter phase.
I0528 12:26:11.310667       1 log.go:194] Pod nginx2 is in Score phase. Calculate the score of Node kind-worker2.
I0528 12:26:11.310958       1 log.go:194] Pod nginx2 is in Score phase. Calculate the score of Node kind-worker.
E0528 12:26:11.354469       1 framework.go:1100] "Failed running Bind plugin" err="Operation cannot be fulfilled on pods/binding \"nginx2\": pod nginx2 is already assigned to node \"kind-worker\"" plugin="DefaultBinder" pod="default/nginx2" node="kind-worker"
I0528 12:26:11.354541       1 schedule_one.go:827] "Failed to bind pod" pod="default/nginx2"
E0528 12:26:11.354571       1 schedule_one.go:283] "scheduler cache ForgetPod failed" err="pod 22593e4e-b46d-46dd-9659-892b78693d72(default/nginx2) wasn't assumed so cannot be forgotten"
E0528 12:26:11.354617       1 schedule_one.go:883] "Error scheduling pod; retrying" err="running Bind plugin \"DefaultBinder\": Operation cannot be fulfilled on pods/binding \"nginx2\": pod nginx2 is already assigned to node \"kind-worker\"" pod="default/nginx2"
I0528 12:26:11.354654       1 schedule_one.go:895] "Pod has been assigned to node. Abort adding it back to queue." pod="default/nginx2" node="kind-worker"
I0528 12:31:38.178019       1 log.go:194] Pod nginx is in Prefilter phase.
I0528 12:31:38.178709       1 log.go:194] Pod nginx is in Score phase. Calculate the score of Node kind-worker.
I0528 12:31:38.178753       1 log.go:194] Pod nginx is in Score phase. Calculate the score of Node kind-worker2.
I0528 12:31:38.225744       1 schedule_one.go:252] "Successfully bound pod to node" pod="default/nginx" node="kind-worker" evaluatedNodes=3 feasibleNodes=2
```

另一個scheduler再把nginx2拿來指定給kind–worker時發現已經指定過了，所以出現error。
之後再把nginx指定給kind–worker。

5. pod-spec2.yaml with Least mode with request memory and limit memory exceed node allocable memory

```yaml
1   apiVersion: v1
2   kind: Pod
3   metadata:
4     name: nginx
5     labels:
6       podGroup: "A"
7       minAvailable: "2"
8   spec:
9     schedulerName: my-scheduler
10    containers:
11    - name: nginx
12      image: nginx:1.14.2
13      ports:
14      - containerPort: 80
15      resources:
16        requests:
17          memory: "2000Mi"
18        limits:
19          memory: "2000Mi"
20  ---
21  apiVersion: v1
22  kind: Pod
23  metadata:
24    name: nginx2
25    labels:
26      podGroup: "A"
27      minAvailable: "2"
28  spec:
29    schedulerName: my-scheduler
30    containers:
31    - name: nginx2
32      image: nginx:1.14.2
33      ports:
34      - containerPort: 80
35      resources:
36        requests:
37          memory: "2000Mi"
38        limits:
39          memory: "2000Mi"
40
```

```
I0528 12:58:21.387727       1 log.go:194] Pod nginx2 is in Prefilter phase.
I0528 12:58:21.388130       1 schedule_one.go:867] "Unable to schedule pod; no fit; waiting" pod="default/nginx2" err="0/3 nodes are available: 1 node(s) had untolerated taint {node-role.kubernetes.io/
control-plane: }, 2 Insufficient memory. preemption: 0/3 nodes are available: 1 Preemption is not helpful for scheduling, 2 No preemption victims found for incoming pod.."
student@ds-student20:~/NTHU-Scheduler-Plugin$ kubectl get po -o wide
NAME                              READY   STATUS      RESTARTS      AGE   IP           NODE          NOMINATED NODE   READINESS GATES
mnist-inference-599dc8b56-ftlbq   1/1     Running     1 (18d ago)   26d   10.244.1.2   kind-worker   <none>           <none>
mnist-inference-599dc8b56-sfqx5   1/1     Running     1 (18d ago)   26d   10.244.2.3   kind-worker2  <none>           <none>
mnist-train                       0/1     Completed   0             26d   <none>       kind-worker2  <none>           <none>
my-scheduler-69cfc986c7-v86pm     1/1     Running     0             97s   10.244.2.11  kind-worker2  <none>           <none>
nginx                             0/1     Pending     0             33s   <none>       <none>        <none>           <none>
nginx2                            0/1     Pending     0             33s   <none>       <none>        <none>           <none>
```

★pod的request memory超過node的allocable memory會無法配置