

Higgs to ss study

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task

- add all 2f BG
- Try multiclass BDT classification. (5 class $\nu\nu H$)
- multiclass BDT classification. ($\mu\mu H$)

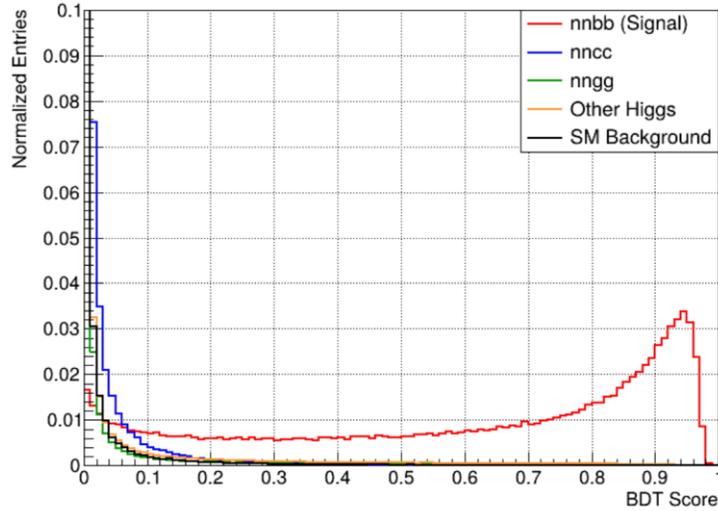
multi-class BDT (vvH)

```
[dataset] : Added class "class_BG"
Add Tree Tree of type class_BG with 19999492 events
[dataset] : Added class "class_bb"
Add Tree Tree of type class_bb with 374896 events
[dataset] : Added class "class_cc"
Add Tree Tree of type class_cc with 375299 events
[dataset] : Added class "class_gg"
Add Tree Tree of type class_gg with 376095 events
[dataset] : Added class "class_other"
Add Tree Tree of type class_other with 3382272 events
Dataset[dataset] : Class index : 0 name : class_BG
Dataset[dataset] : Class index : 1 name : class_bb
Dataset[dataset] : Class index : 2 name : class_cc
Dataset[dataset] : Class index : 3 name : class_gg
Dataset[dataset] : Class index : 4 name : class_other
```

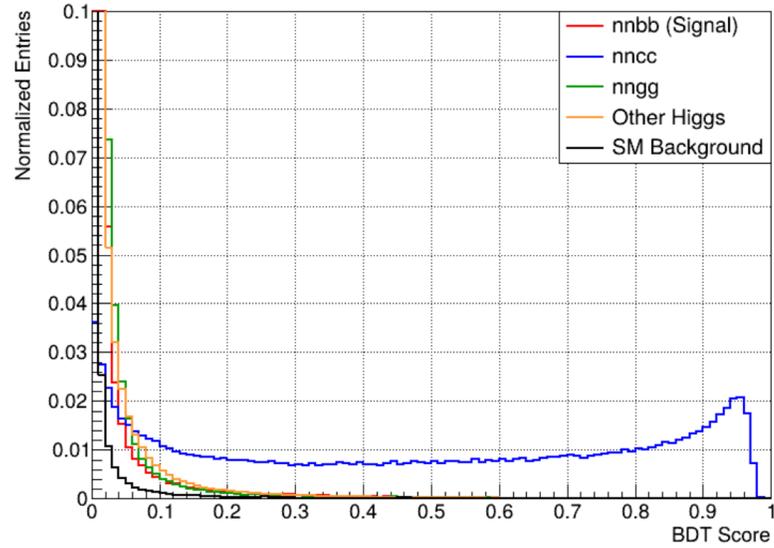
- class_bb is $vvbb$, class_cc is $vvcc$, class_gg is $vvgg$, class_other is $vvss$, $vvWW$, $vvZZ$, $vv\tau\tau$, class_BG is 2f and 4f events other than Higgs
- Increased the statistics for 2f_hadronic.

multi-class BDT Score Distribution

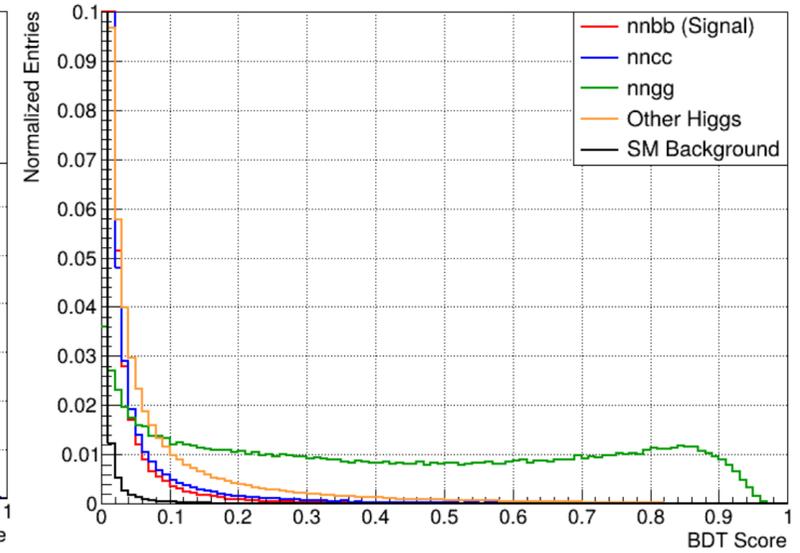
Score Distribution: class_bb



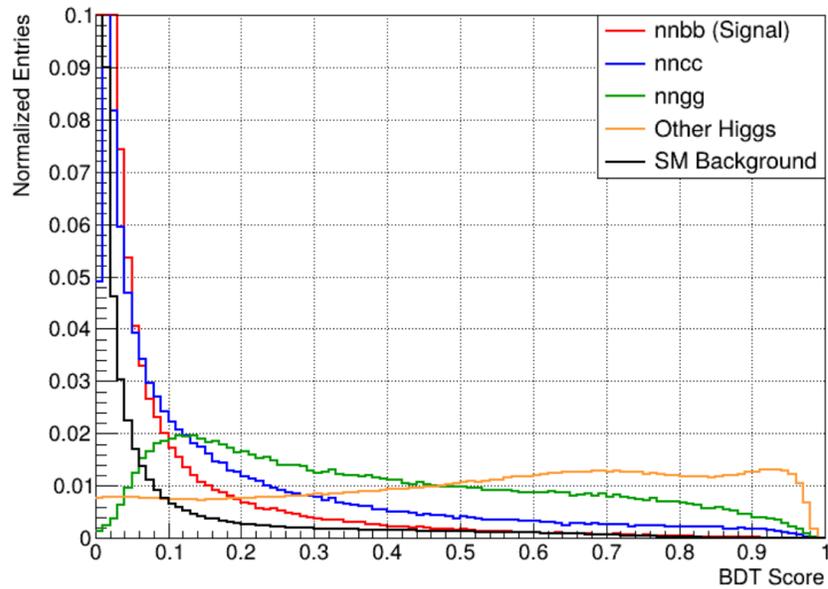
Score Distribution: class_cc



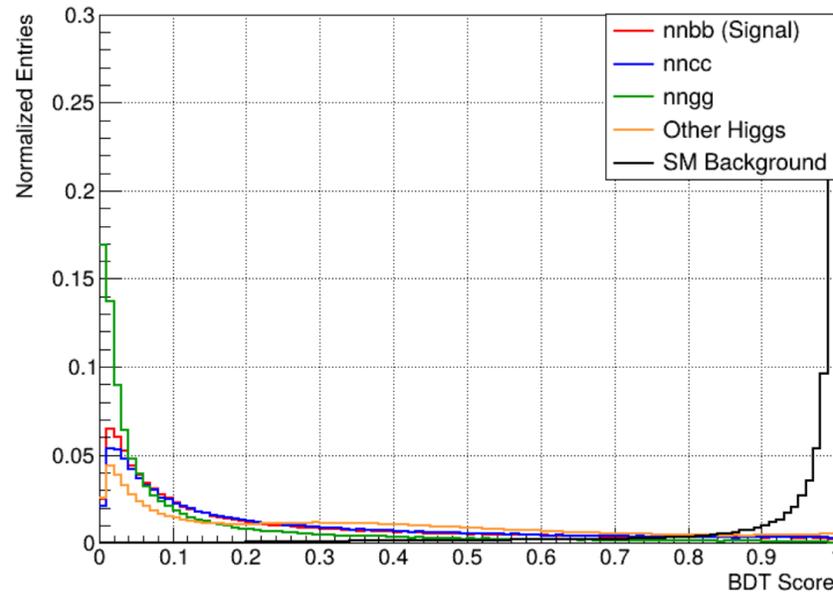
Score Distribution: class_gg



Score Distribution: class_other



Score Distribution: class_BG



bb, cc, and gg are all uniformly distributed from 0 to 0.7.

Result (5-class)

b did not show a significant decrease in significance.

However, c and g showed a substantial decrease in significance.

2 Class BDT (Before)

vvbb_eLpR

```
=====
Max Significance : 135.497
Best BDT Cut    : 0.125
=====
```

vvcc_eLpR

```
=====
Max Significance : 14.467
Best BDT Cut    : 0.225
=====
```

vvgg_eLpR

```
=====
Max Significance : 40.1862
Best BDT Cut    : 0.185
=====
```

MultiClass BDT (After)

vvbb_eLpR

```
=====
Max Significance : 133.193
Best BDT Cut    : 0.395
=====
```

vvcc_eLpR

```
=====
Max Significance : 11.6694
Best BDT Cut    : 0.75
=====
```

vvgg_eLpR

```
=====
Max Significance : 36.5132
Best BDT Cut    : 0.455
=====
```

Cut Table

The efficiencies were 67% for bb, 28% for cc, and 45% for gg.
The number of events was lowest for cc.

vvbb_eLpR

```
-----  
cut: BDTG.class_bb>0.395  
signal: 26608.4, bg: 13301.3  
| 2fZ          7603.6  
| mixhad       0  
| mixlep      50.7151  
| 4fwwhad     0  
| 4fwwsemilep 237.104  
| 4fzzhad     5.91338  
| 4fzzsemilep 5250.13  
| htautau     0.765502  
| hww         2.04423  
| hzz         90.223  
| nss         0.00275736  
| ncc         7.99493  
| nngg        52.8269  
efficiency    : 0.674315  
Significance  : 133.193
```

vvcc_eLpR

```
-----  
cut: BDTG.class_cc>0.75  
signal: 540.84, bg: 1607.19  
| 2fZ          702.161  
| mixhad       0  
| mixlep      36.1438  
| 4fwwhad     0  
| 4fwwsemilep 237.213  
| 4fzzhad     0  
| 4fzzsemilep 600.577  
| htautau     0.809542  
| hww         3.09015  
| hzz         3.68903  
| nss         0.00290069  
| nbb         19.1733  
| nngg        4.33111  
efficiency    : 0.27916  
Significance  : 11.6694
```

vvgg_eLpR

```
-----  
cut: BDTG.class_gg>0.455  
signal: 2386.18, bg: 1884.58  
| 2fZ          145.559  
| mixhad       0  
| mixlep      0.20523  
| 4fwwhad     0  
| 4fwwsemilep 672.012  
| 4fzzhad     0  
| 4fzzsemilep 804.228  
| htautau     0  
| hww         136.665  
| hzz         23.2884  
| nss         0.978153  
| nbb         87.0402  
| ncc         14.6023  
efficiency    : 0.450399  
Significance  : 36.5132
```

Next

- Combine the scores from class_bb, class_cc, class_gg, class_other, and class_BG to perform the cut. Does this increase the significance

Result $\mu\mu H$ (5-class)

2 Class BDT (Before)

$\mu\mu bb_eLpR$

```
=====  
Max Significance : 61.8978  
Best BDT Cut   : 0.12  
=====
```

$\mu\mu cc_eLpR$

```
=====  
Max Significance : 7.14474  
Best BDT Cut   : 0.115  
=====
```

$\mu\mu gg_eLpR$

```
=====  
Max Significance : 16.4132  
Best BDT Cut   : 0.1  
=====
```

MultiClass BDT (After)

$\mu\mu bb_eLpR$

```
=====  
Max Significance : 57.4337  
Best BDT Cut   : 0.165  
=====
```

$\mu\mu cc_eLpR$

```
=====  
Max Significance : 4.81823  
Best BDT Cut   : 0.245  
=====
```

$\mu\mu gg_eLpR$

```
=====  
Max Significance : 13.7264  
Best BDT Cut   : 0.245  
=====
```