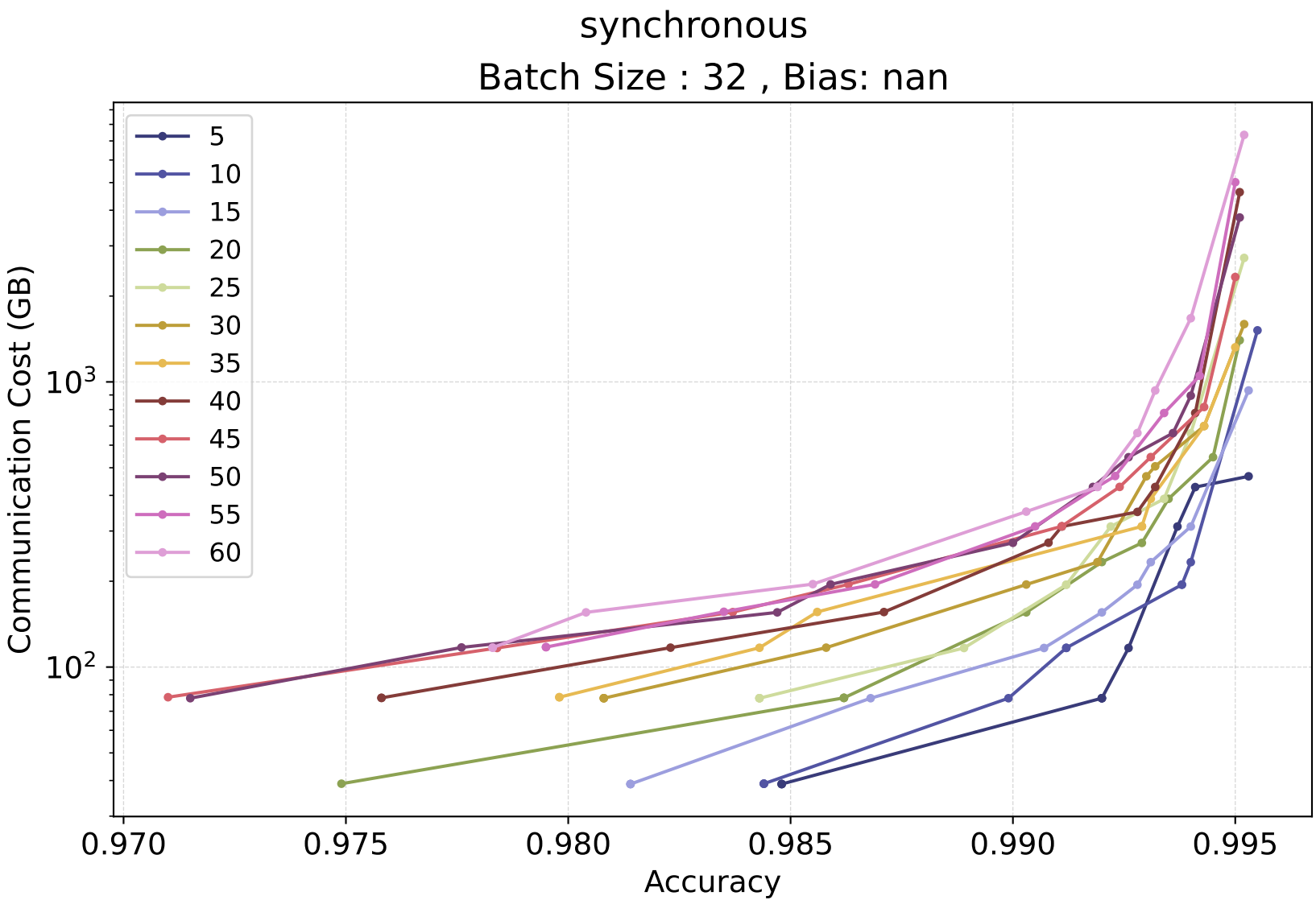
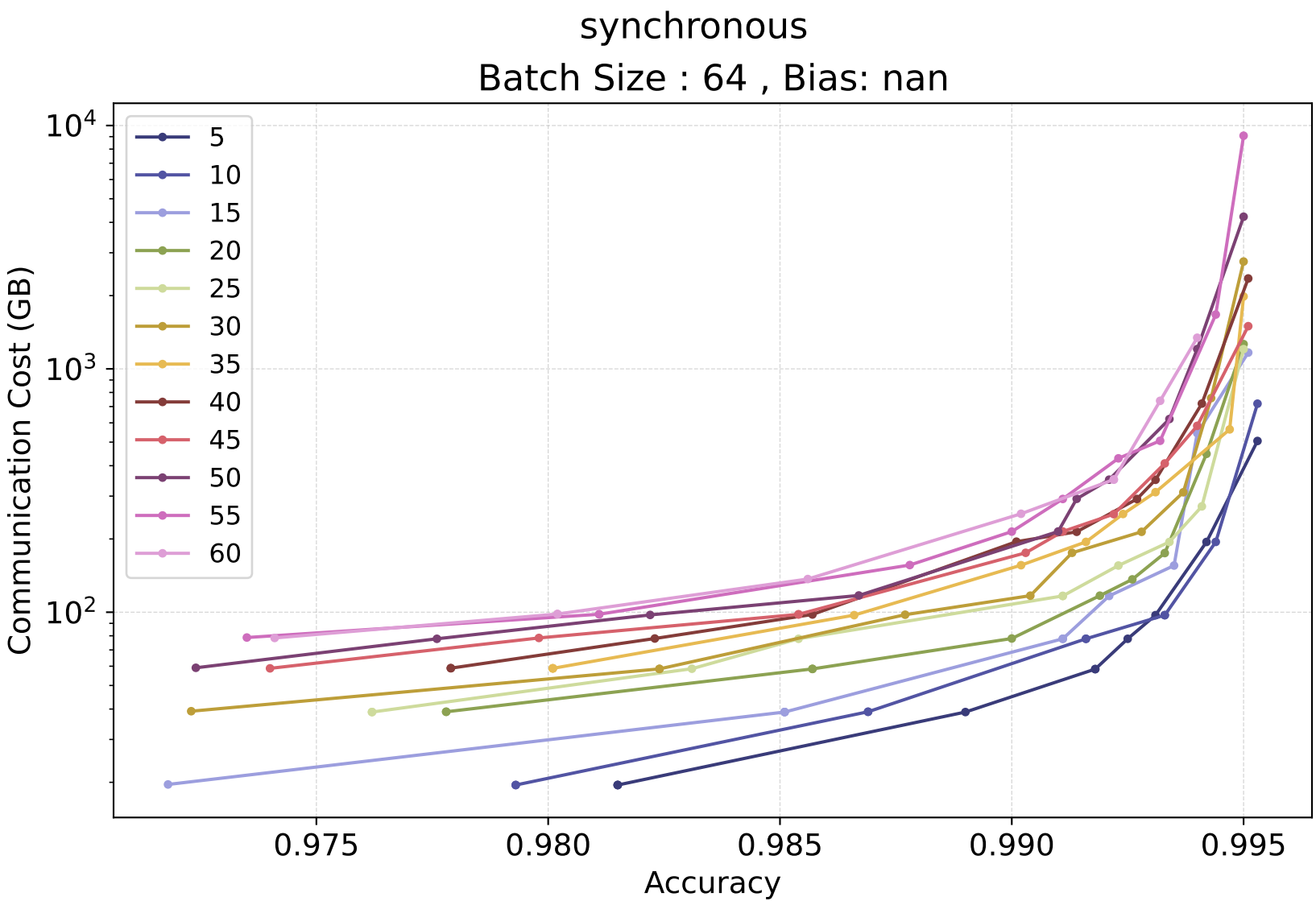
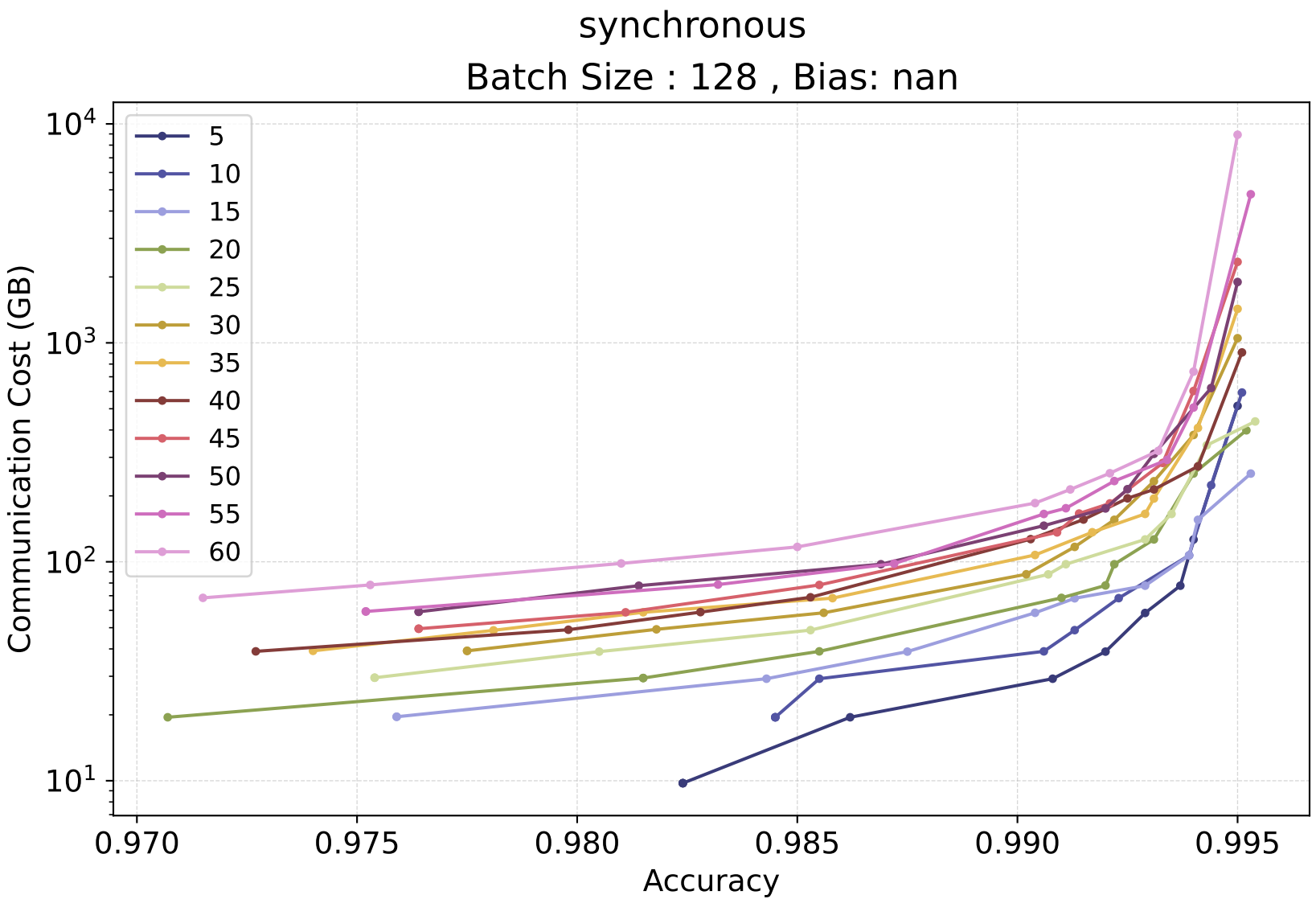
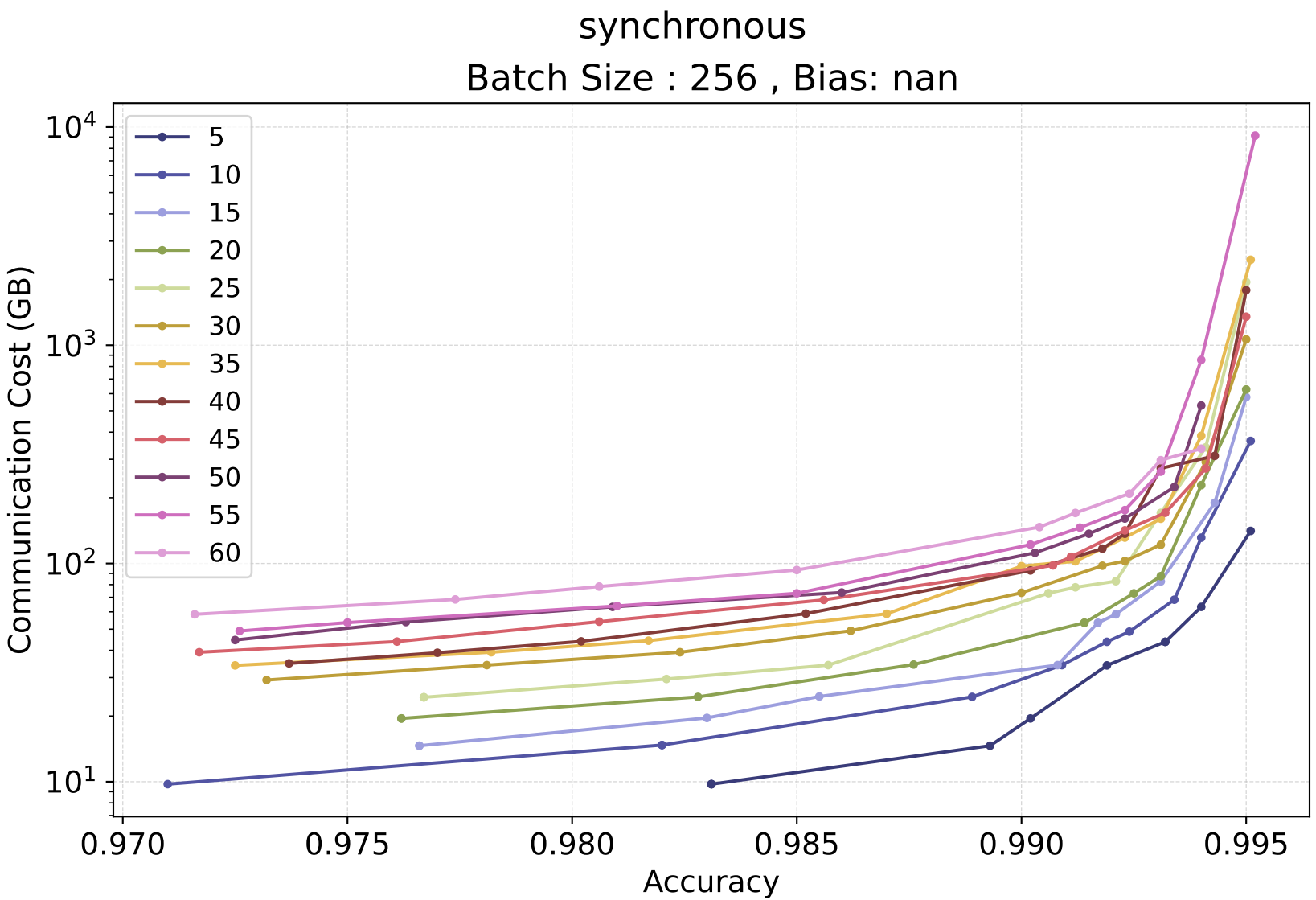
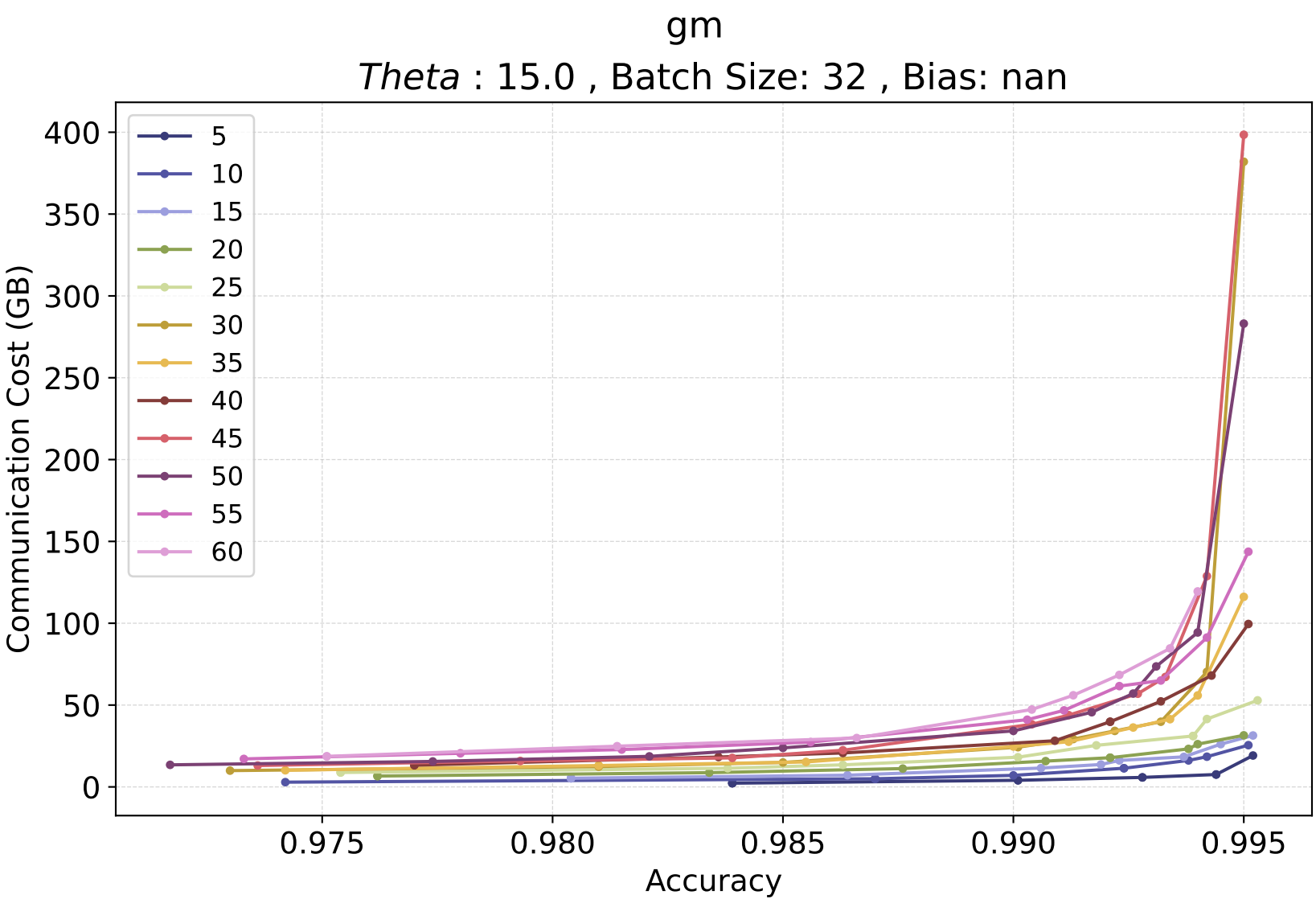
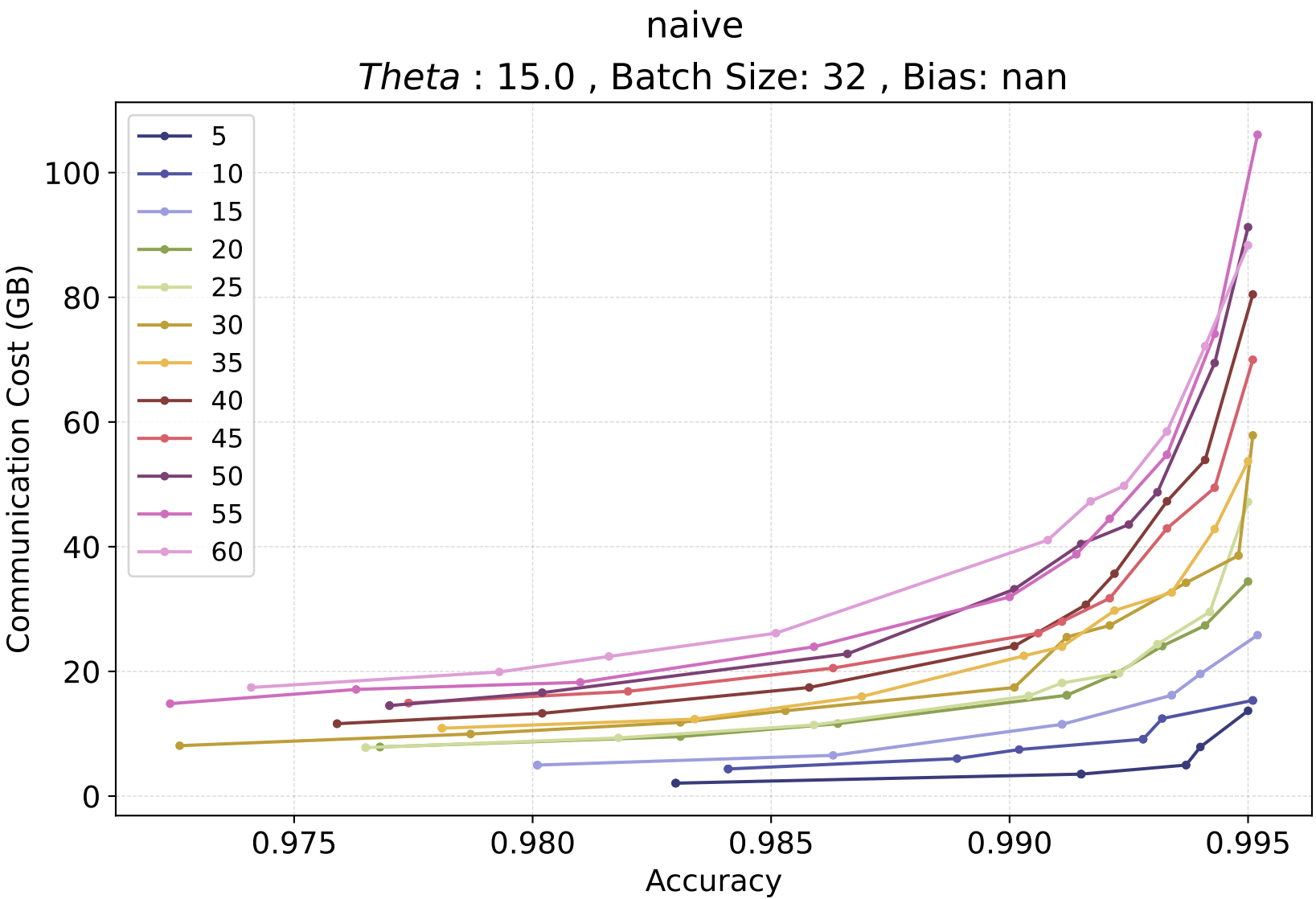

synchronous
Batch Size : 32 , Bias: nan
Communication Cost (GB)
10^3
10^2
0.970
0.975
0.980
0.985
0.990
0.995
Accuracy
5
10
15
20
25
30
35
40
45
50
55
60

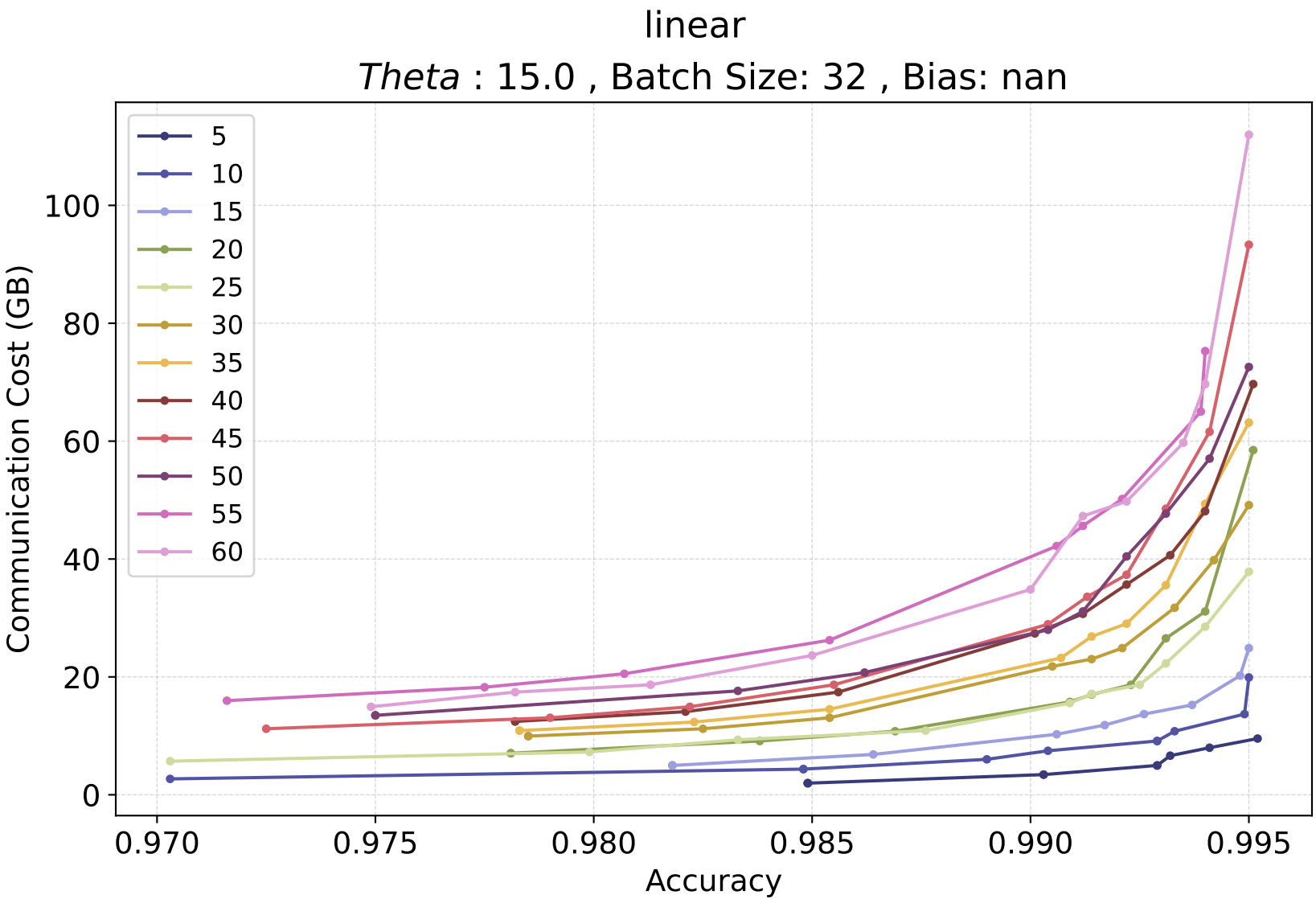

synchronous
Batch Size : 64 , Bias: nan
Communication Cost (GB)
10^4
10^3
10^2
5
10
15
20
25
30
35
40
45
50
55
60
0.975
0.980
0.985
0.990
0.995
Accuracy

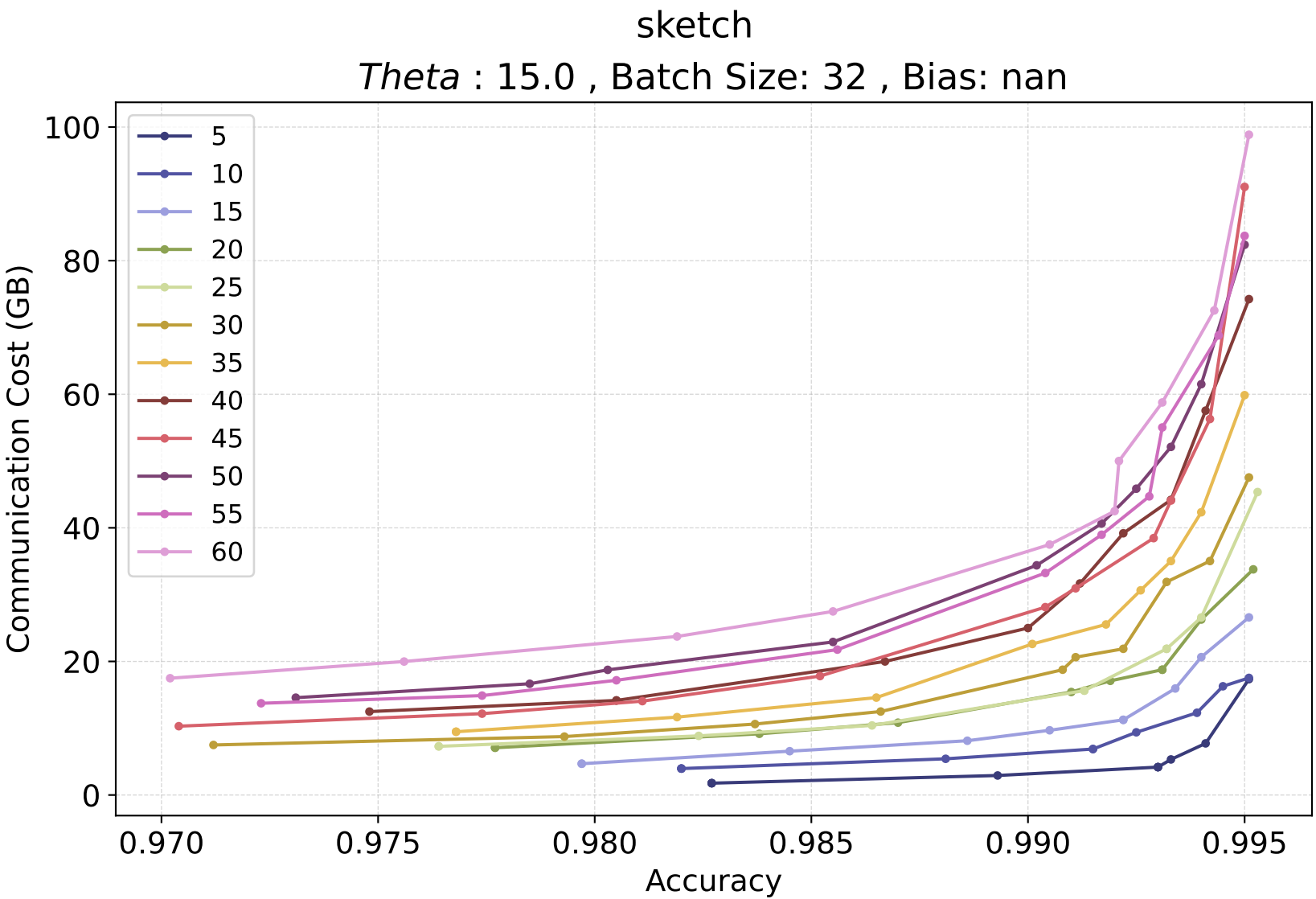

synchronous
Batch Size : 128 , Bias: nan
Communication Cost (GB)
10^4
10^3
10^2
10^1
5
10
15
20
25
30
35
40
45
50
55
60
0.970
0.975
0.980
0.985
0.990
0.995
Accuracy

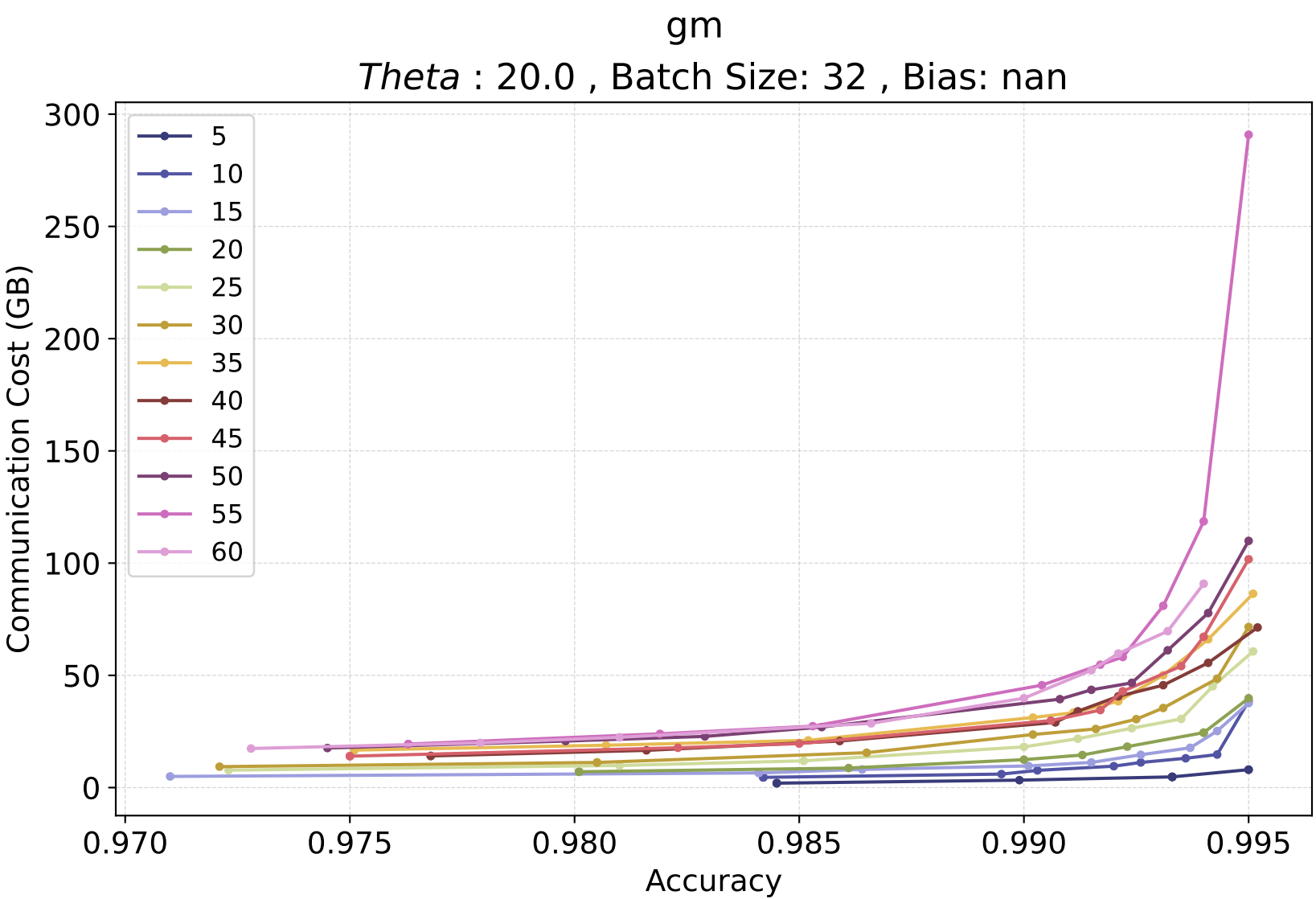

synchronous
Batch Size : 256 , Bias: nan
Communication Cost (GB)
10^4
10^3
10^2
10^1
0.970
0.975
0.980
0.985
0.990
0.995
Accuracy
5
10
15
20
25
30
35
40
45
50
55
60

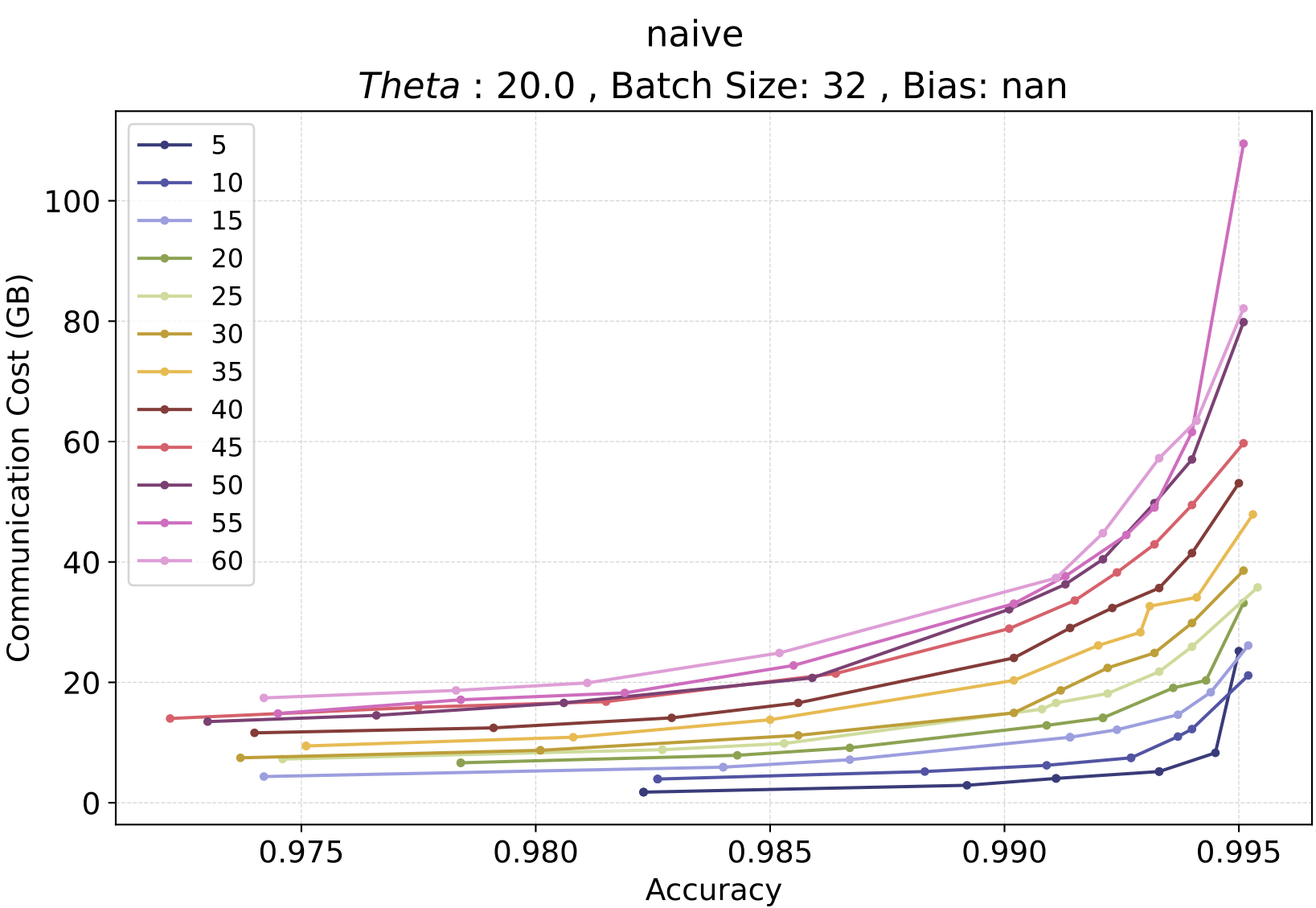

gm
Theta : 15.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
50
100
150
200
250
300
350
400
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

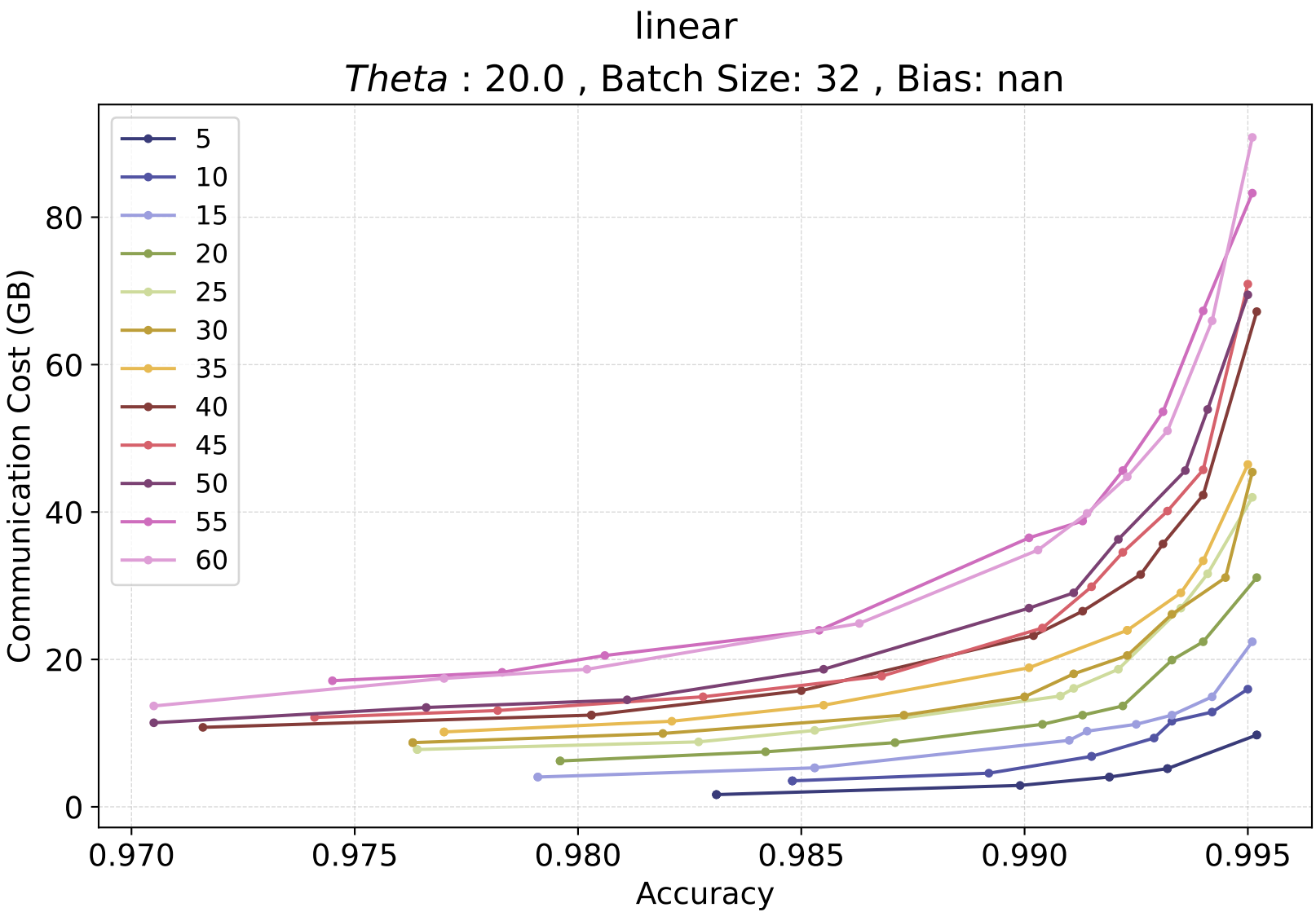

naive
Theta : 15.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

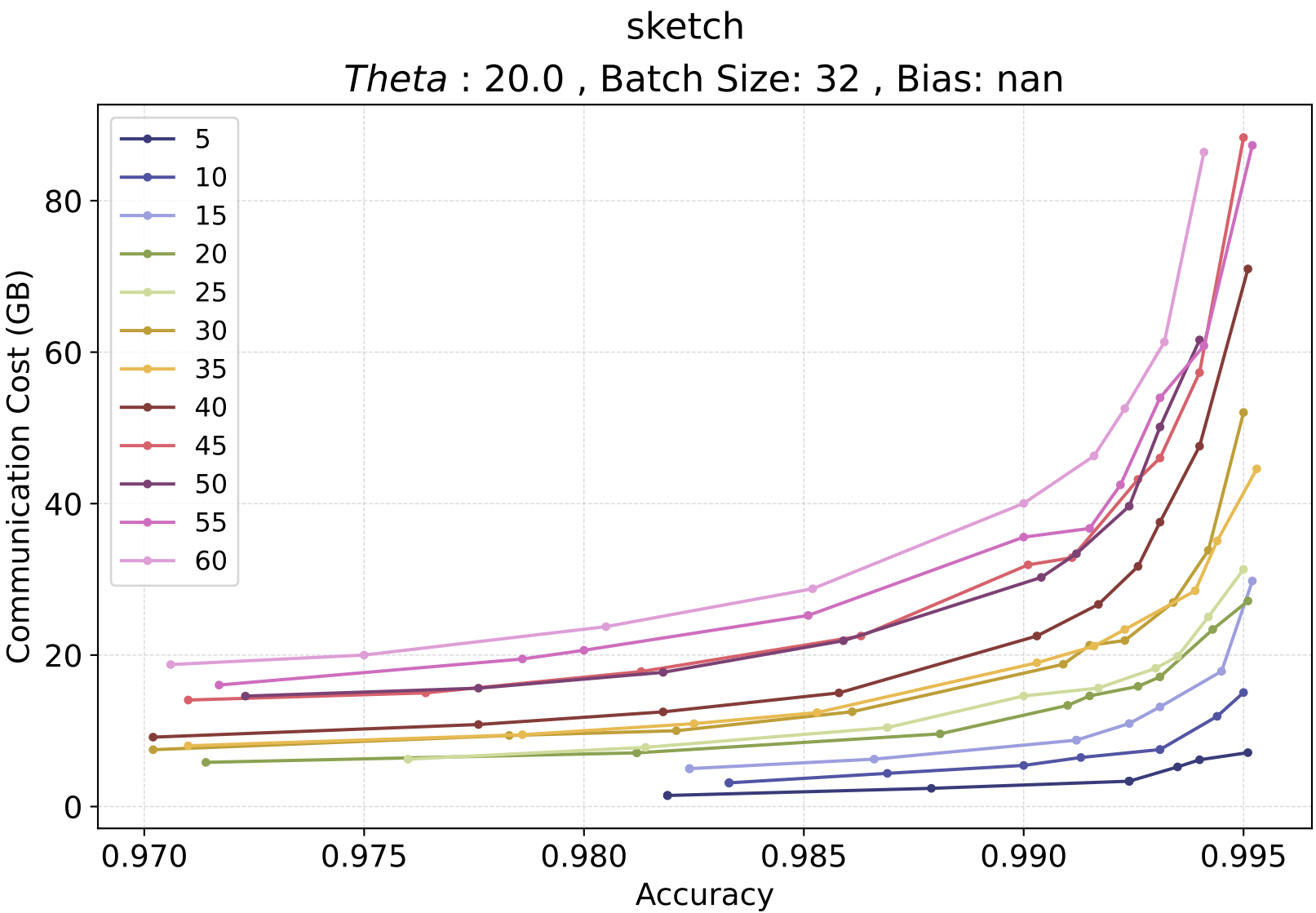

linear
Theta : 15.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

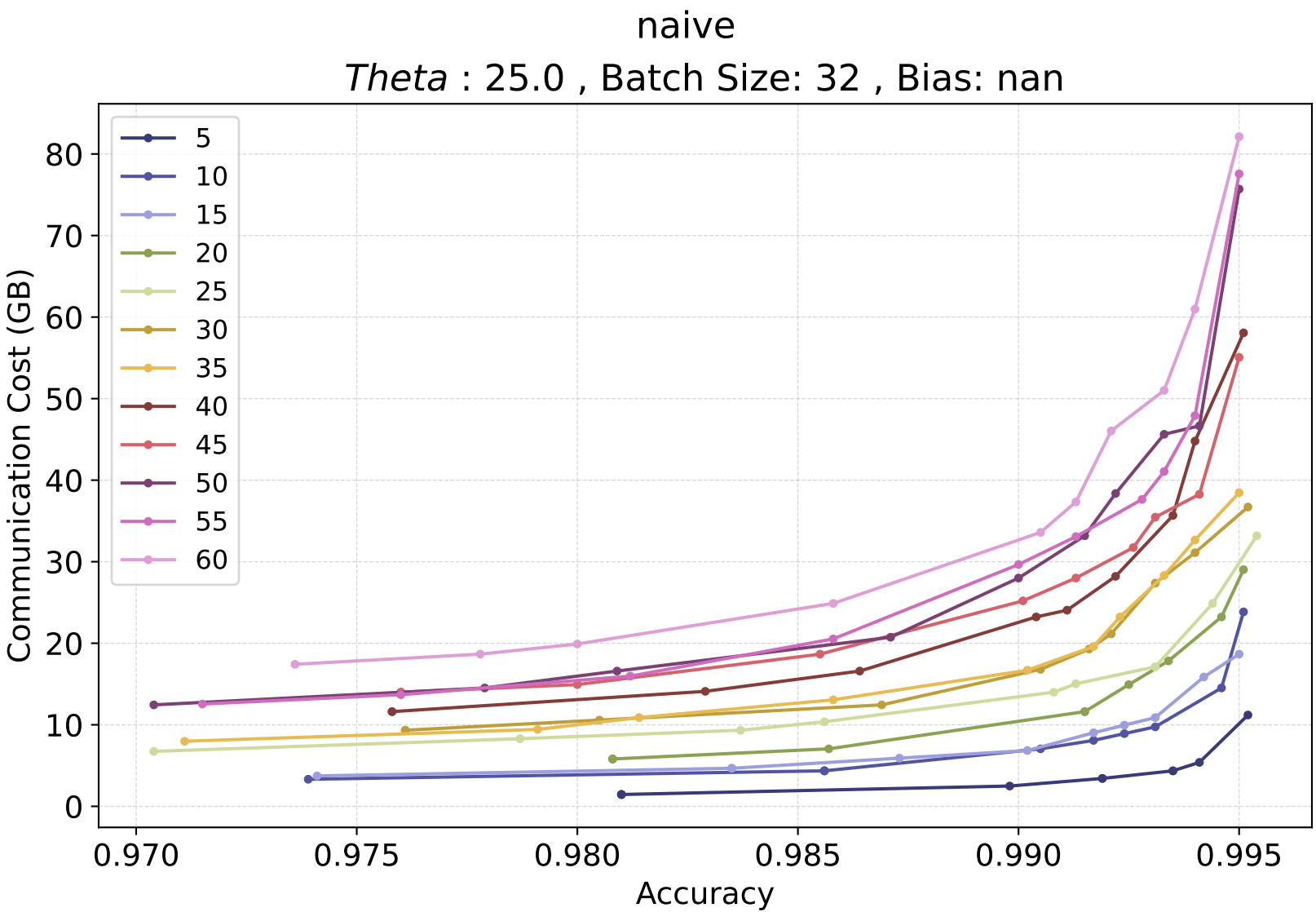

sketch
Theta : 15.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

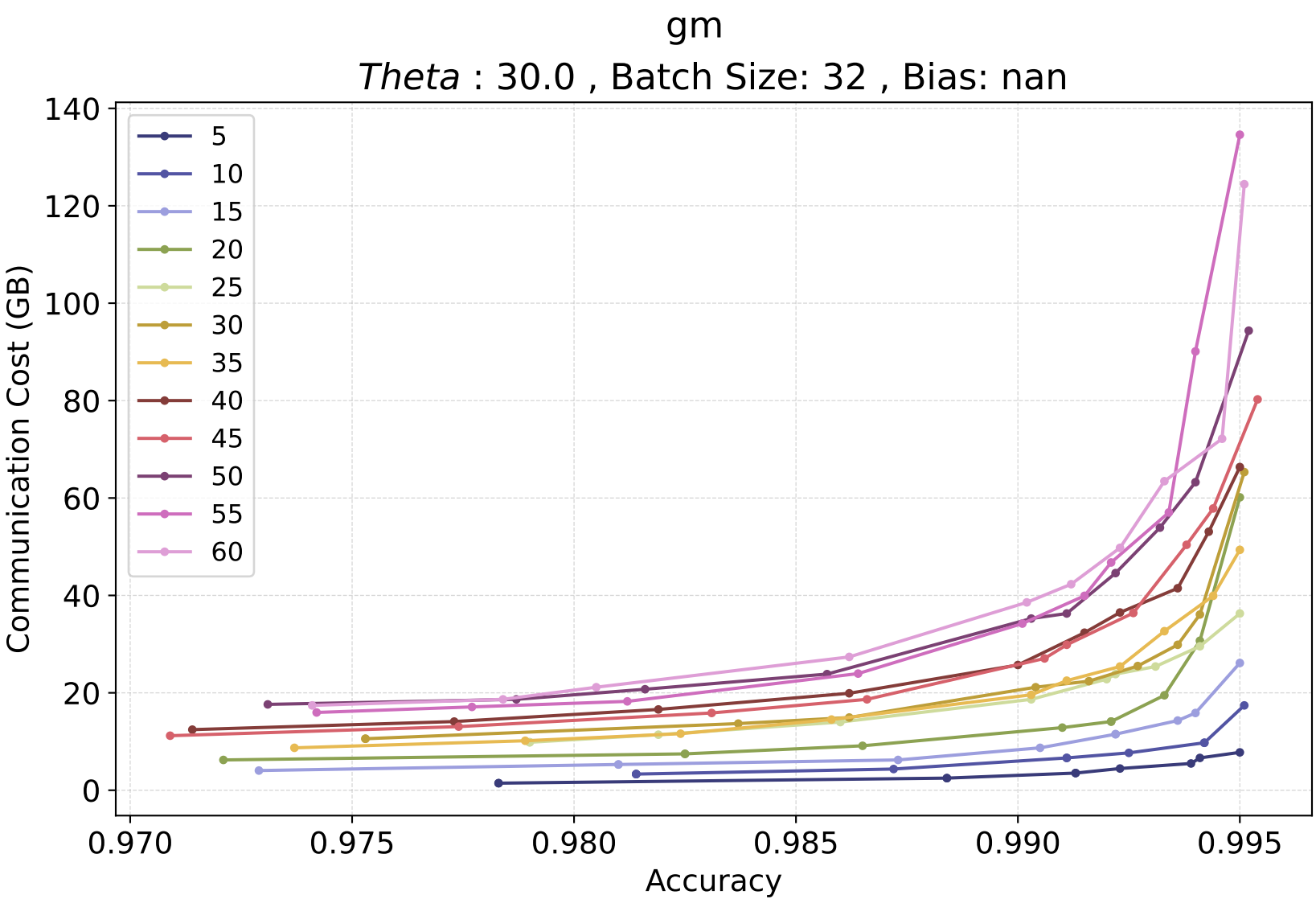

gm
Theta : 20.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
50
100
150
200
250
300
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

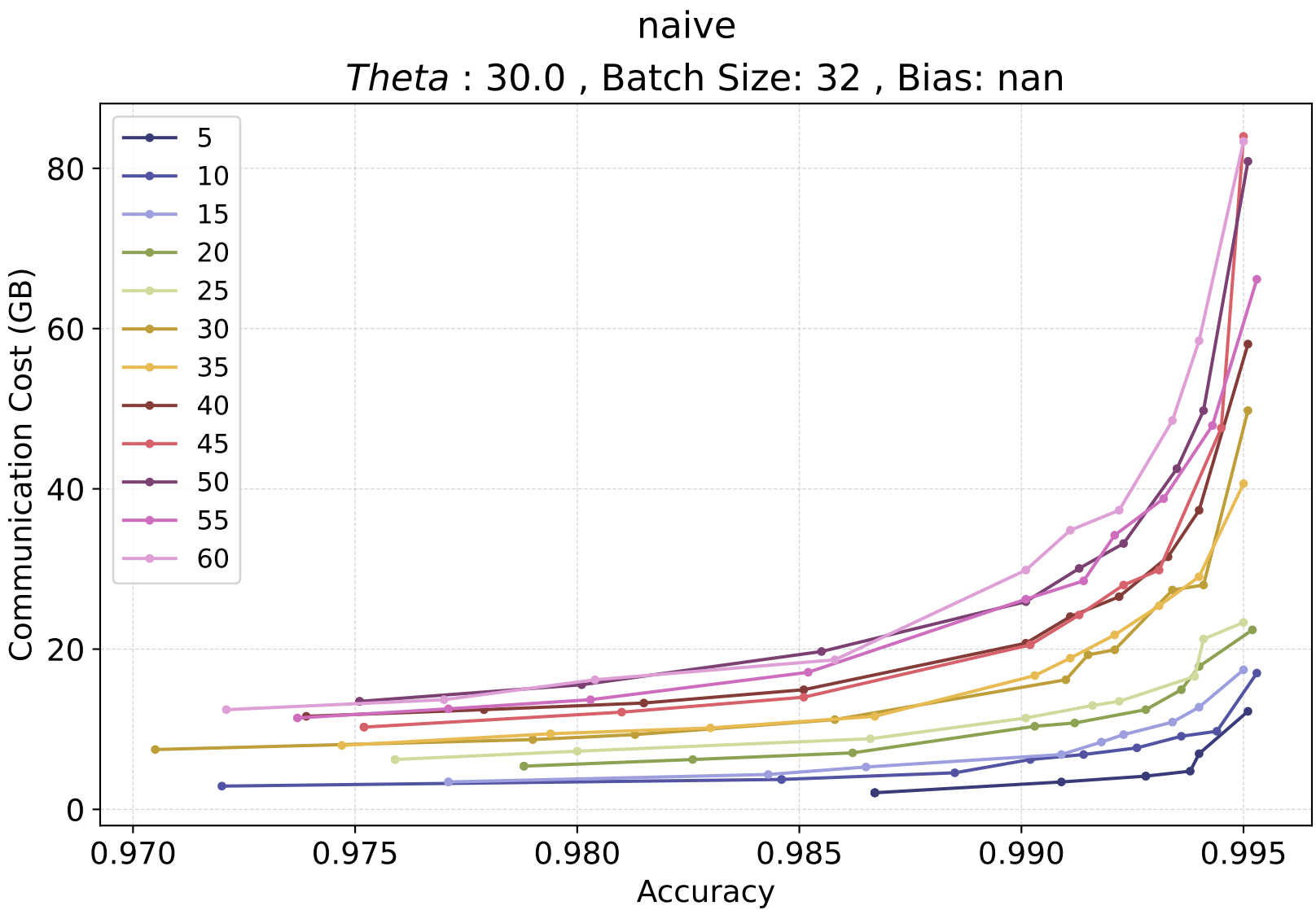

naive
Theta : 20.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

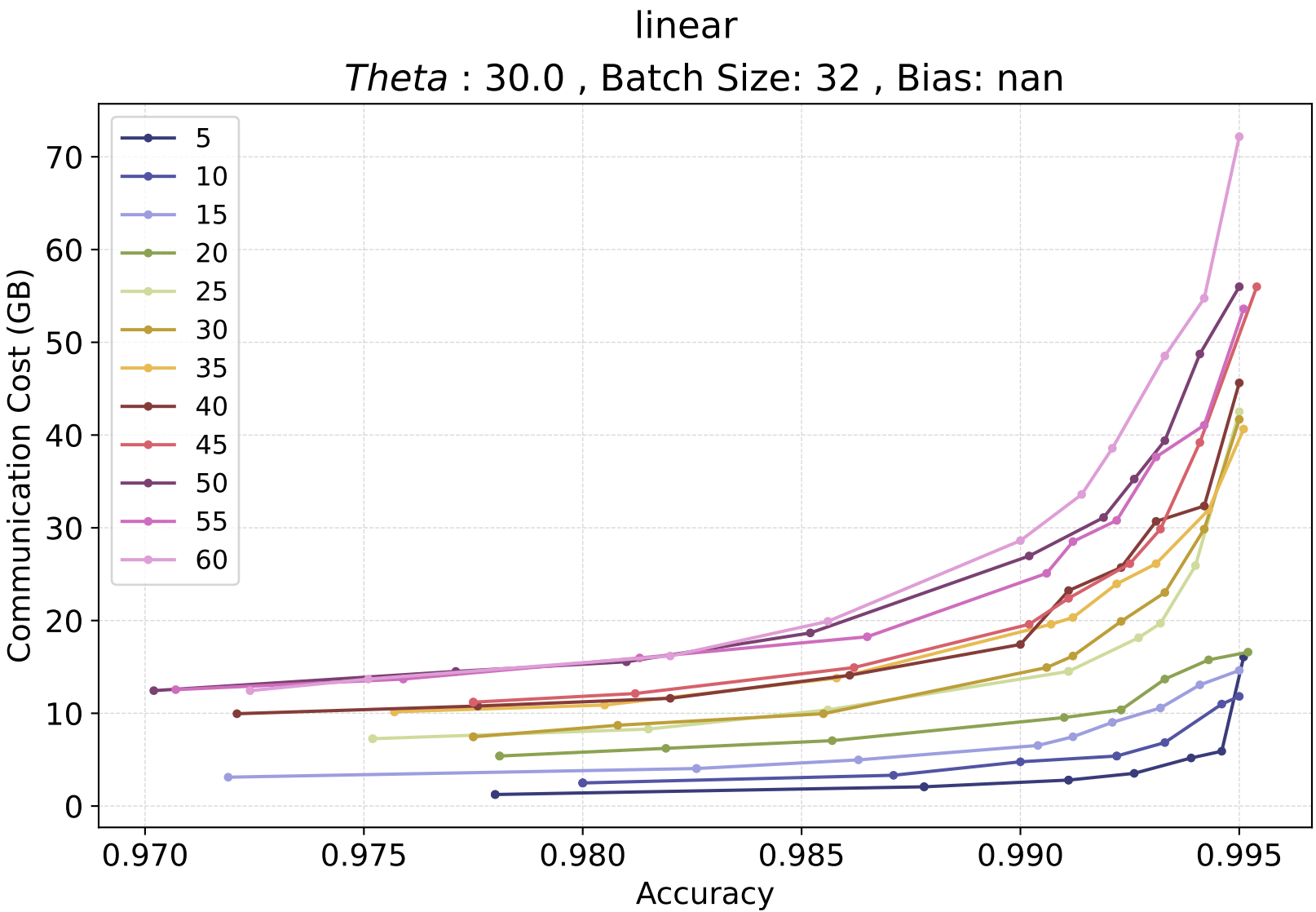

linear
Theta : 20.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
20
40
60
80
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

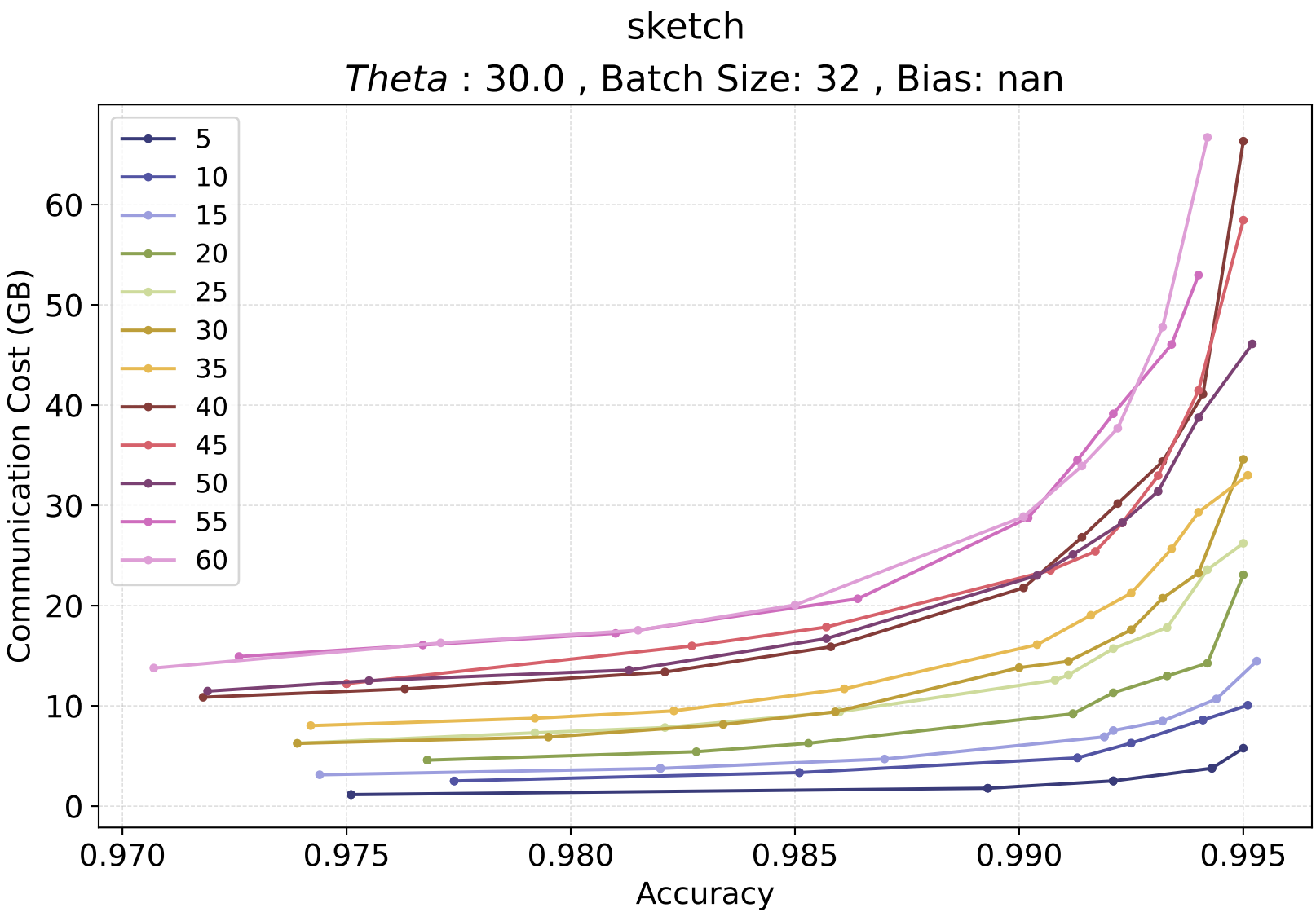

sketch
Theta : 20.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
20
40
60
80
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

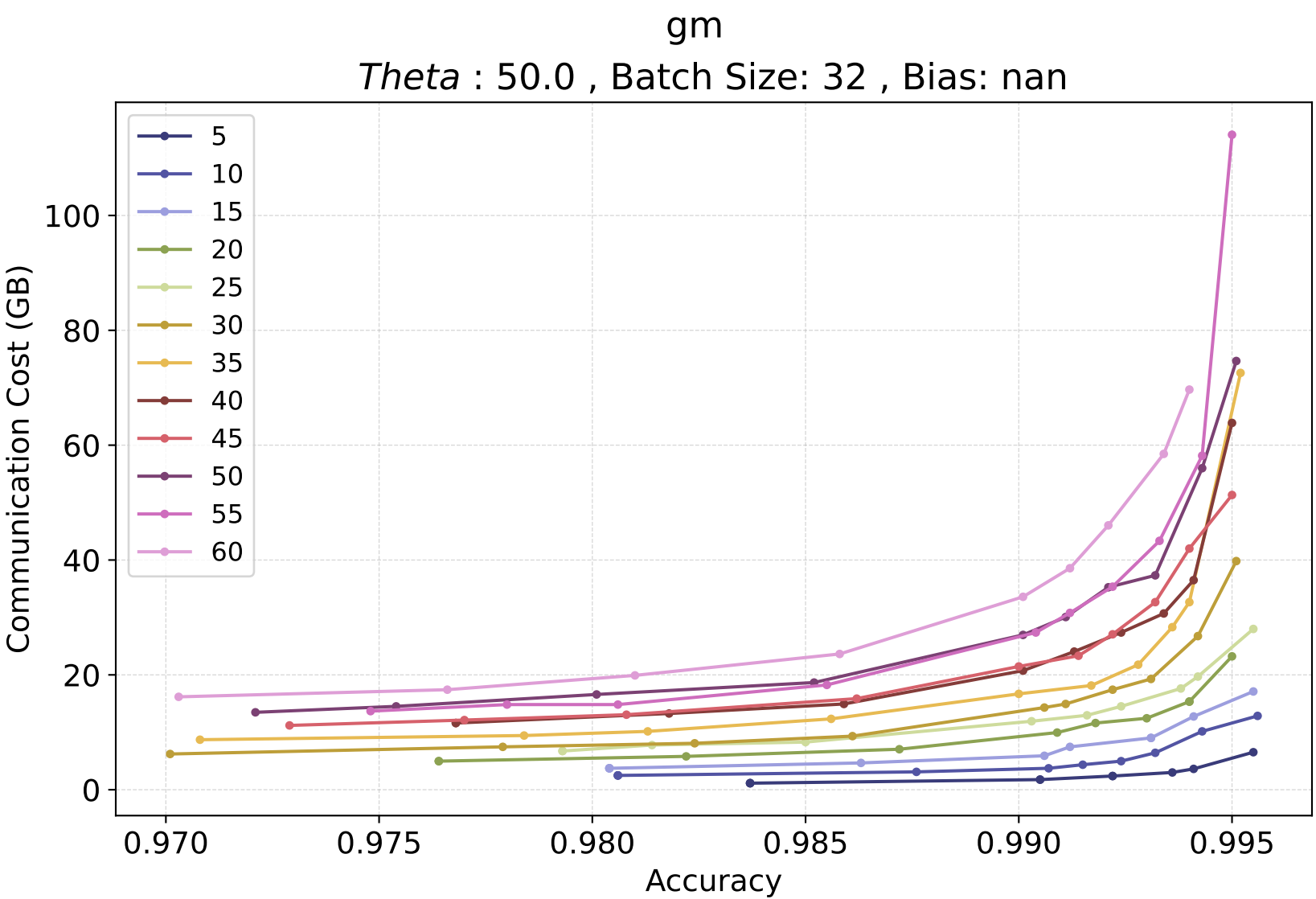

naive
Theta : 25.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
10
20
30
40
50
60
70
80
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60


gm
Theta : 30.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
120
140
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60


naive
Theta : 30.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
20
40
60
80
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60


linear
Theta : 30.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
10
20
30
40
50
60
70
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60


sketch
Theta : 30.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
10
20
30
40
50
60
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60


gm
Theta : 50.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
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45
50
55
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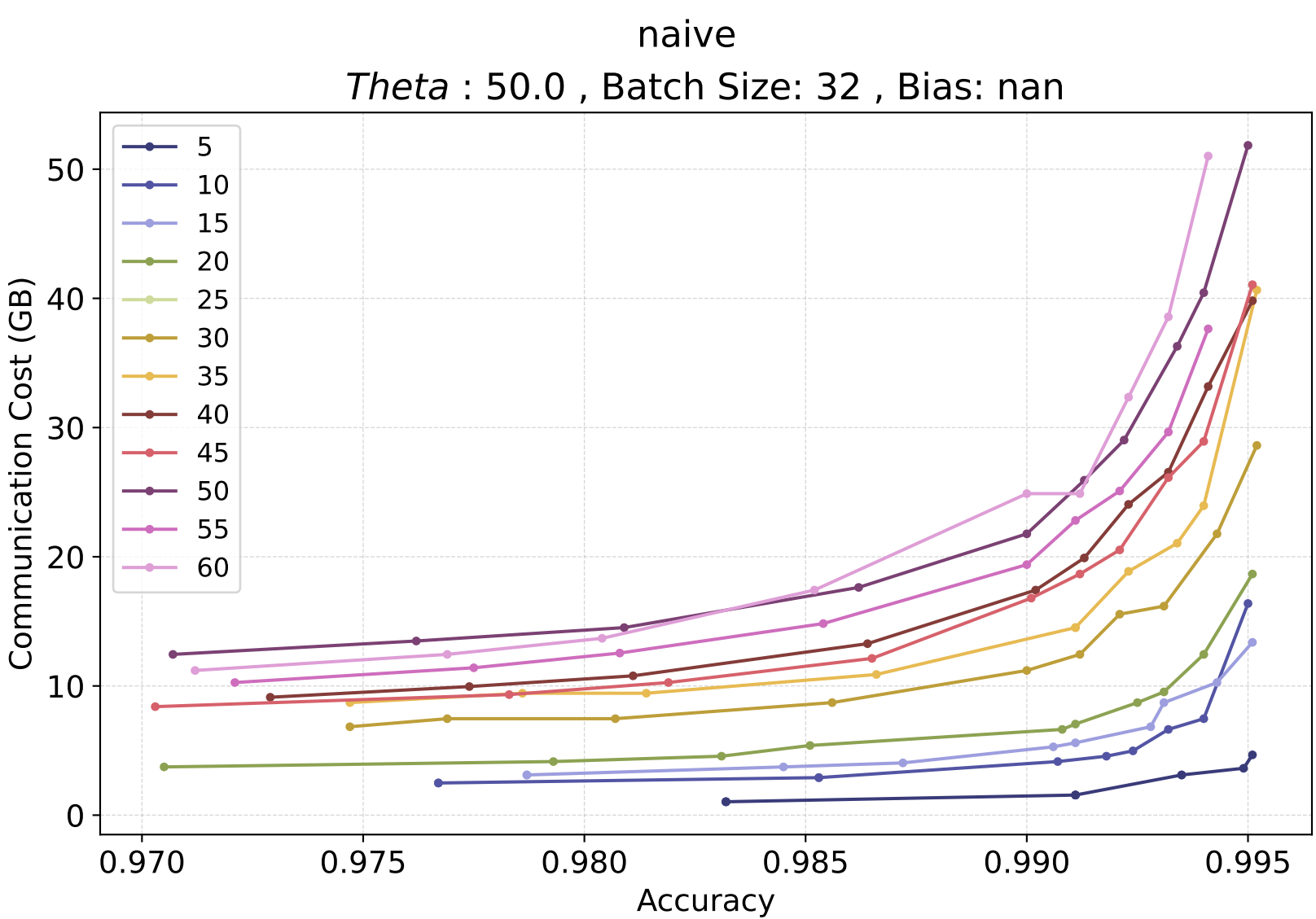
naive
Theta : 50.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
10
20
30
40
50
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
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25
30
35
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45
50
55
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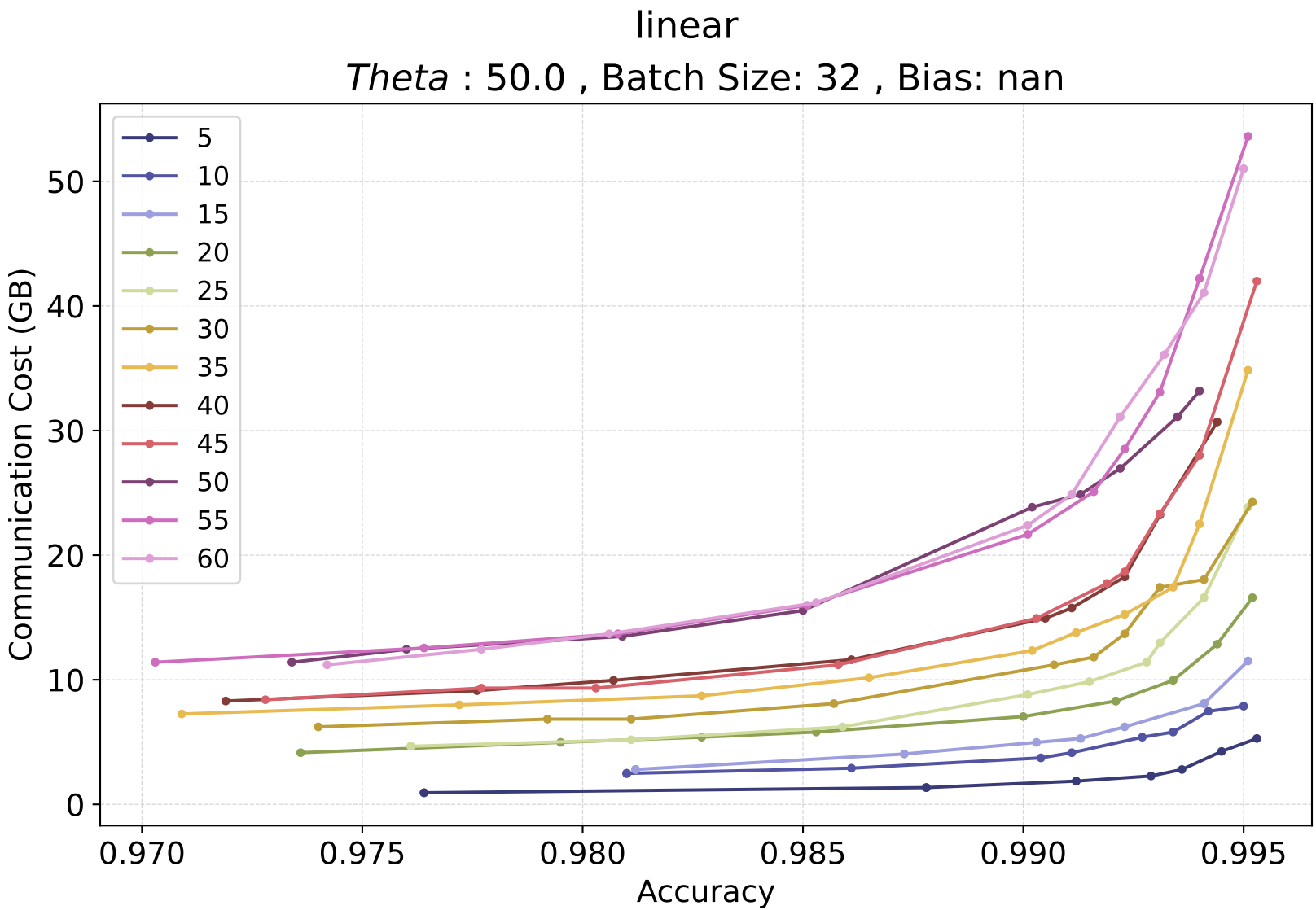
linear
Theta : 50.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
10
20
30
40
50
0.970
0.975
0.980
0.985
0.990
0.995
5
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25
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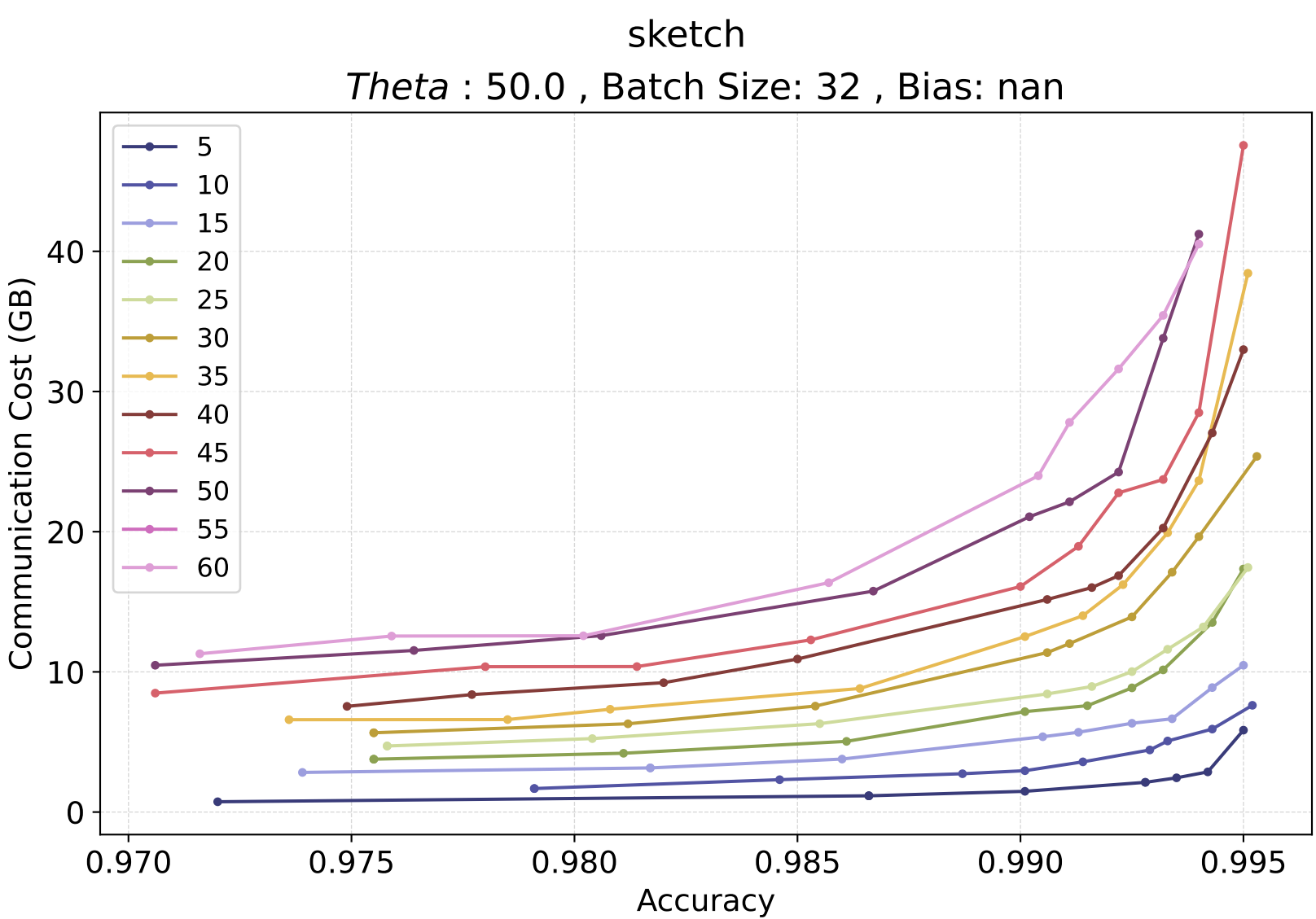
sketch
Theta : 50.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
10
20
30
40
0.970
0.975
0.980
0.985
0.990
0.995
5
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15
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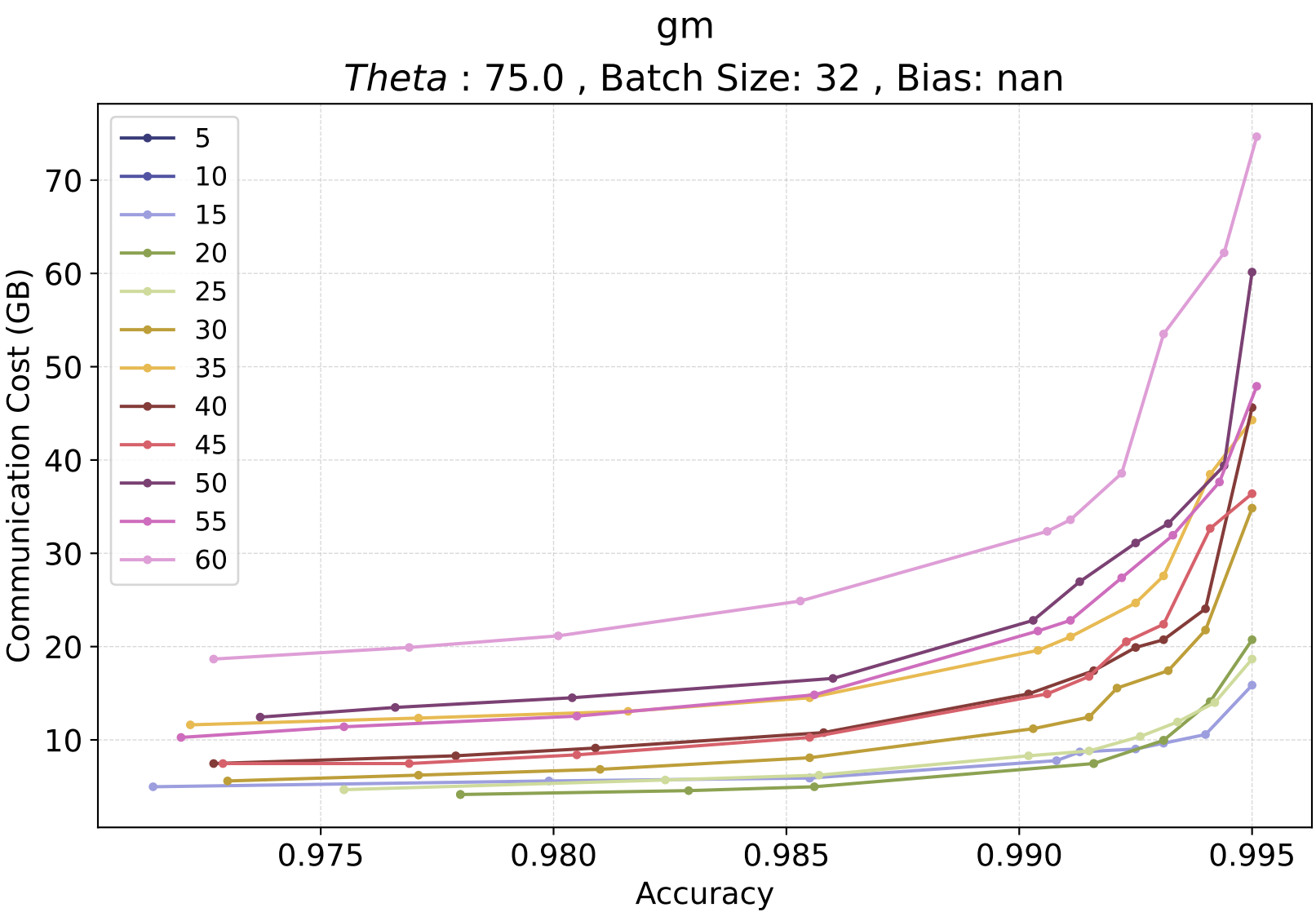
gm
Theta : 75.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
10
20
30
40
50
60
70
0.975
0.980
0.985
0.990
0.995
5
10
15
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25
30
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40
45
50
55
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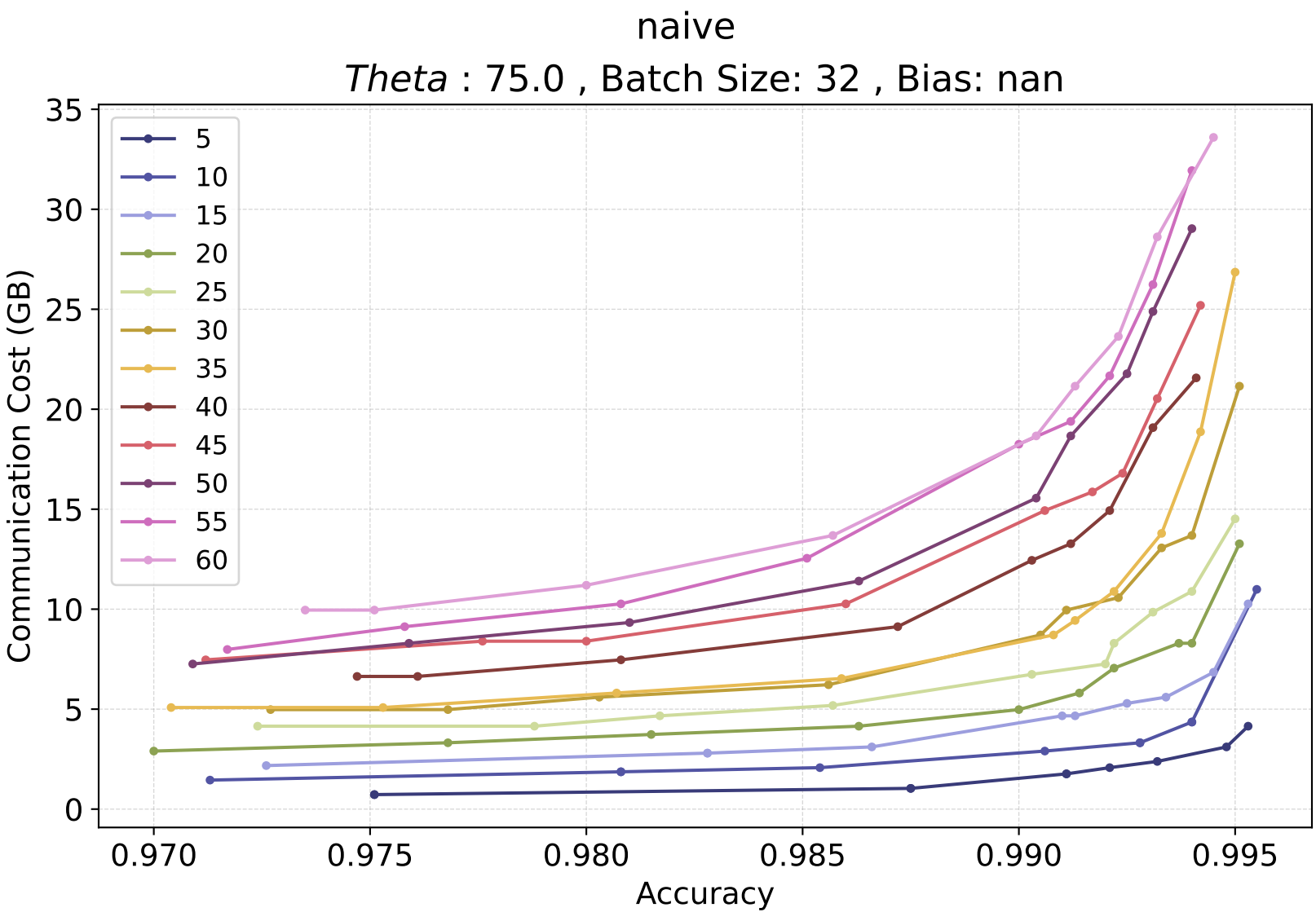
naive
Theta : 75.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
5
10
15
20
25
30
35
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
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25
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45
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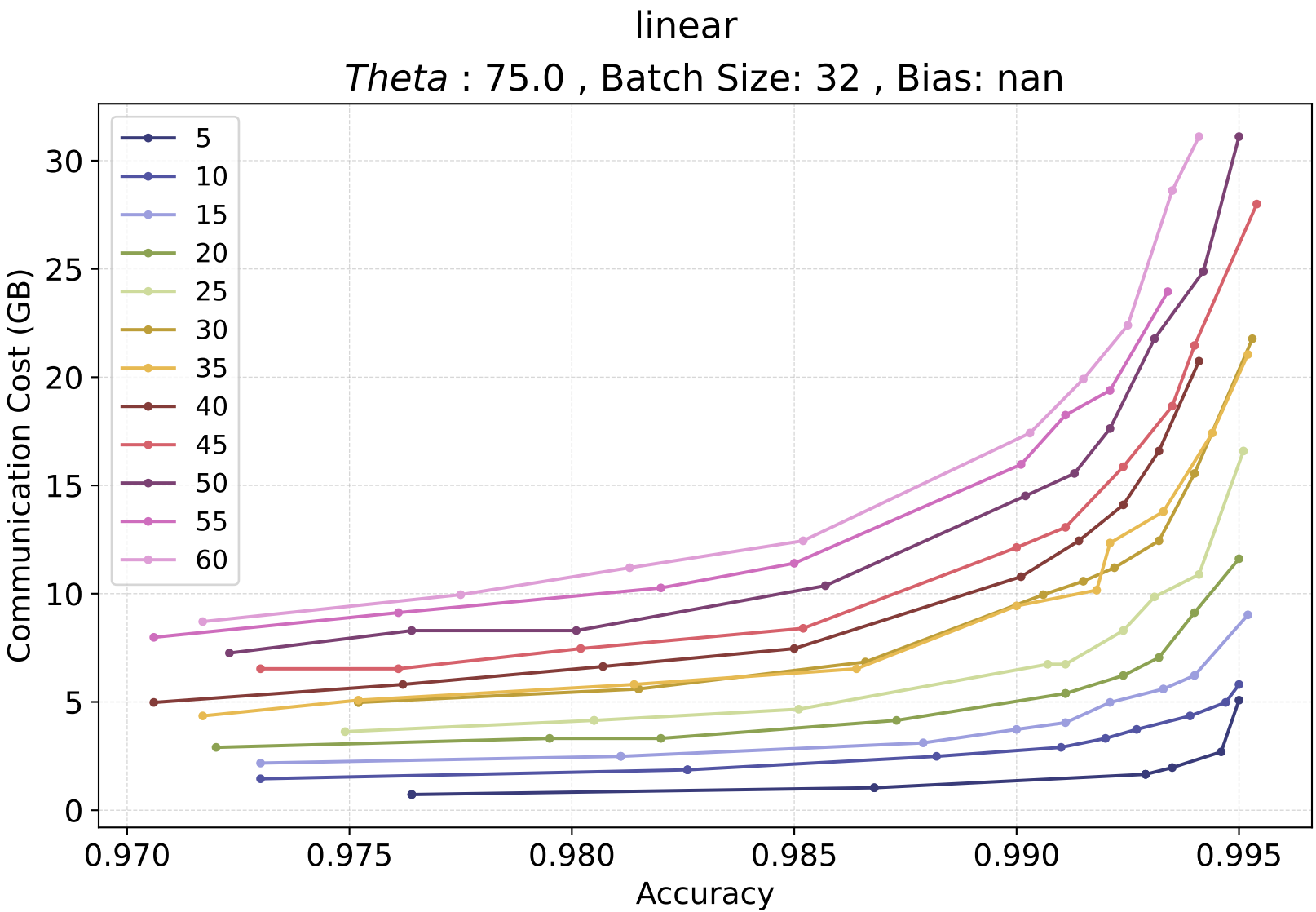
55
60


linear
Theta : 75.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
5
10
15
20
25
30
0.970
0.975
0.980
0.985
0.990
0.995
5
10
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55
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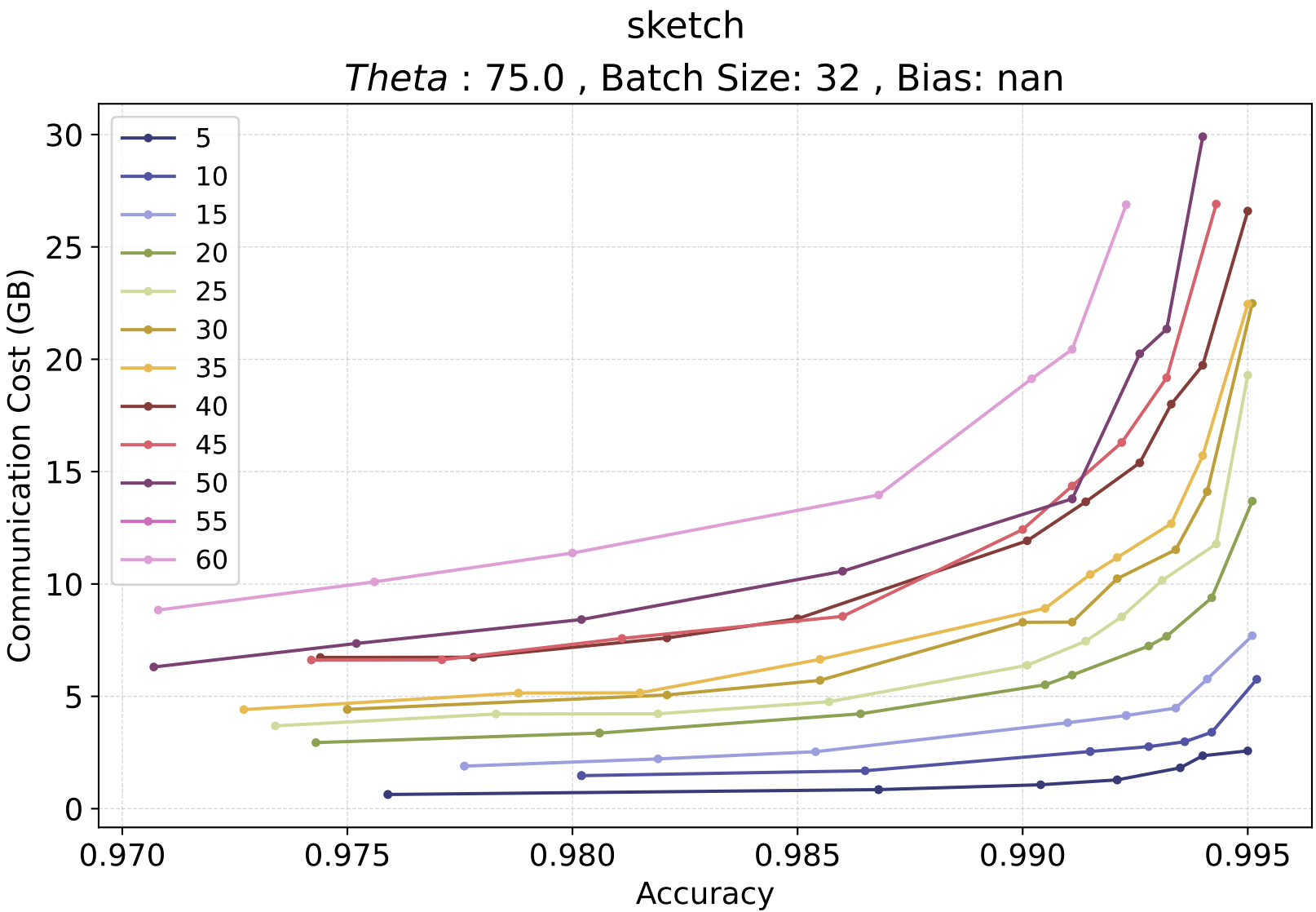
sketch
Theta : 75.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
5
10
15
20
25
30
0.970
0.975
0.980
0.985
0.990
0.995
5
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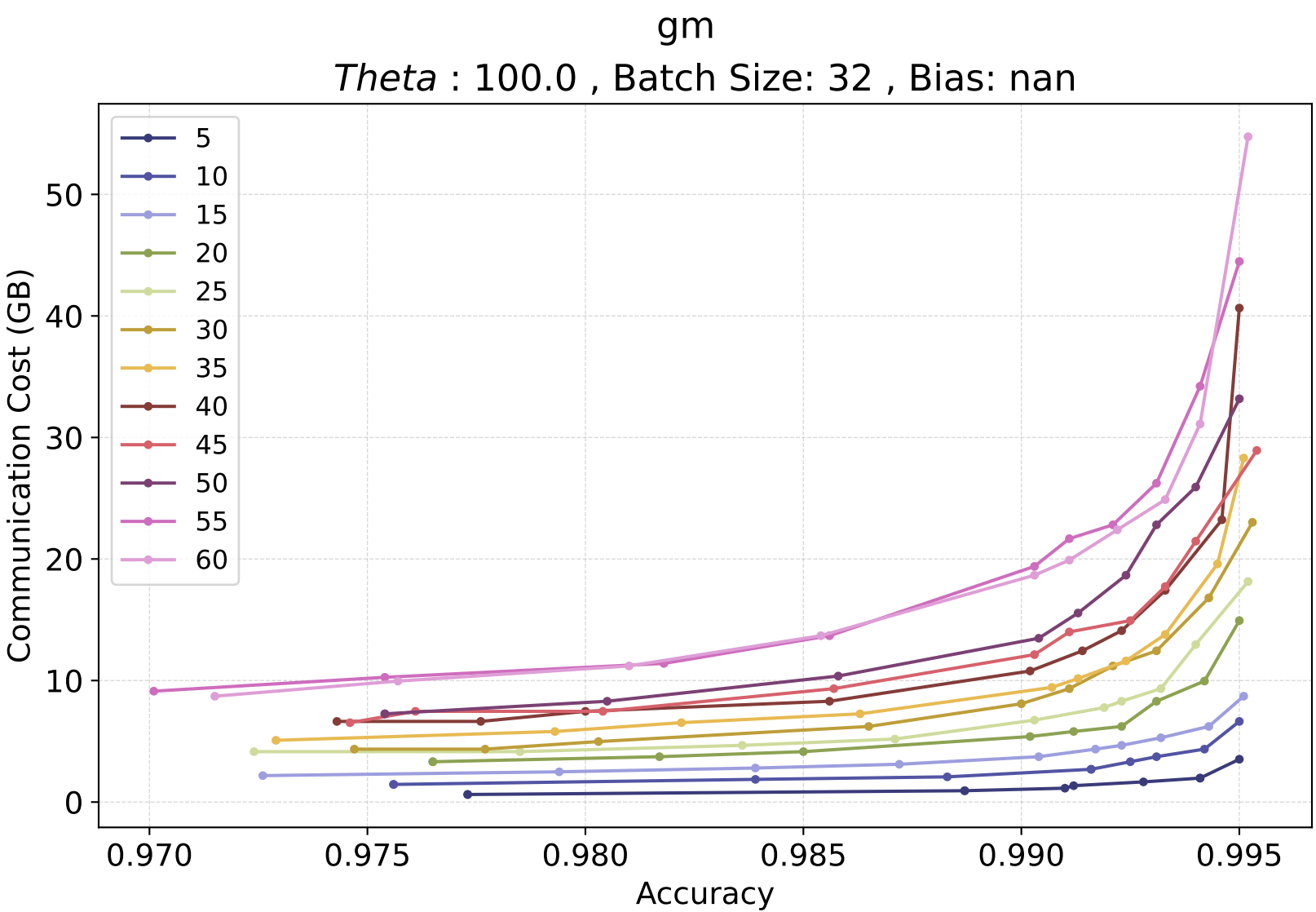
gm
Theta : 100.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
10
20
30
40
50
0.970
0.975
0.980
0.985
0.990
0.995
5
10
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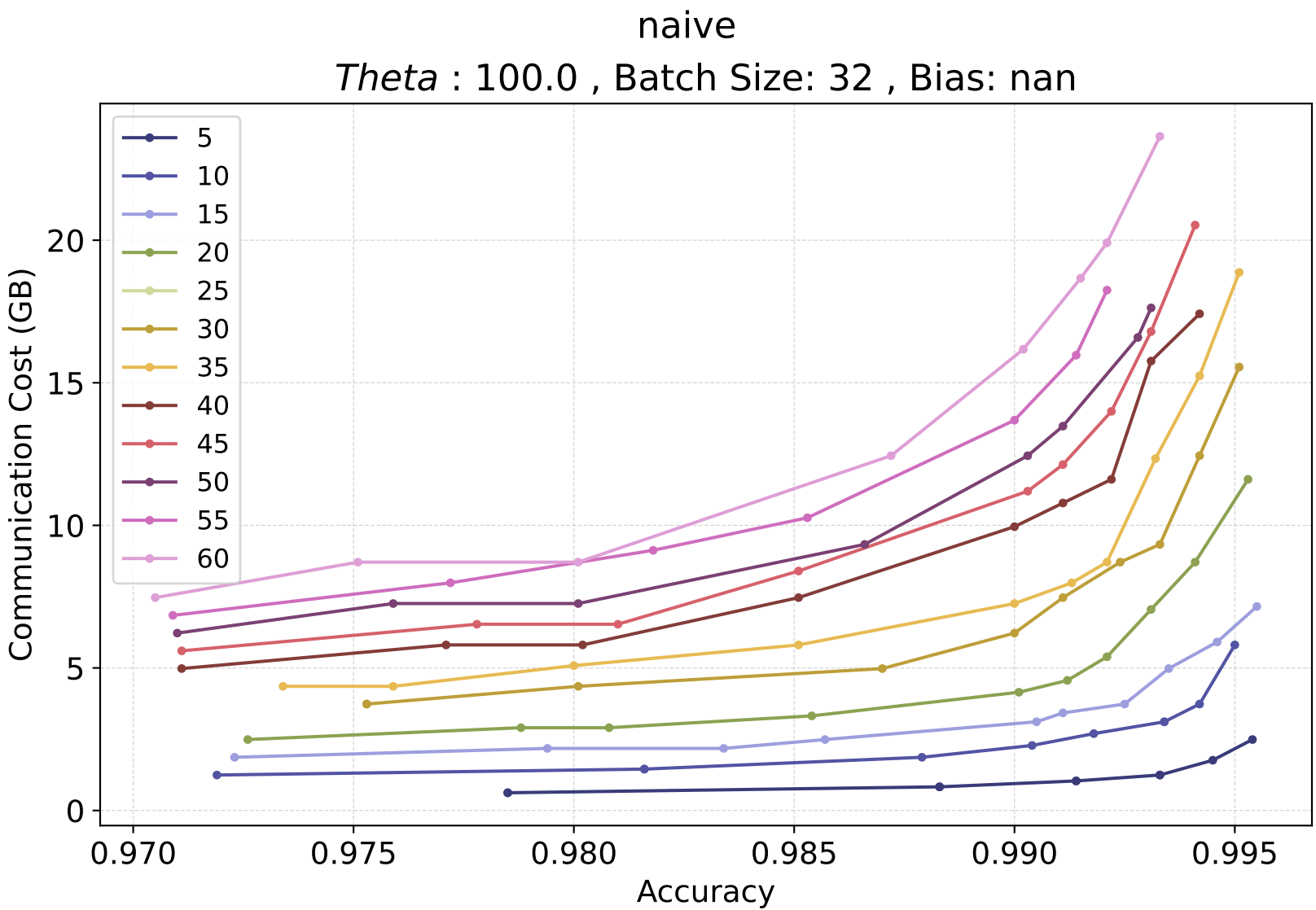
naive
Theta : 100.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
5
10
15
20
0.970
0.975
0.980
0.985
0.990
0.995
5
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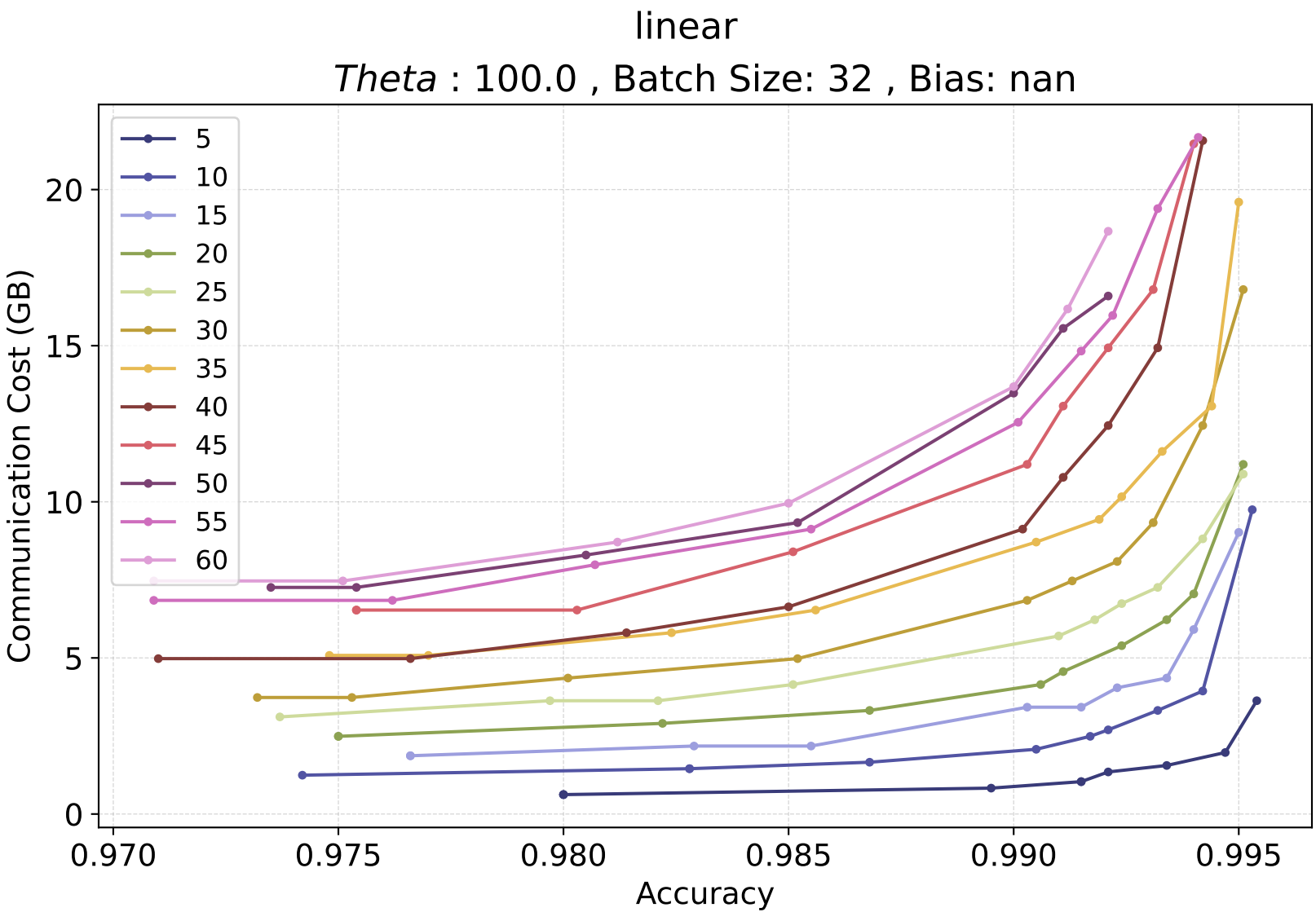
linear
Theta : 100.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
5
10
15
20
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
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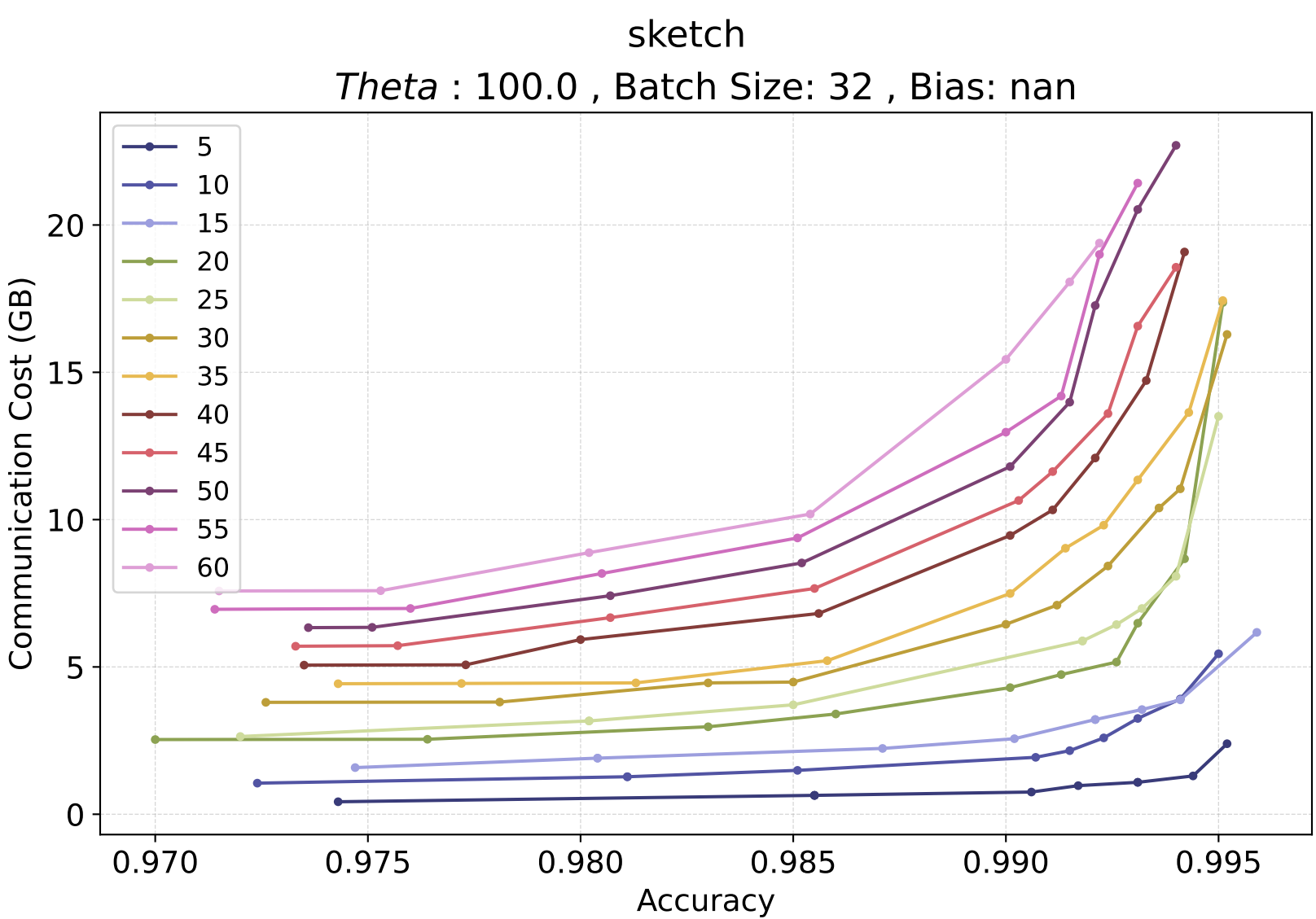
sketch
Theta : 100.0 , Batch Size: 32 , Bias: nan
Communication Cost (GB)
Accuracy
0
5
10
15
20
0.970
0.975
0.980
0.985
0.990
0.995
5
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25
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55
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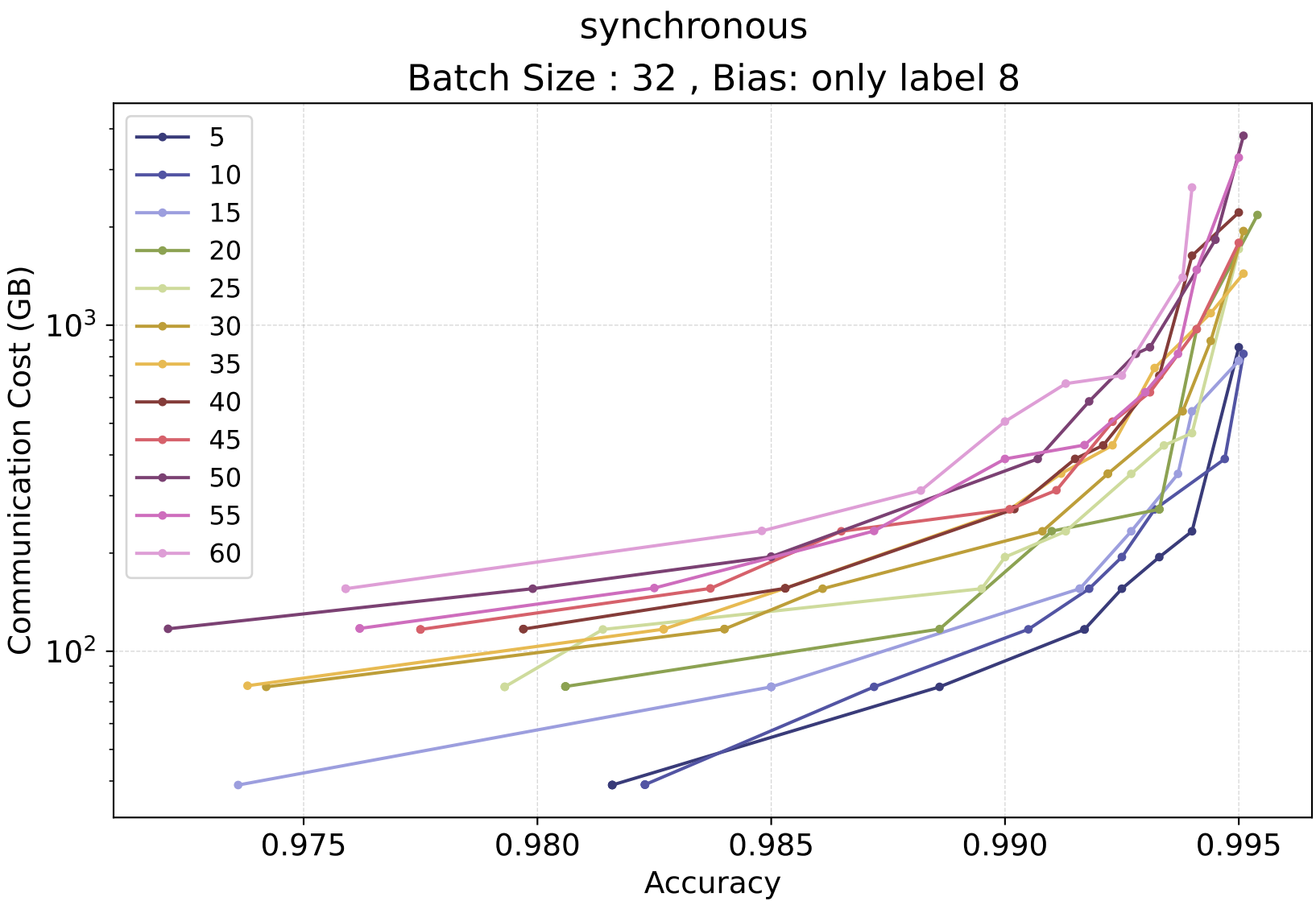
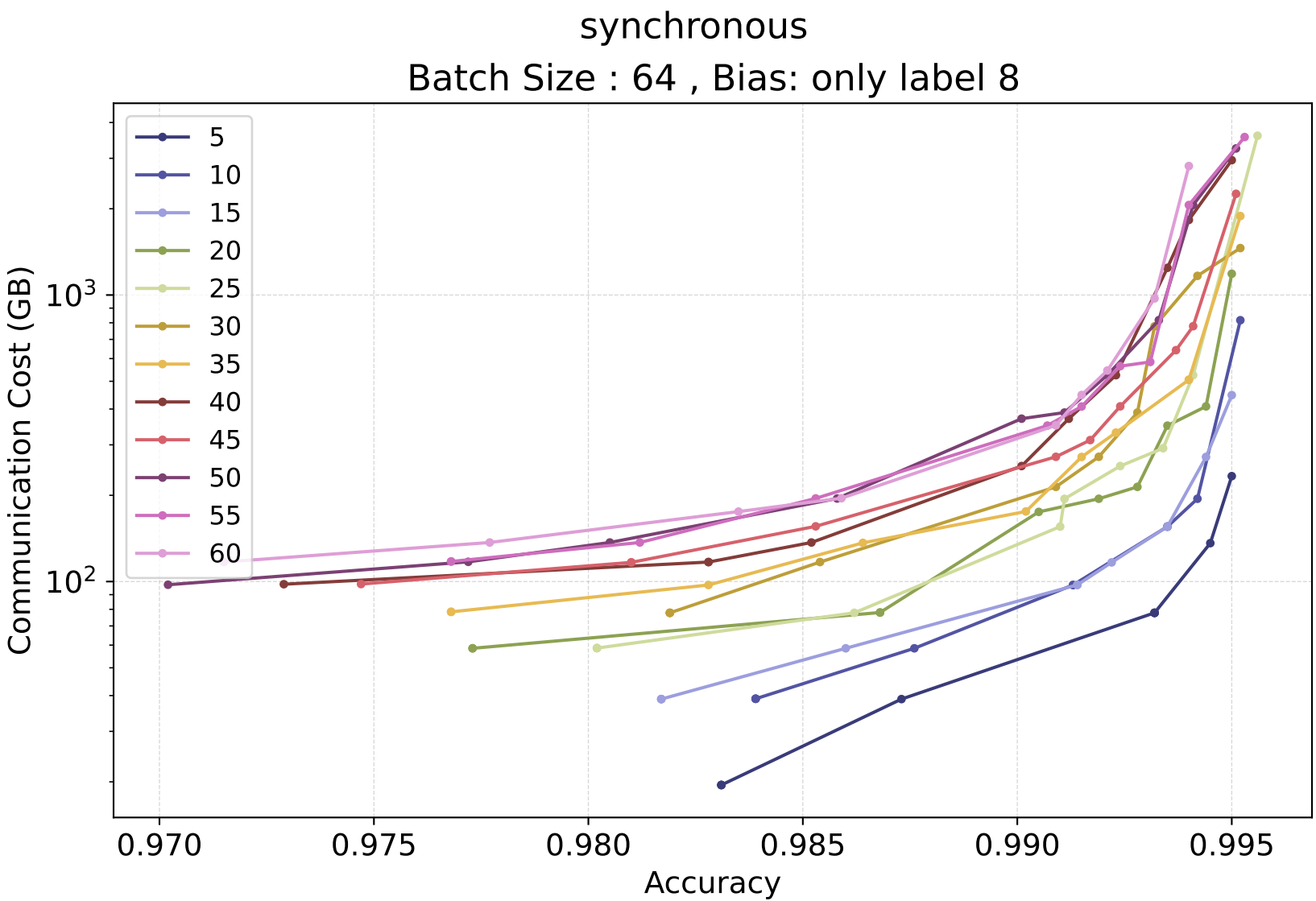
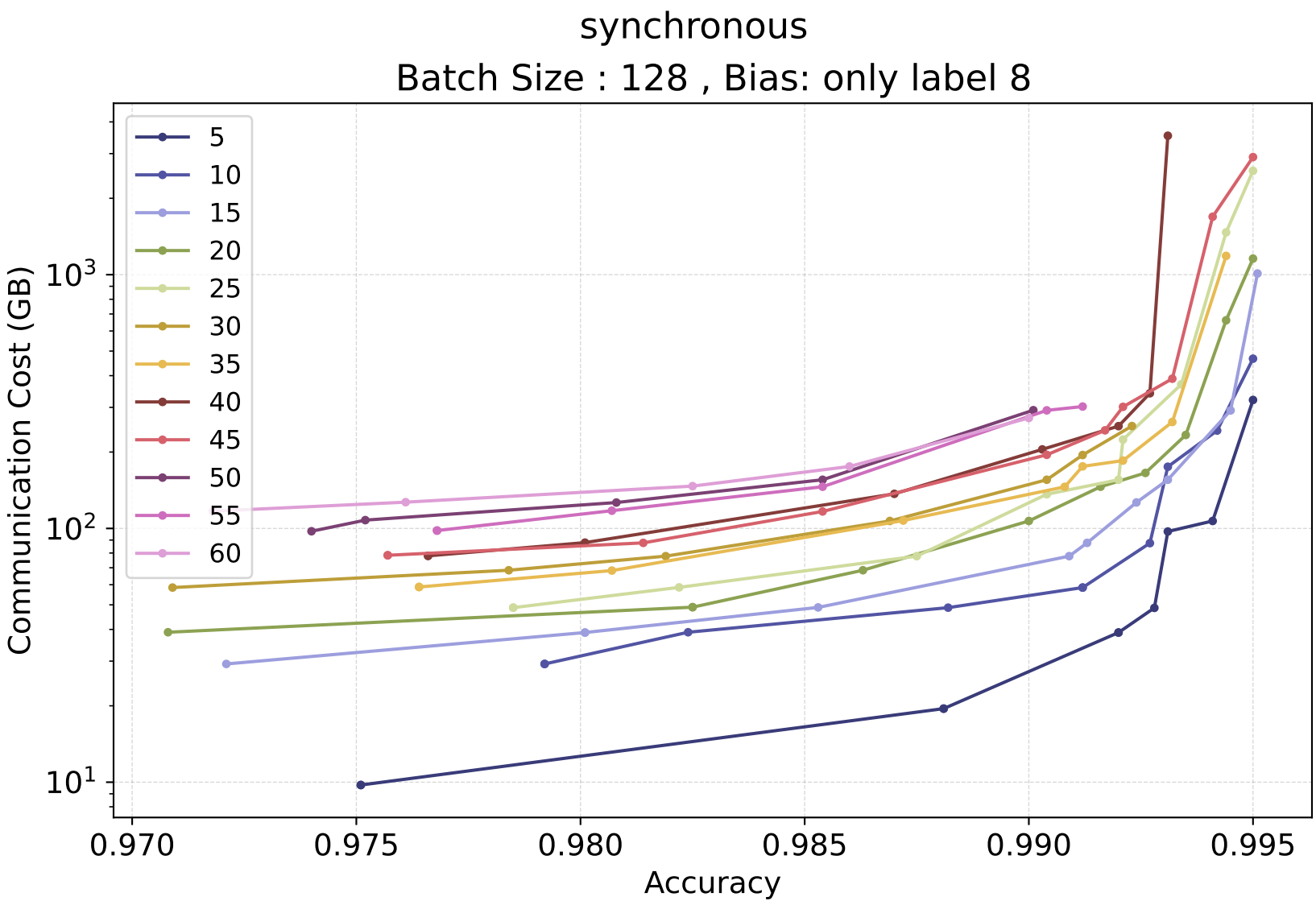
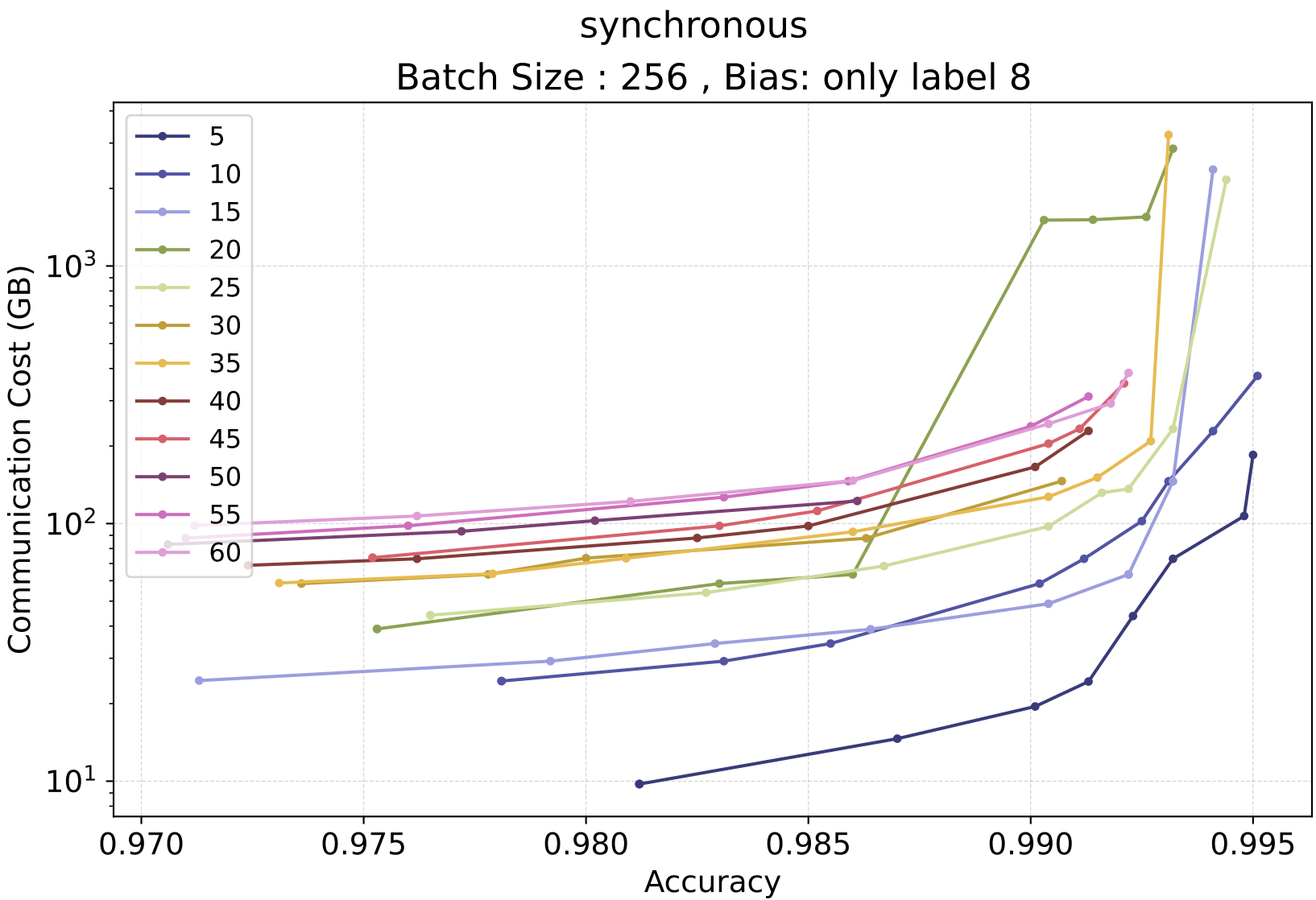
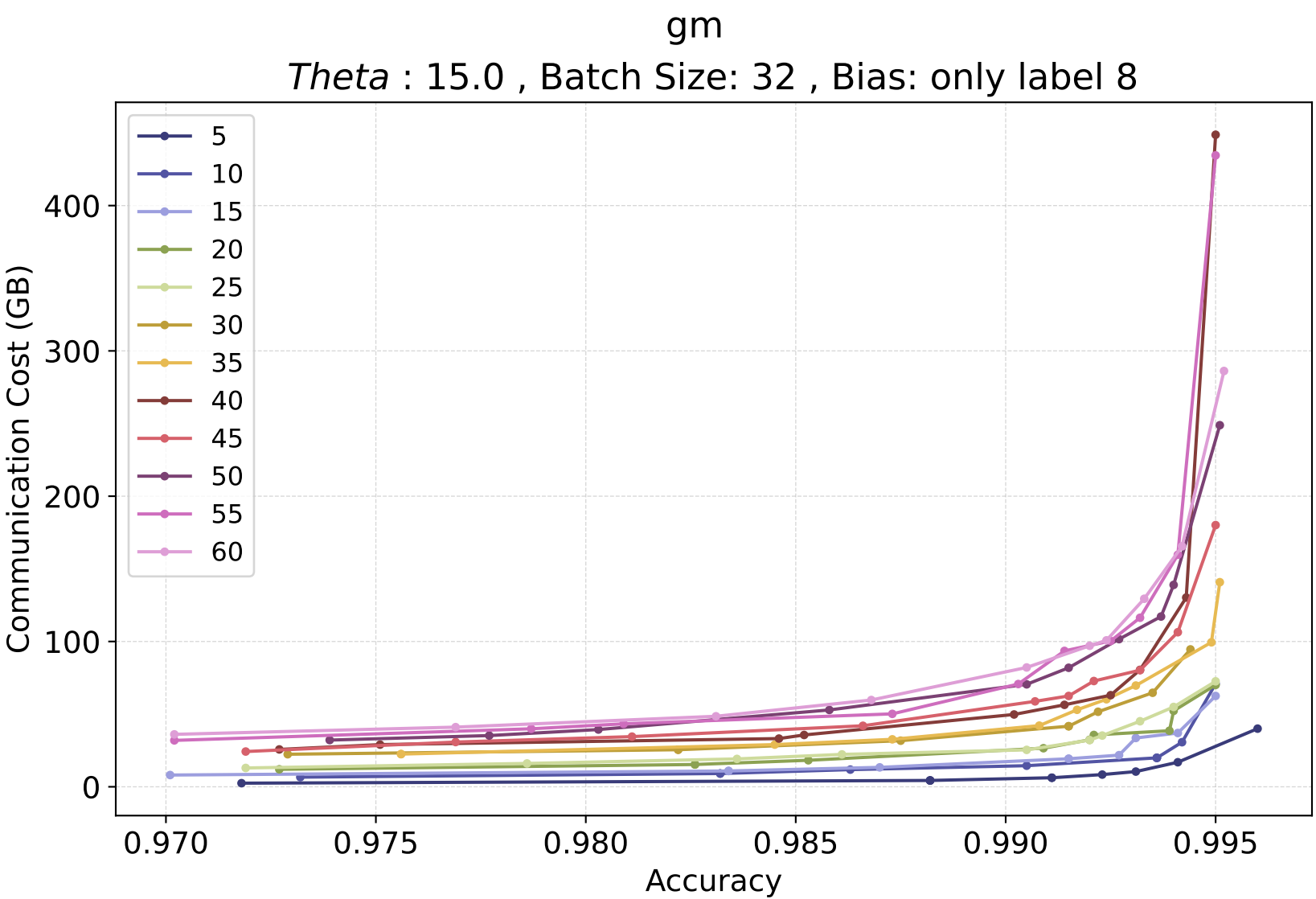
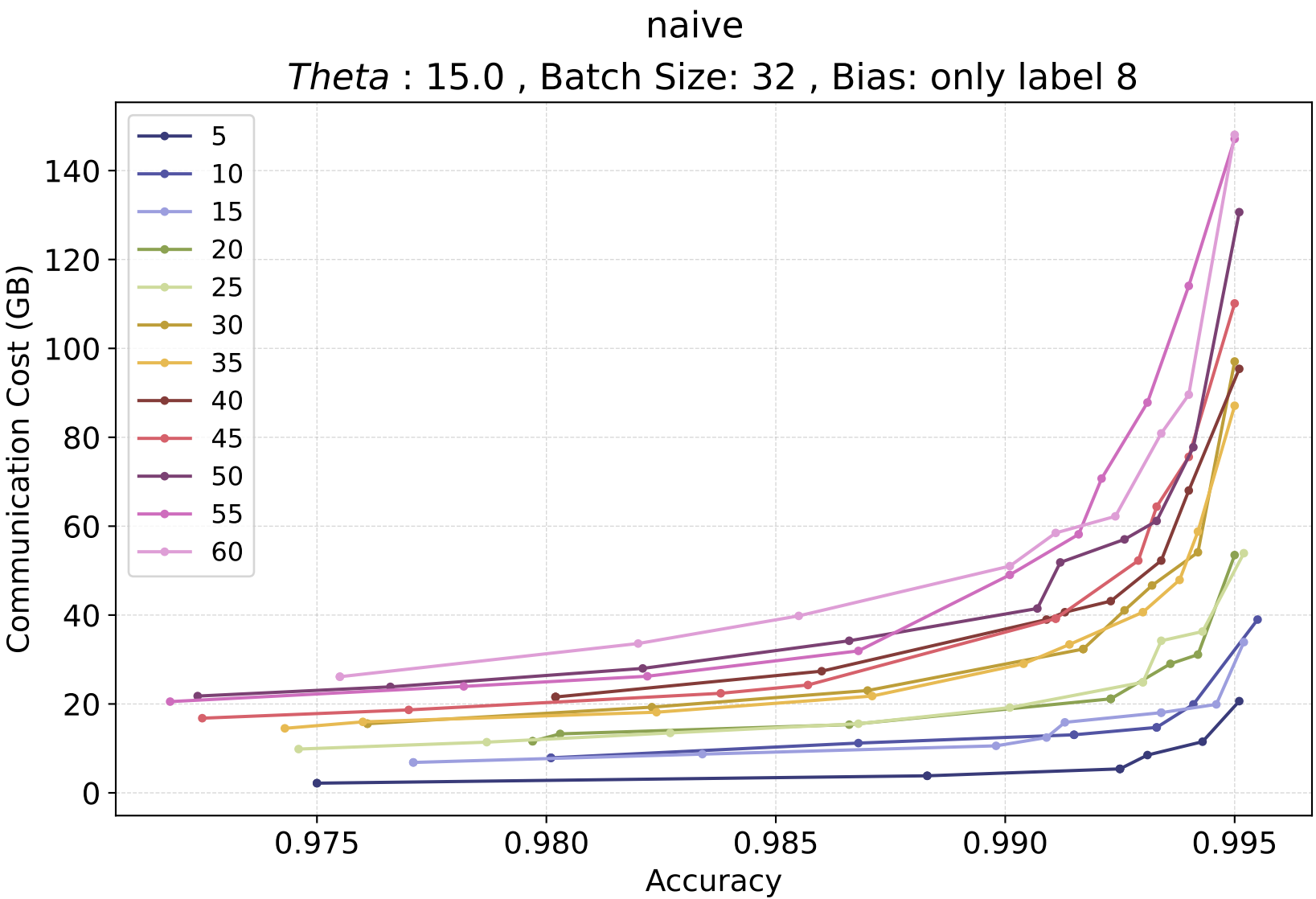

synchronous
Batch Size : 32 , Bias: only label 8
Communication Cost (GB)
10^3
10^2
0.975
0.980
0.985
0.990
0.995
Accuracy
5
10
15
20
25
30
35
40
45
50
55
60

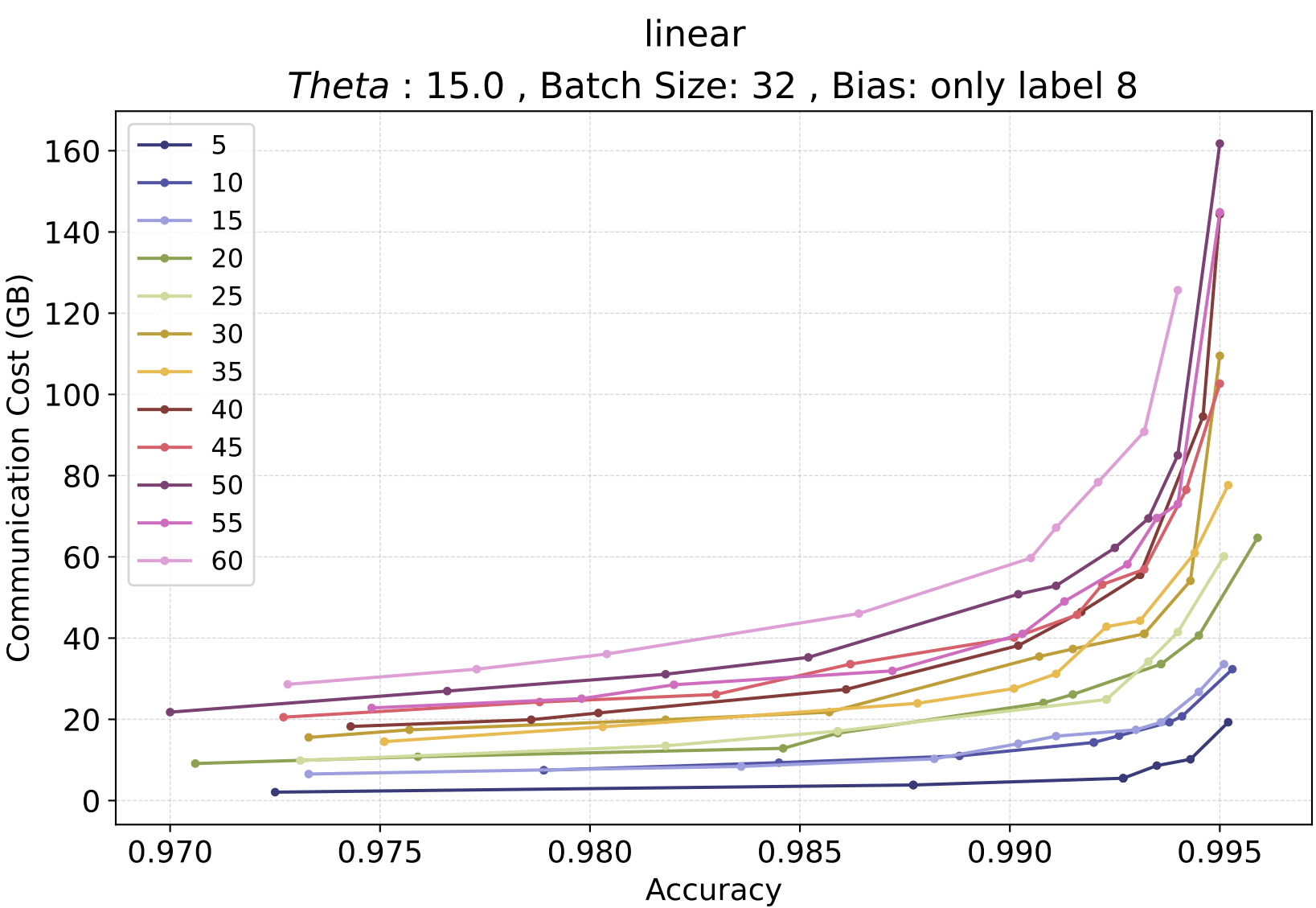

synchronous
Batch Size : 64 , Bias: only label 8
Communication Cost (GB)
10^3
10^2
5
10
15
20
25
30
35
40
45
50
55
60
0.970
0.975
0.980
0.985
0.990
0.995
Accuracy

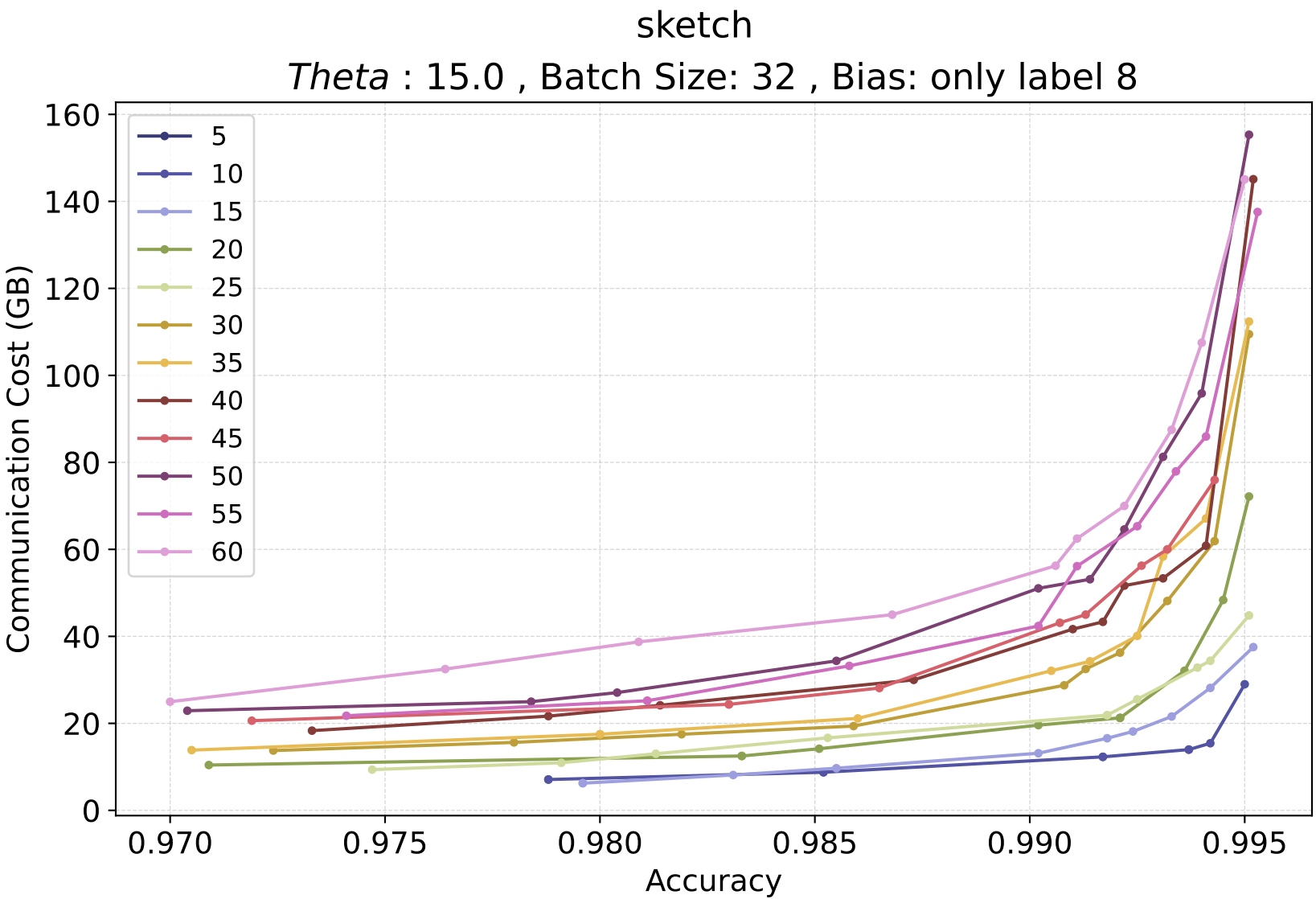

synchronous
Batch Size : 128 , Bias: only label 8
Communication Cost (GB)
10^3
10^2
10^1
0.970
0.975
0.980
0.985
0.990
0.995
Accuracy
5
10
15
20
25
30
35
40
45
50
55
60

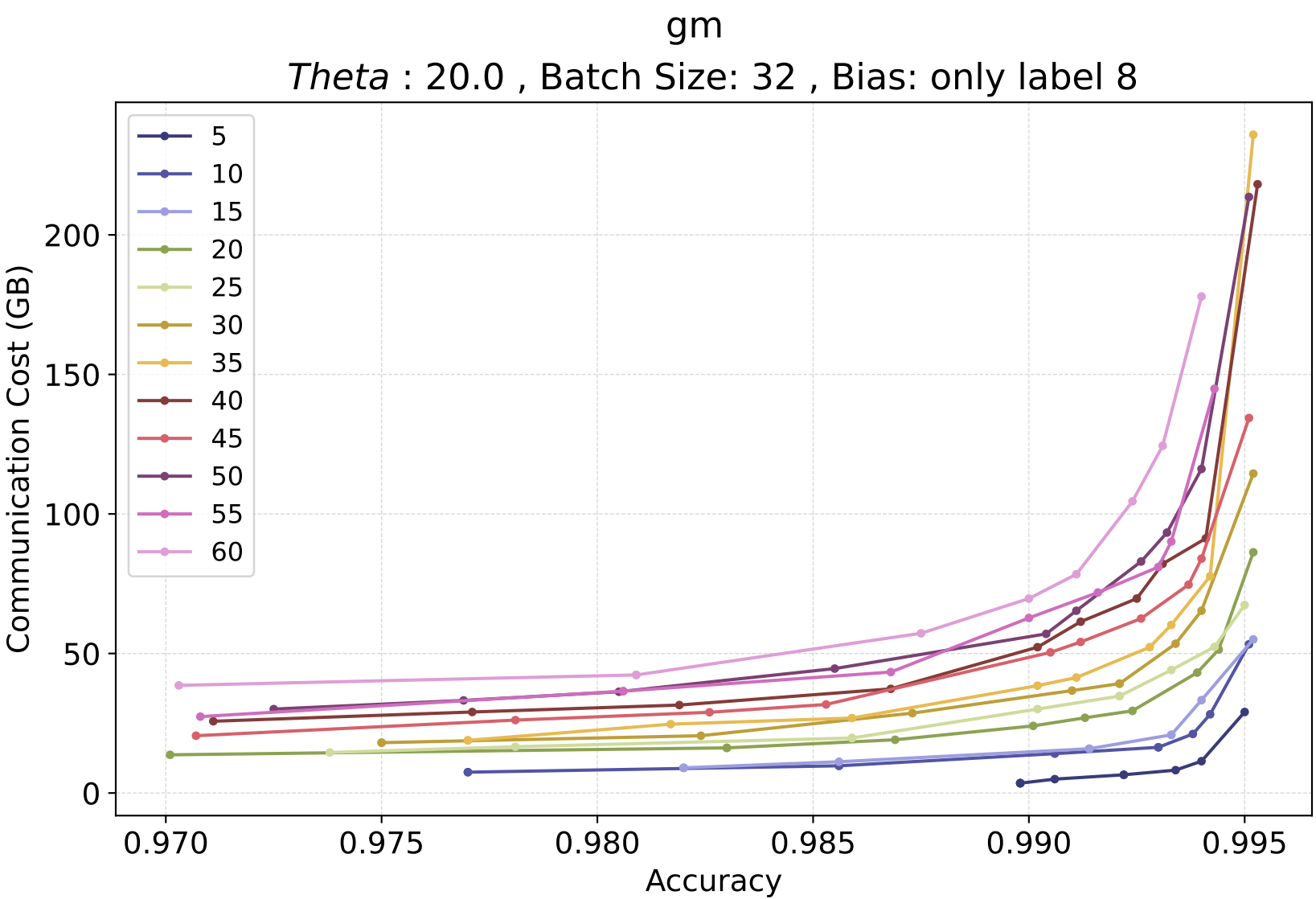

synchronous
Batch Size : 256 , Bias: only label 8
Communication Cost (GB)
10^3
10^2
10^1
0.970
0.975
0.980
0.985
0.990
0.995
Accuracy
5
10
15
20
25
30
35
40
45
50
55
60

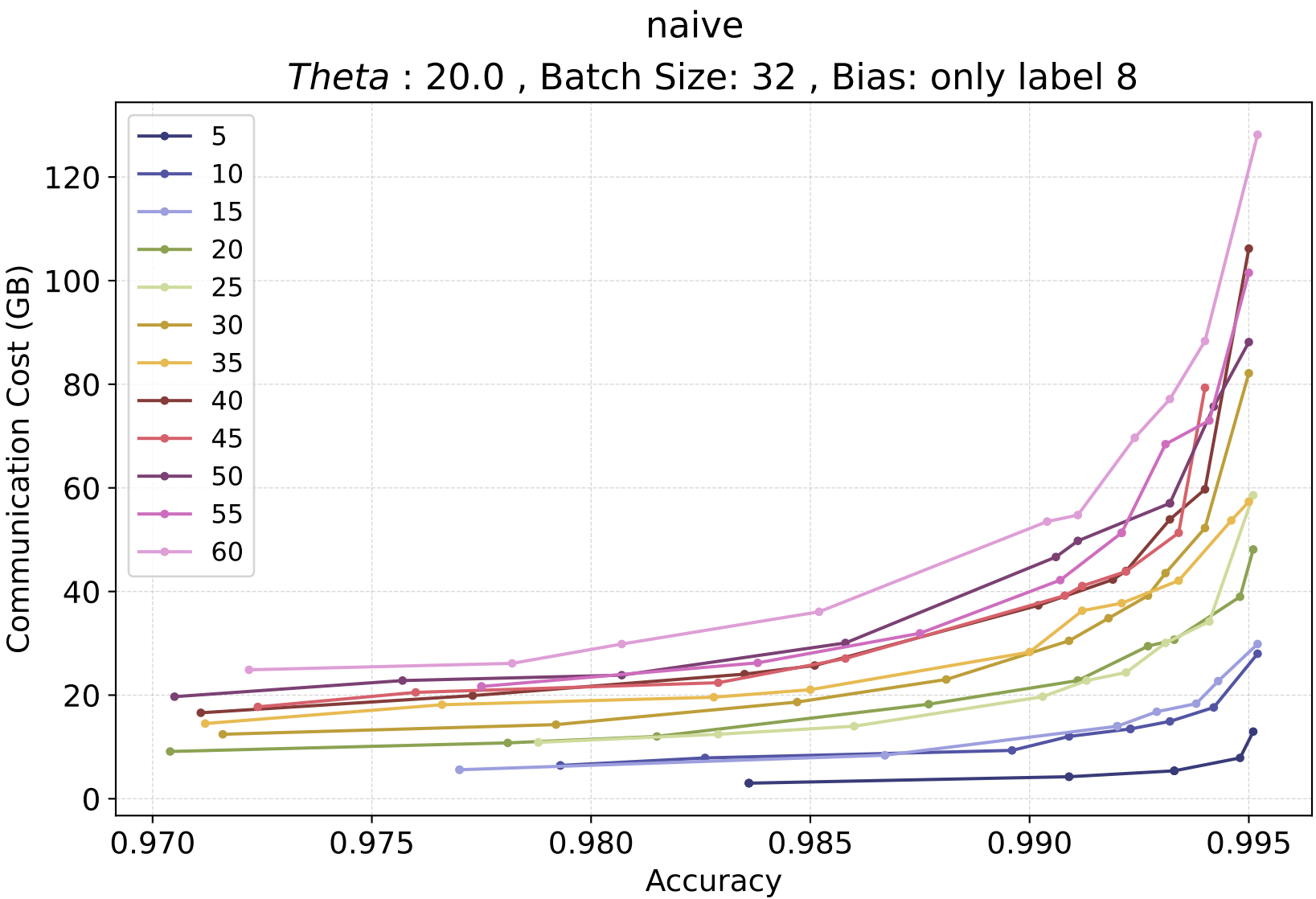

gm
Theta : 15.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
100
200
300
400
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

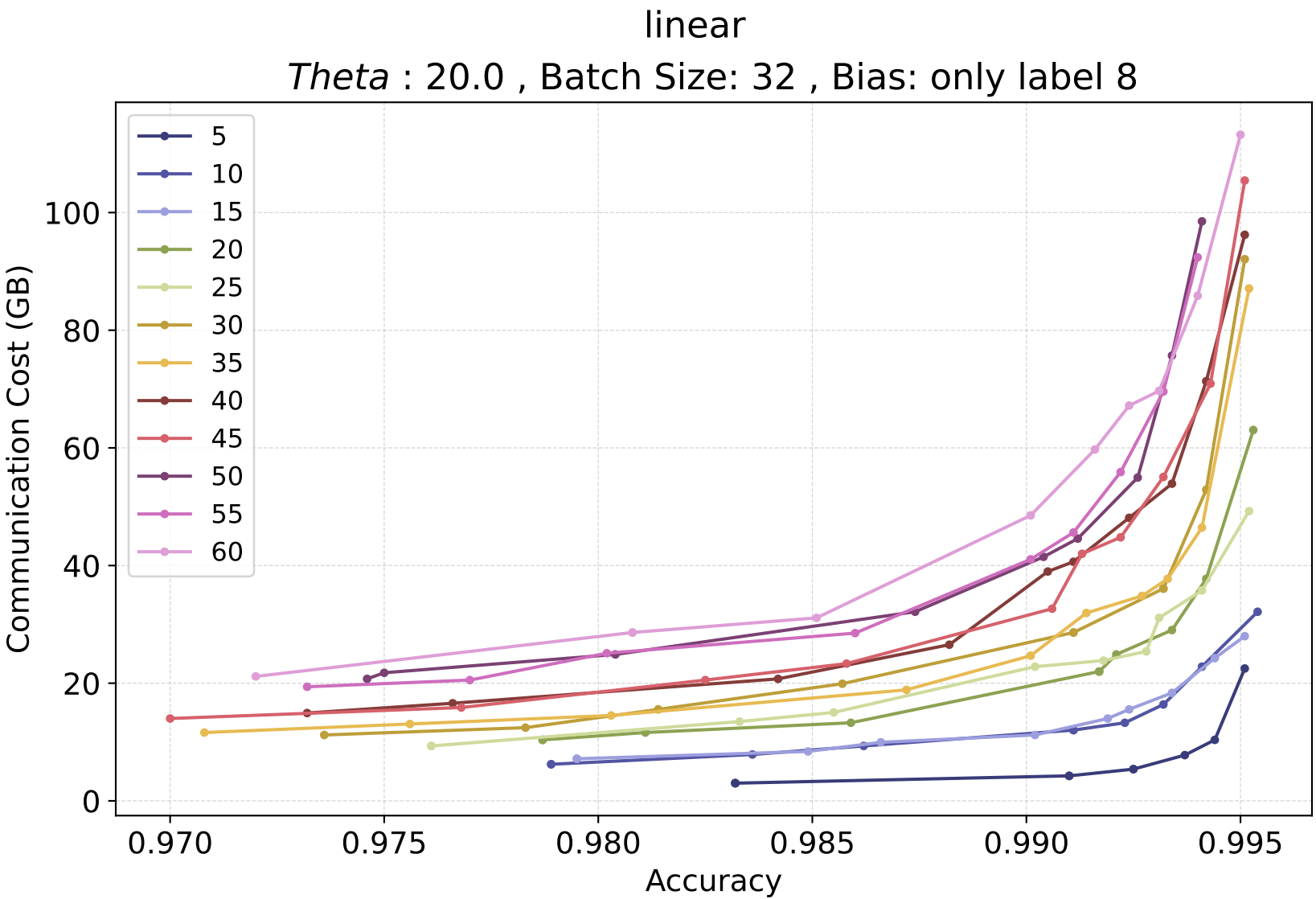

naive
Theta : 15.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
120
140
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

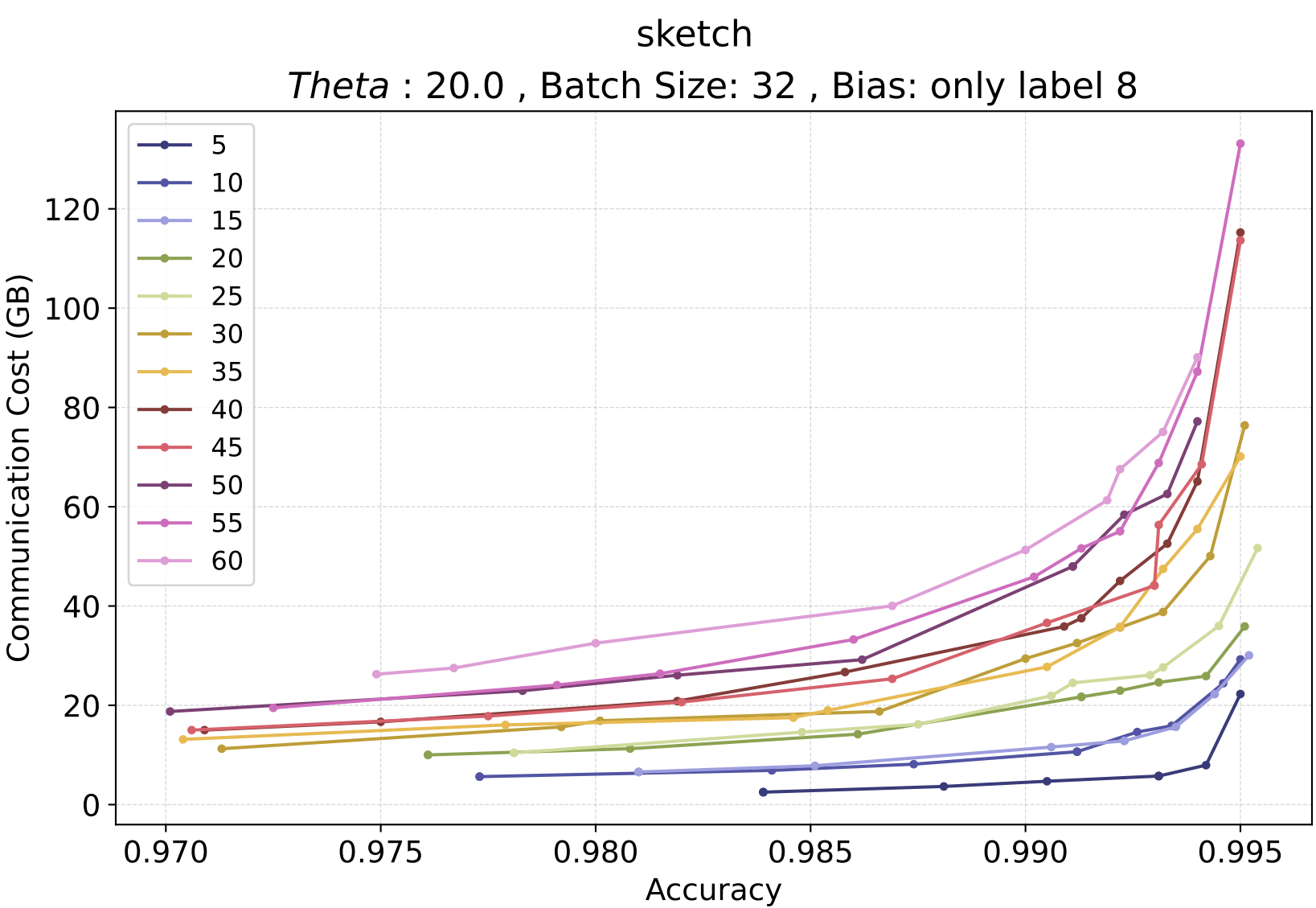

linear
Theta : 15.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
120
140
160
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

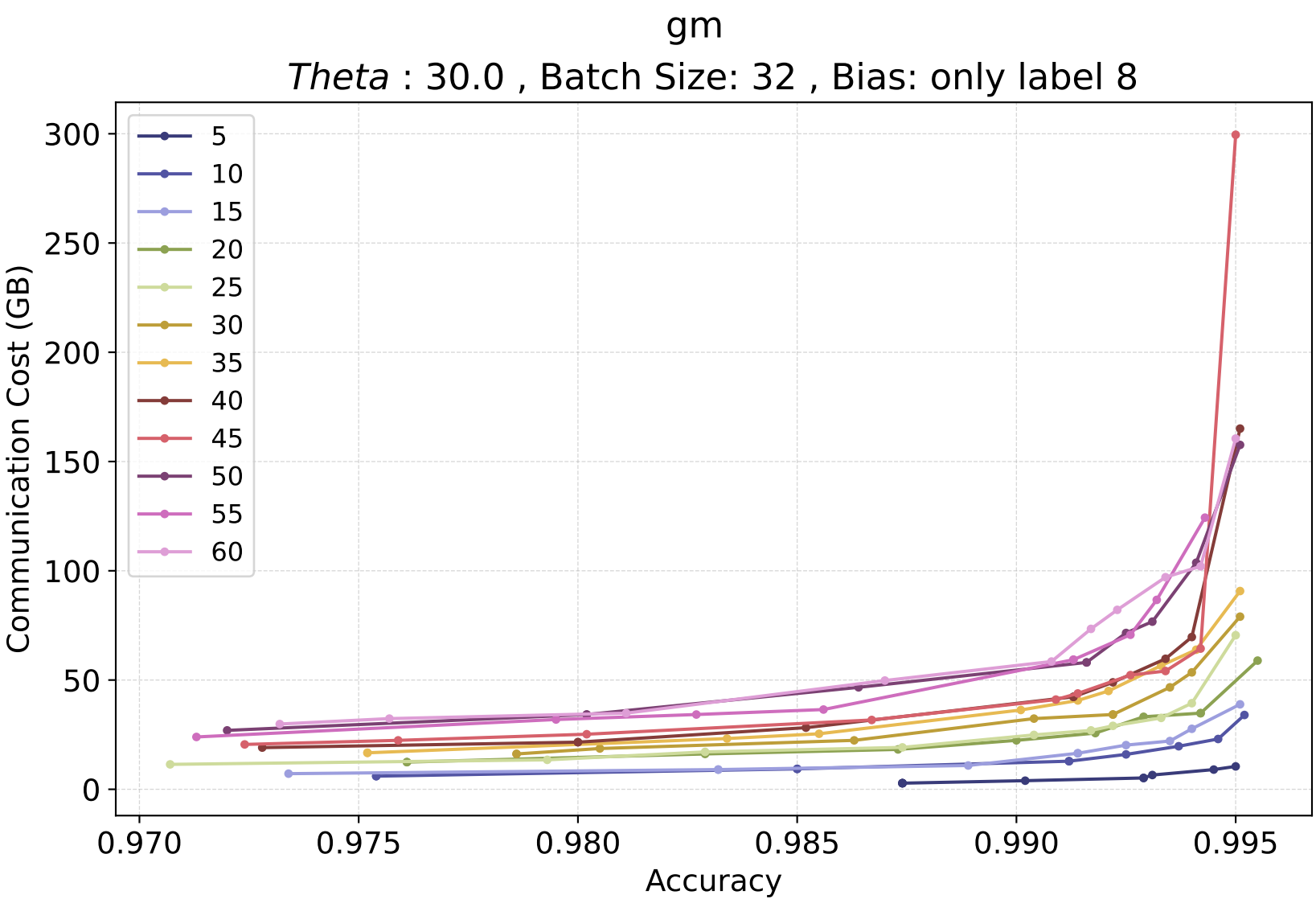

sketch
Theta : 15.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
120
140
160
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

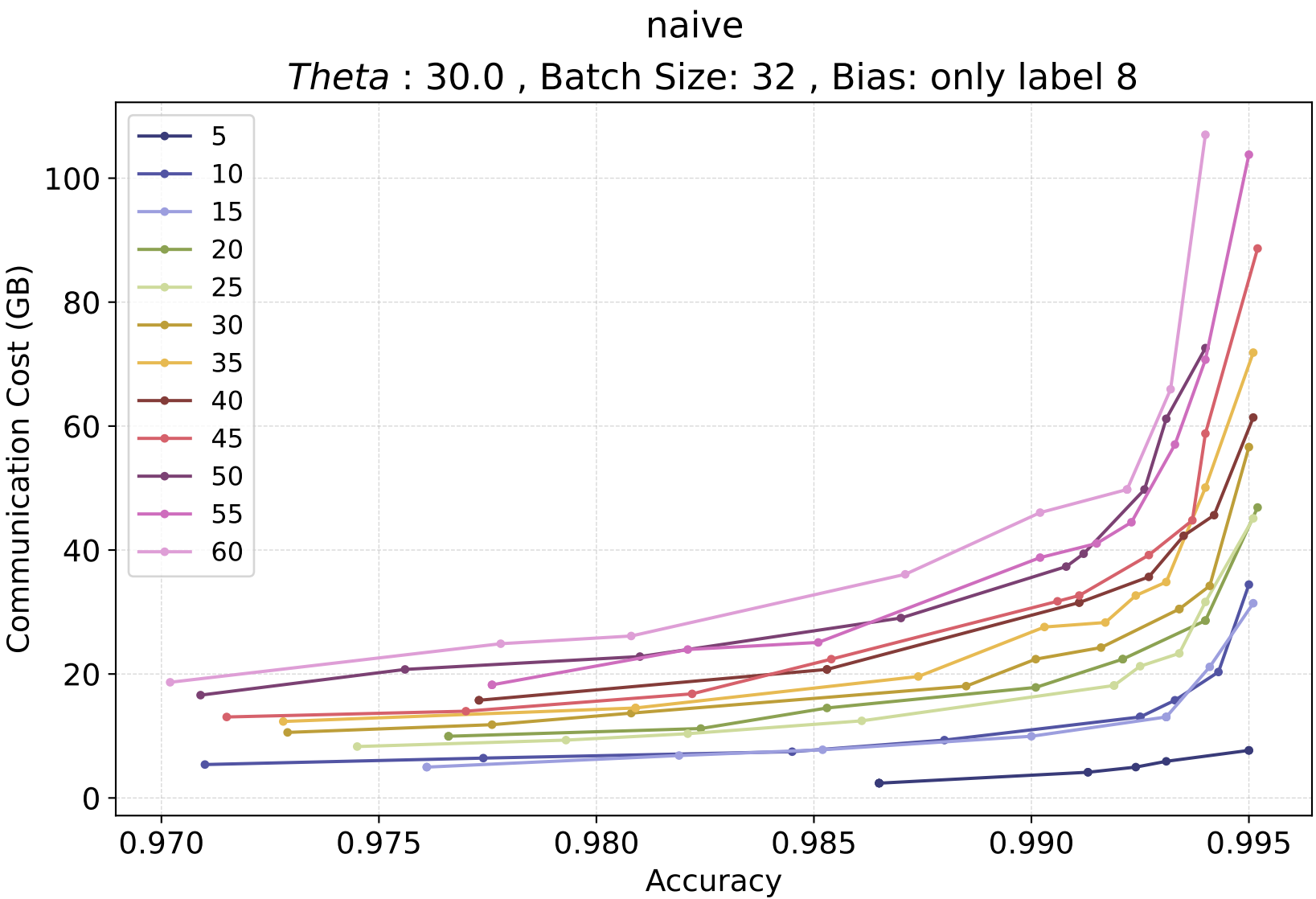

gm
Theta : 20.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
50
100
150
200
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

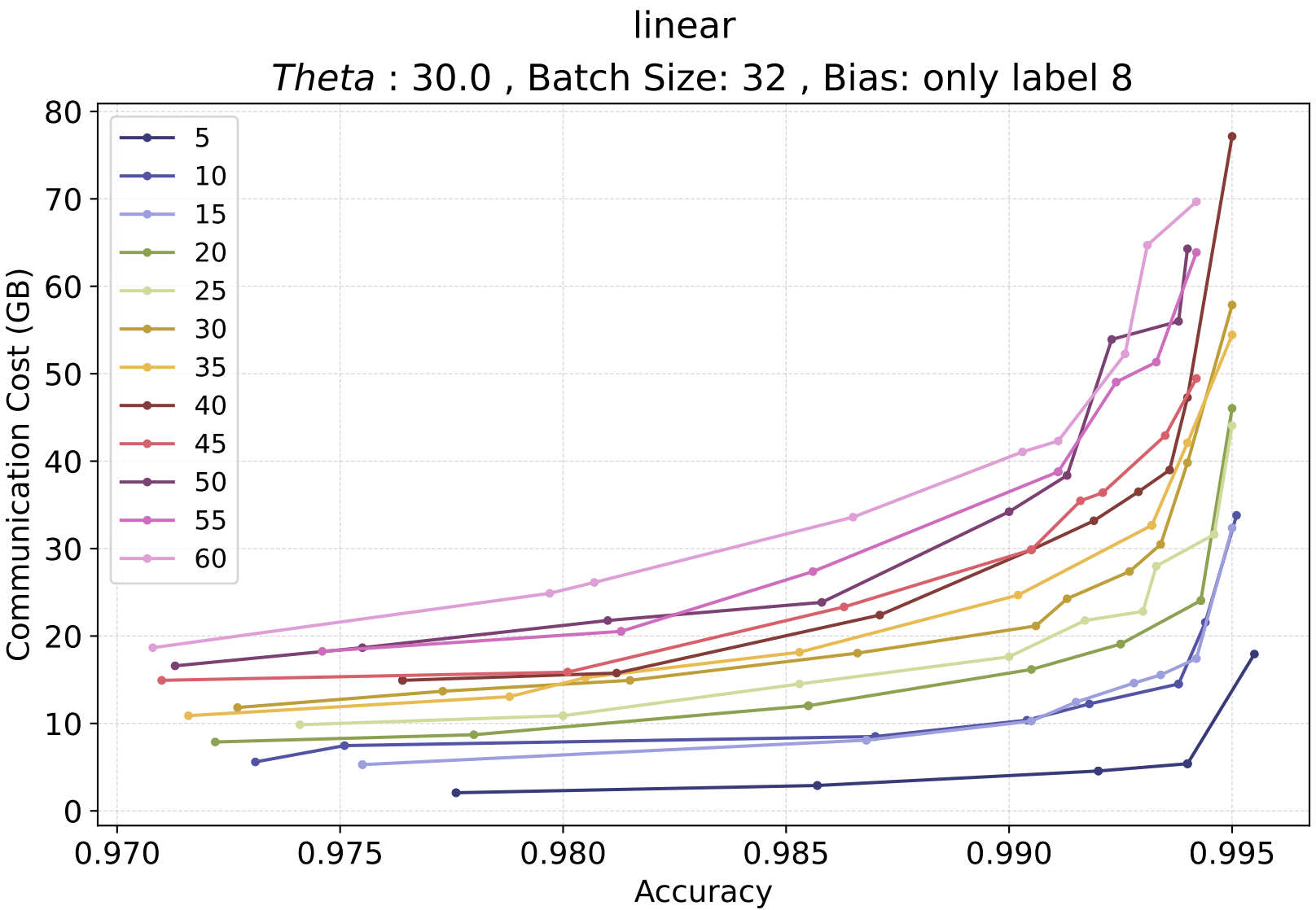

naive
Theta : 20.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
120
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

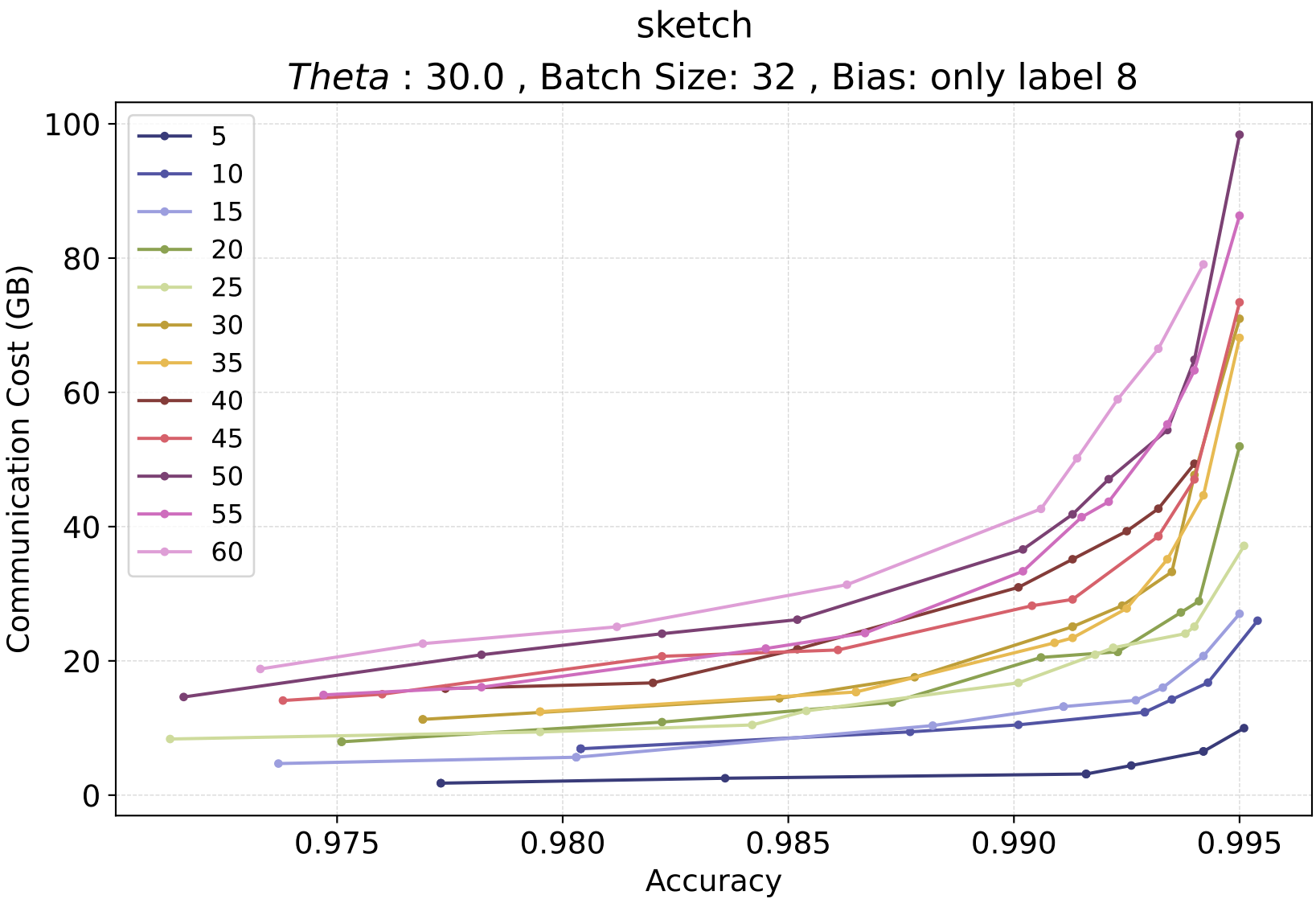

linear
Theta : 20.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

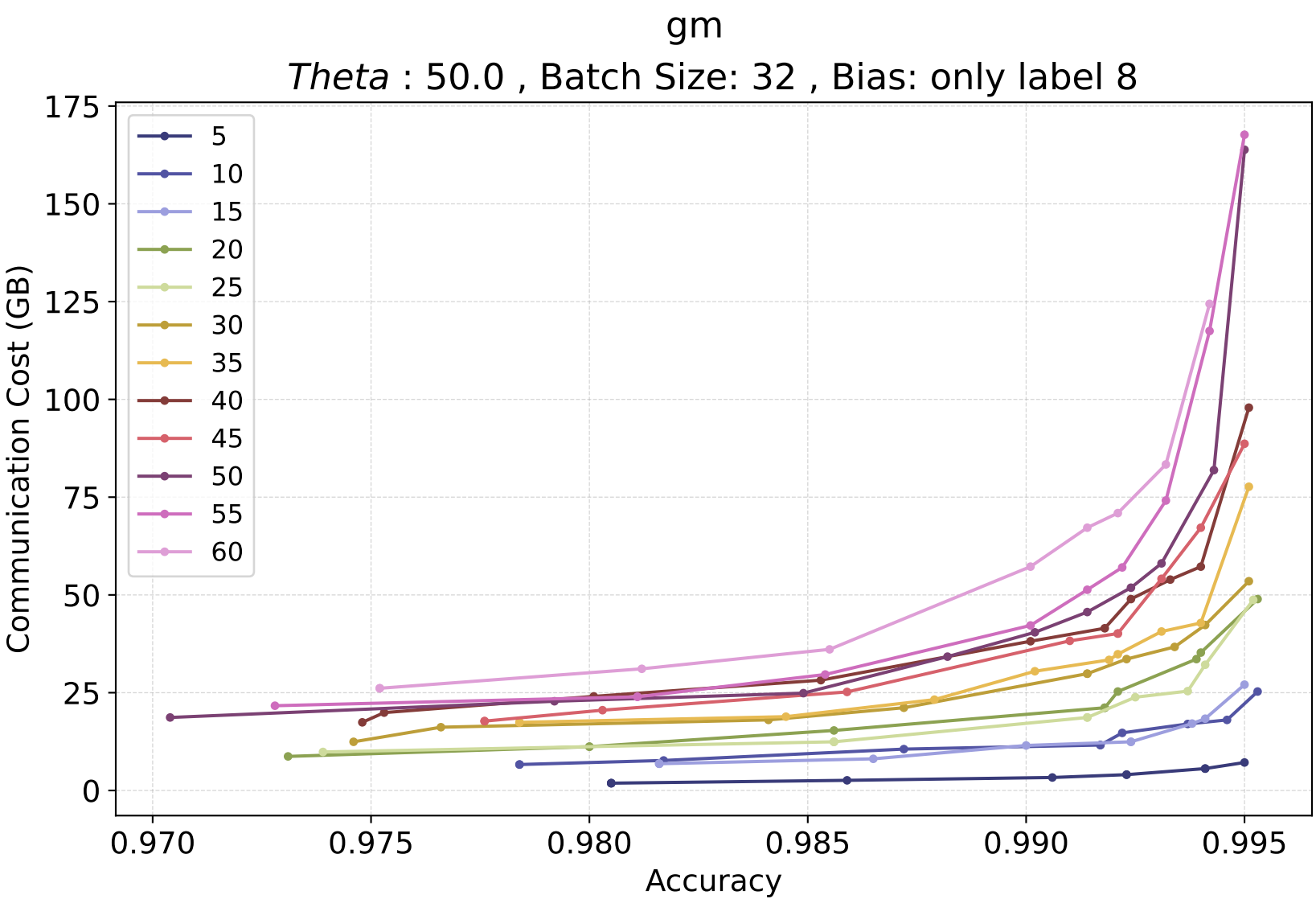

sketch
Theta : 20.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
120
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

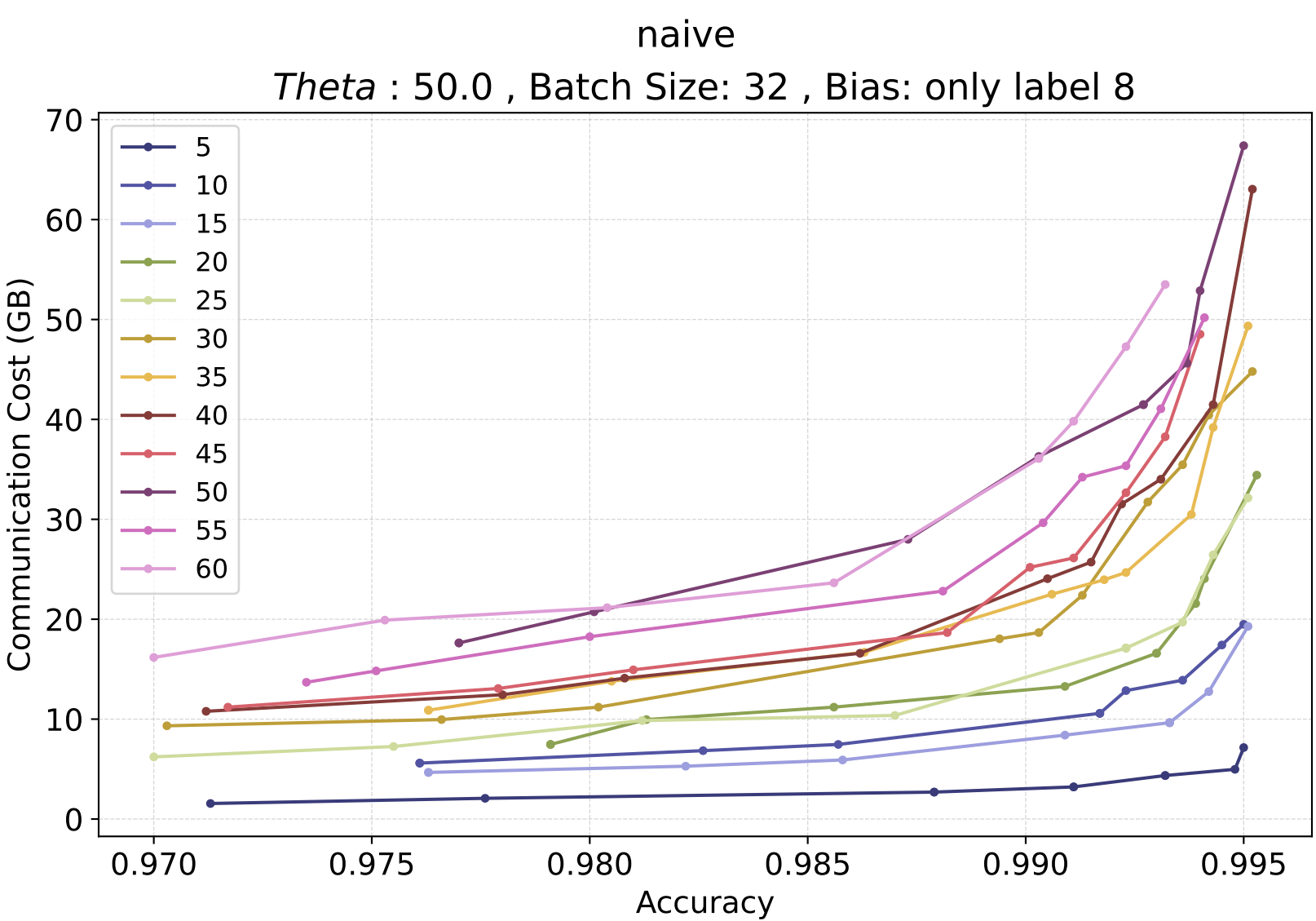

gm
Theta : 30.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
50
100
150
200
250
300
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

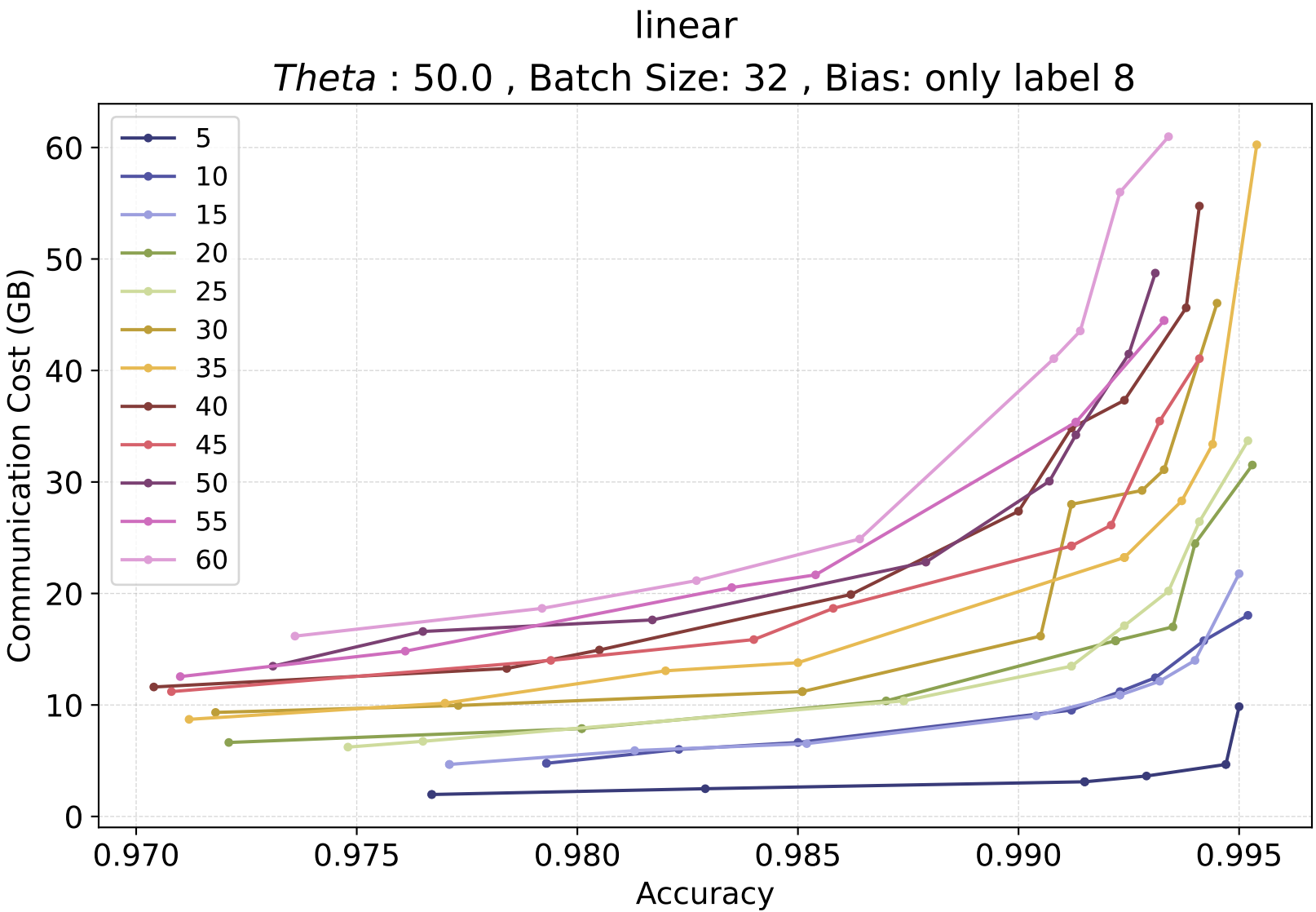

naive
Theta : 30.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

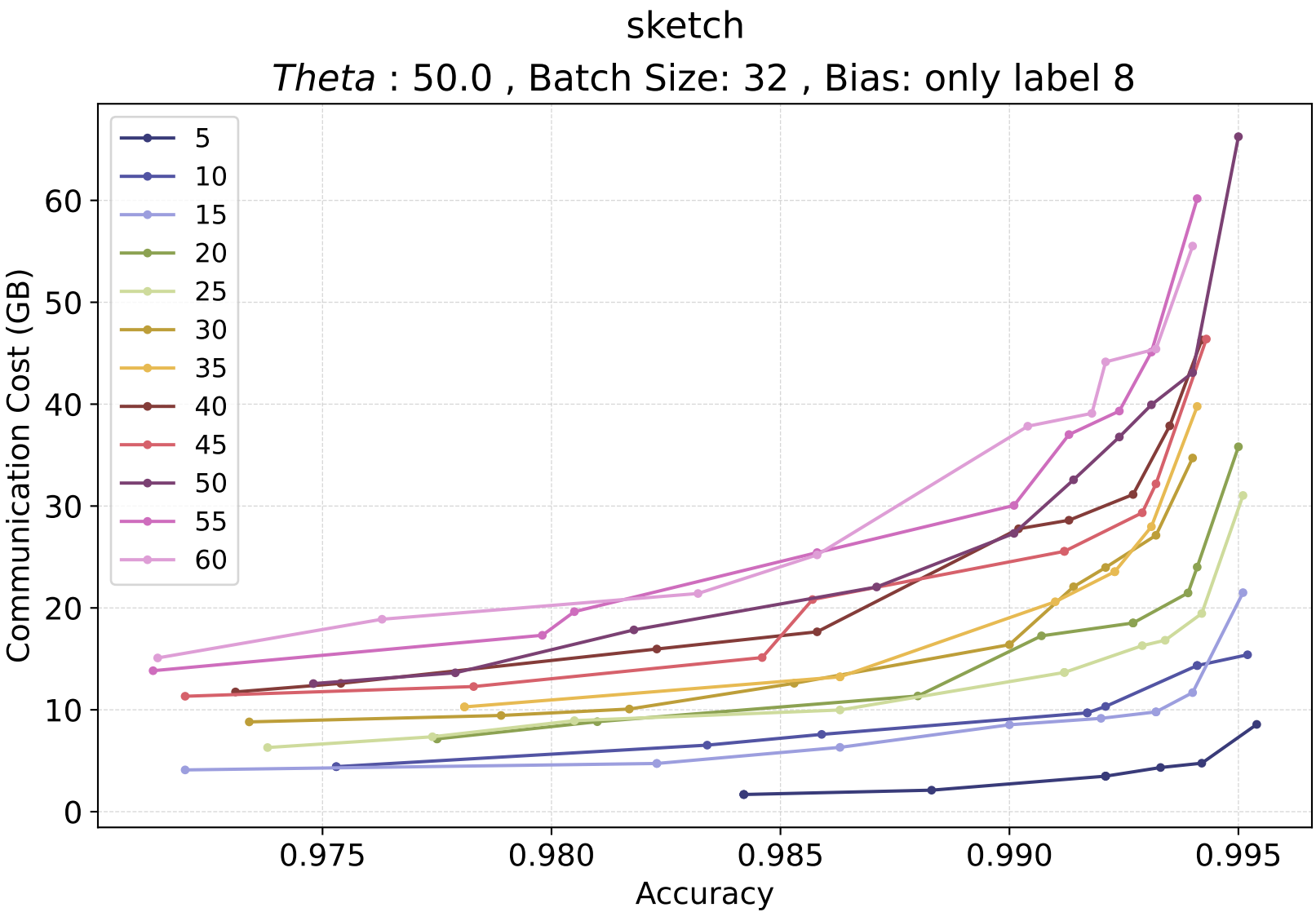

linear
Theta : 30.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
10
20
30
40
50
60
70
80
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60


sketch
Theta : 30.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60


gm
Theta : 50.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
25
50
75
100
125
150
175
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60


naive
Theta : 50.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
10
20
30
40
50
60
70
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60


linear
Theta : 50.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
10
20
30
40
50
60
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60


sketch
Theta : 50.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
10
20
30
40
50
60
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
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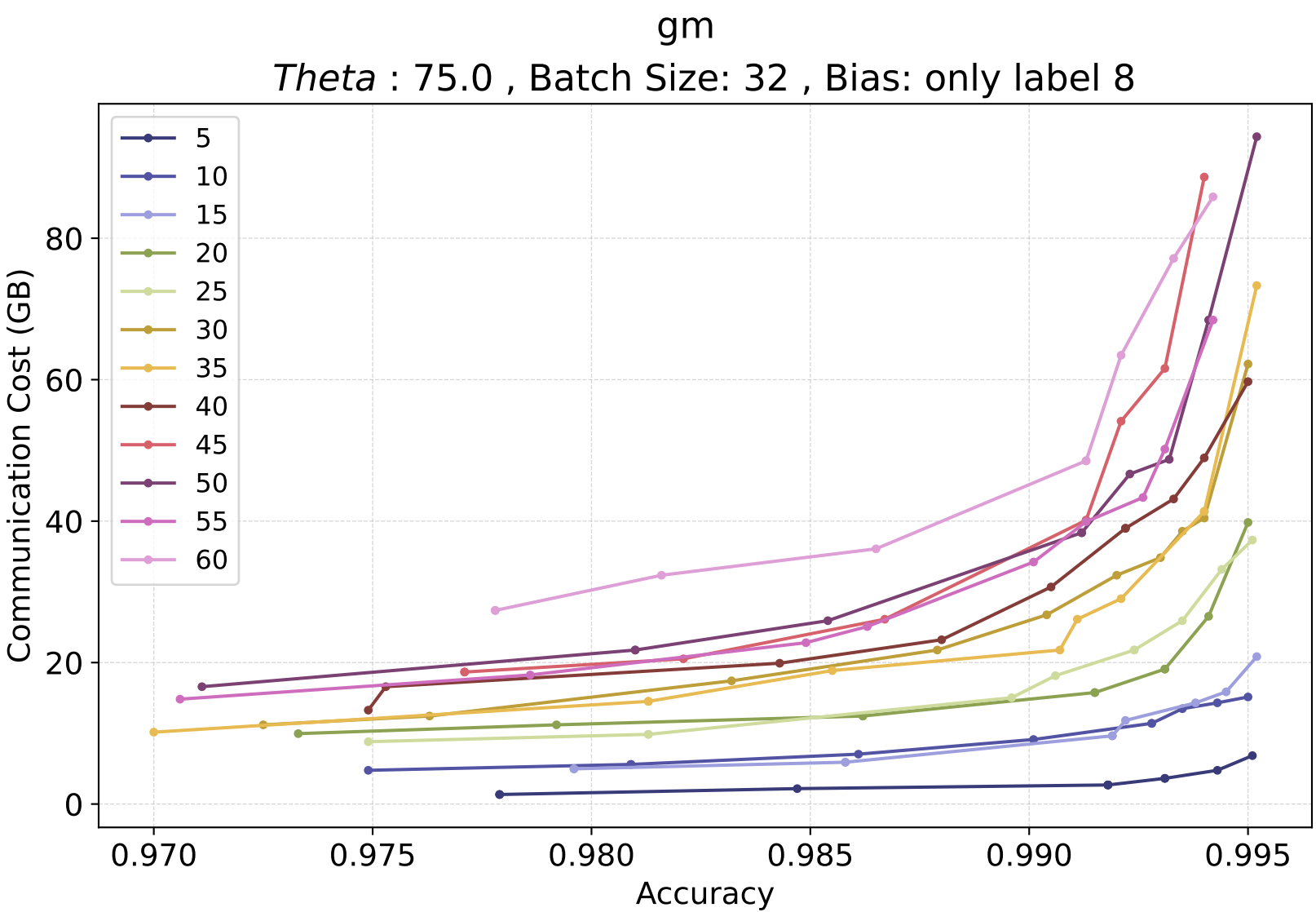
45
50
55
60


gm
Theta : 75.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
20
40
60
80
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
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45
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55
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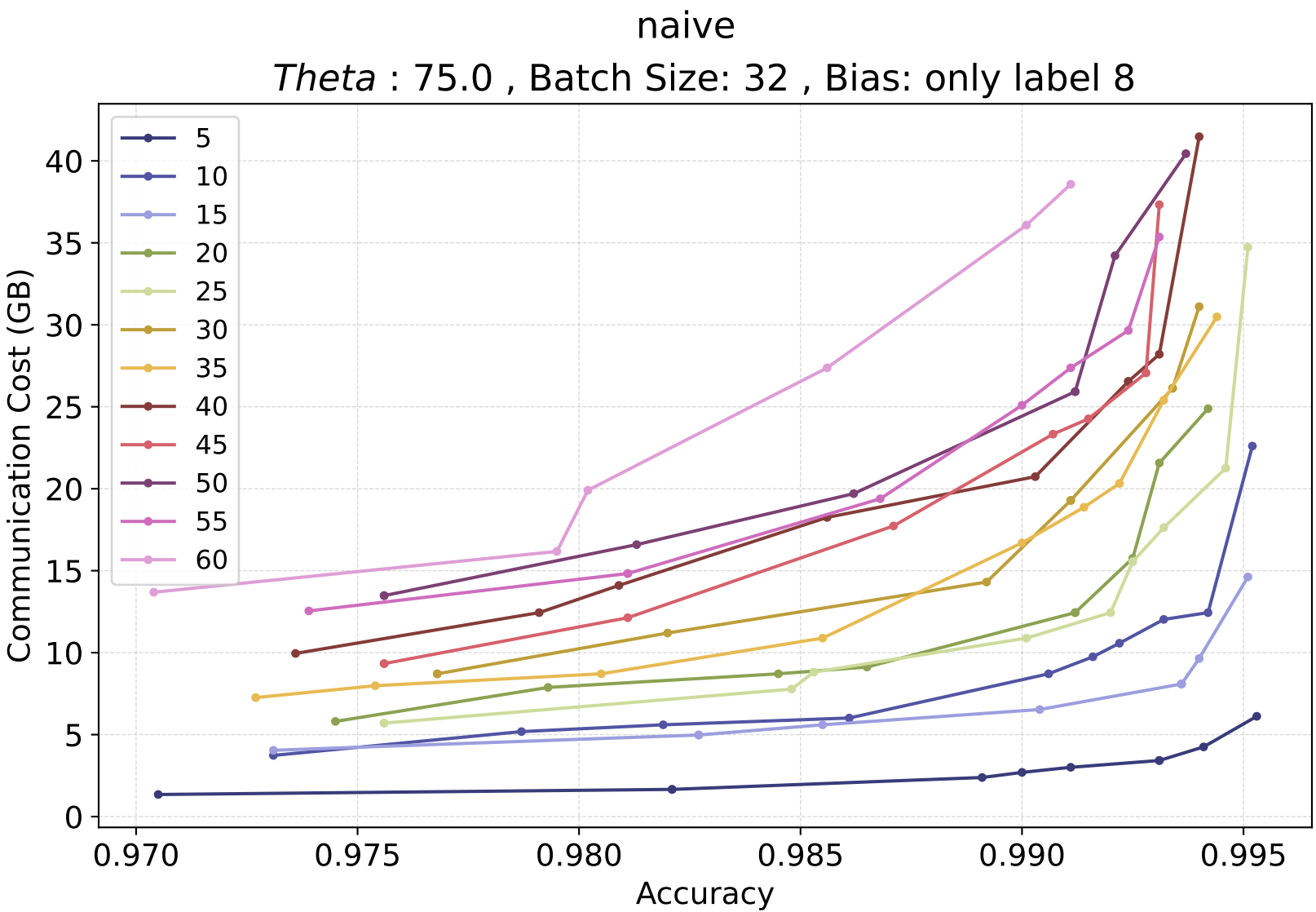
naive
Theta : 75.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
5
10
15
20
25
30
35
40
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
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25
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45
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55
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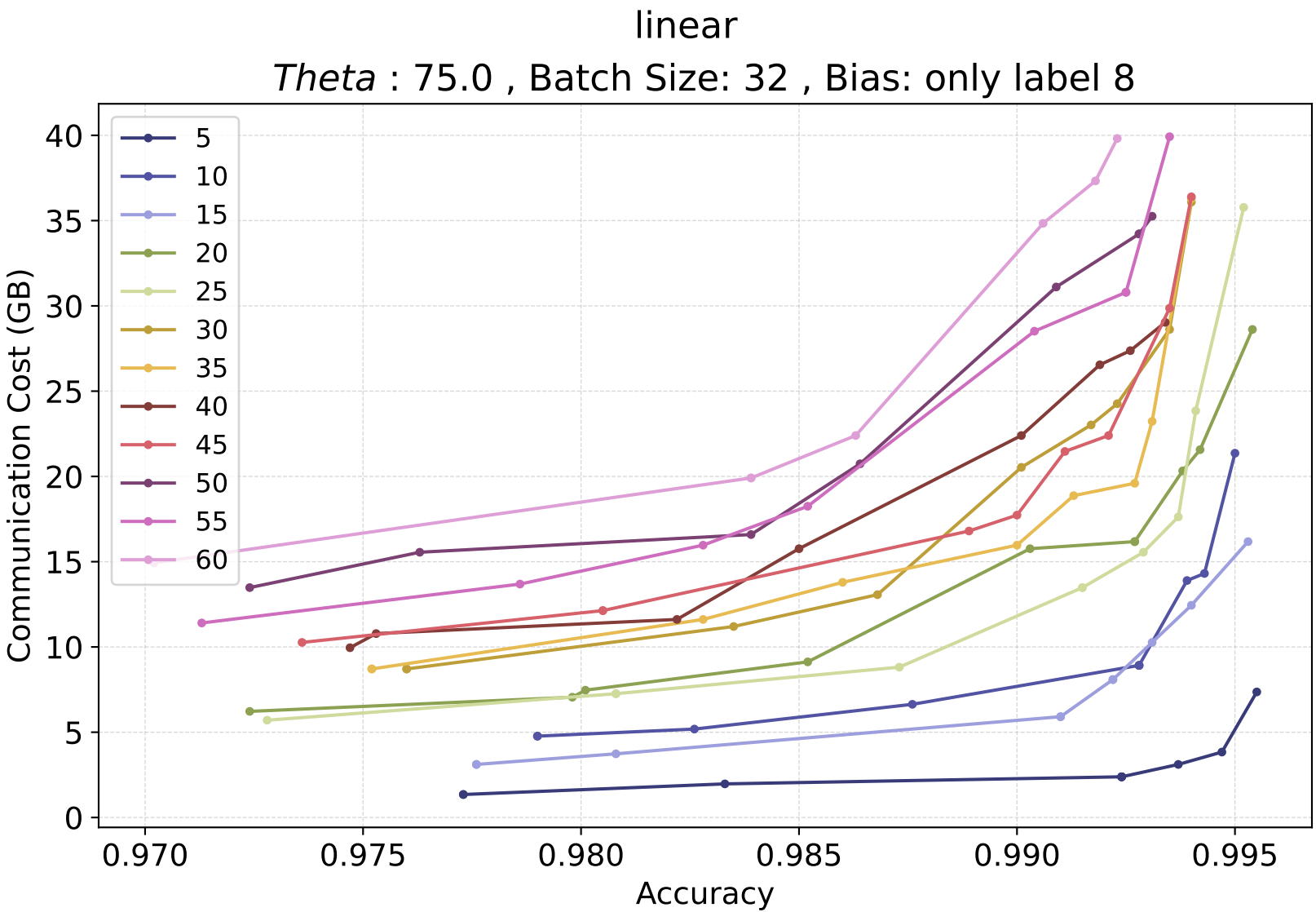
linear
Theta : 75.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
5
10
15
20
25
30
35
40
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
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25
30
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45
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55
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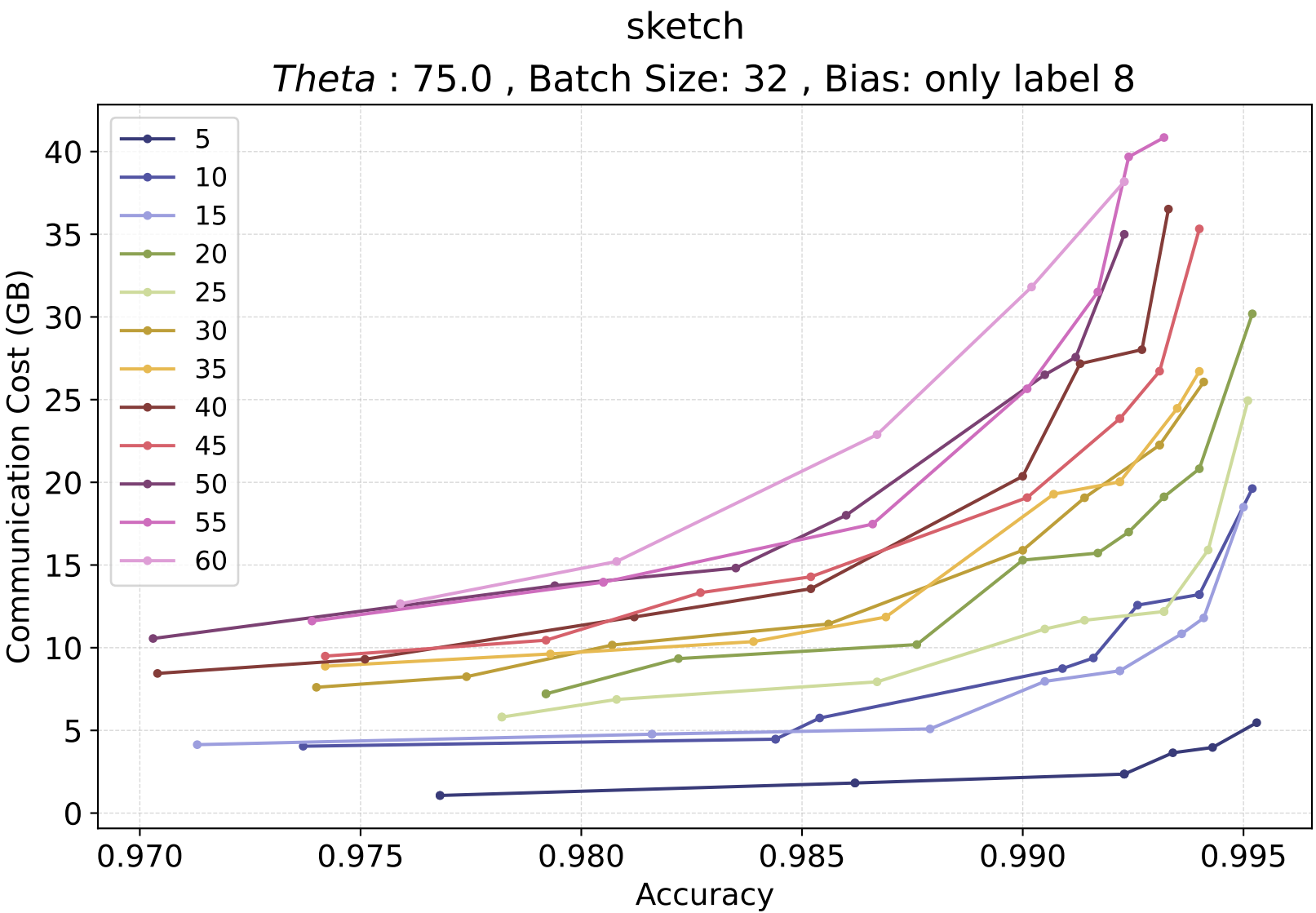
sketch
Theta : 75.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
5
10
15
20
25
30
35
40
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
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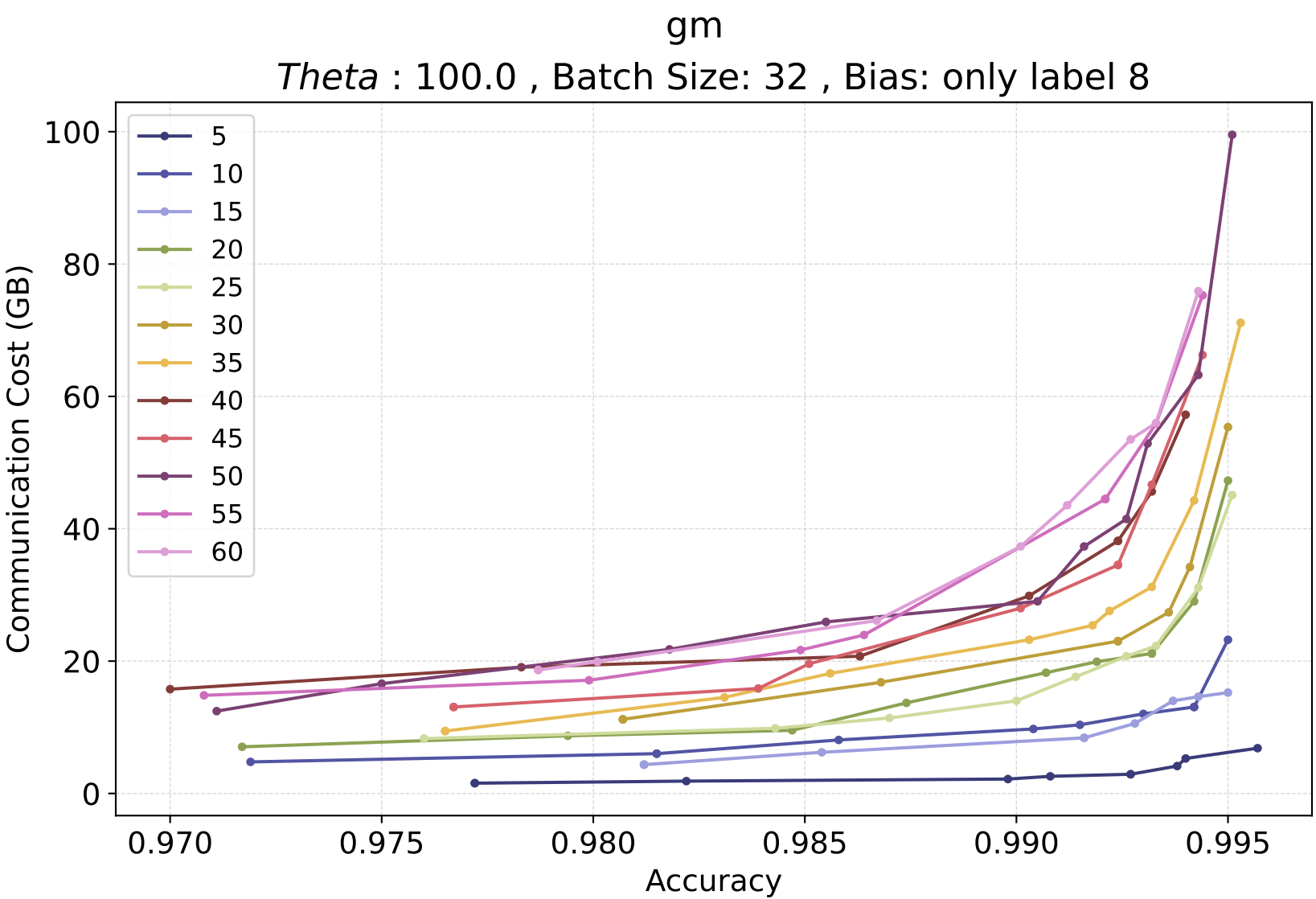
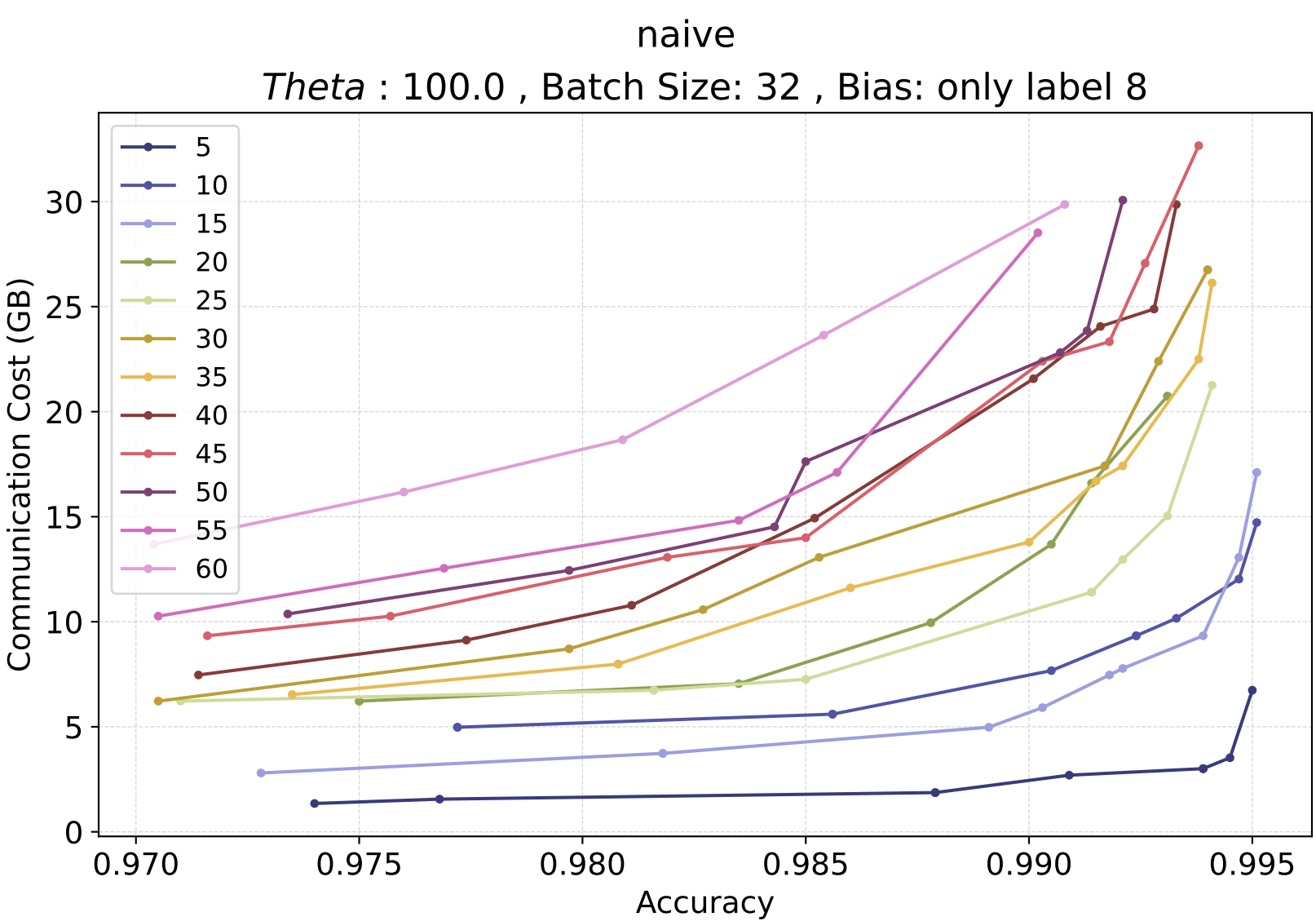
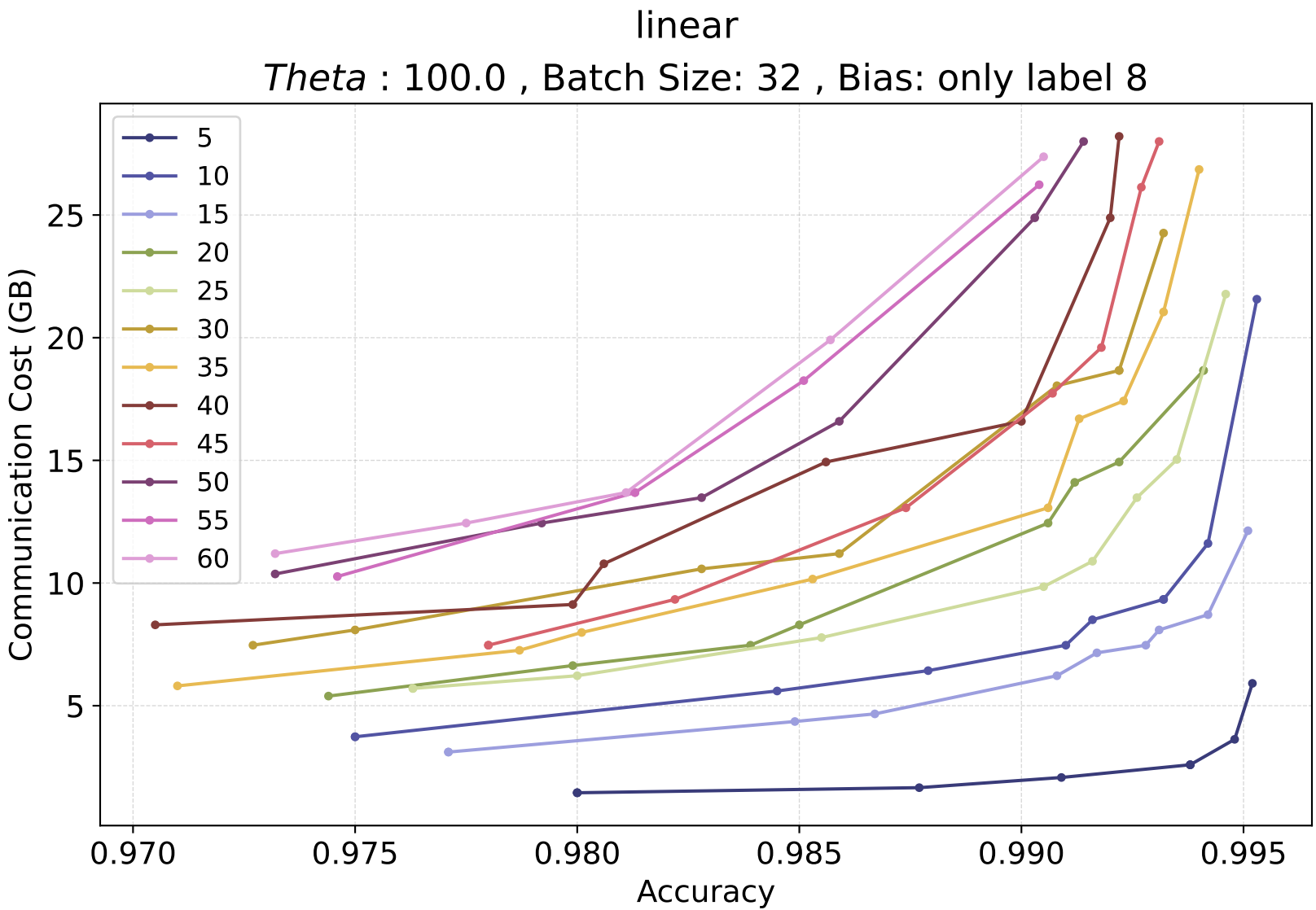
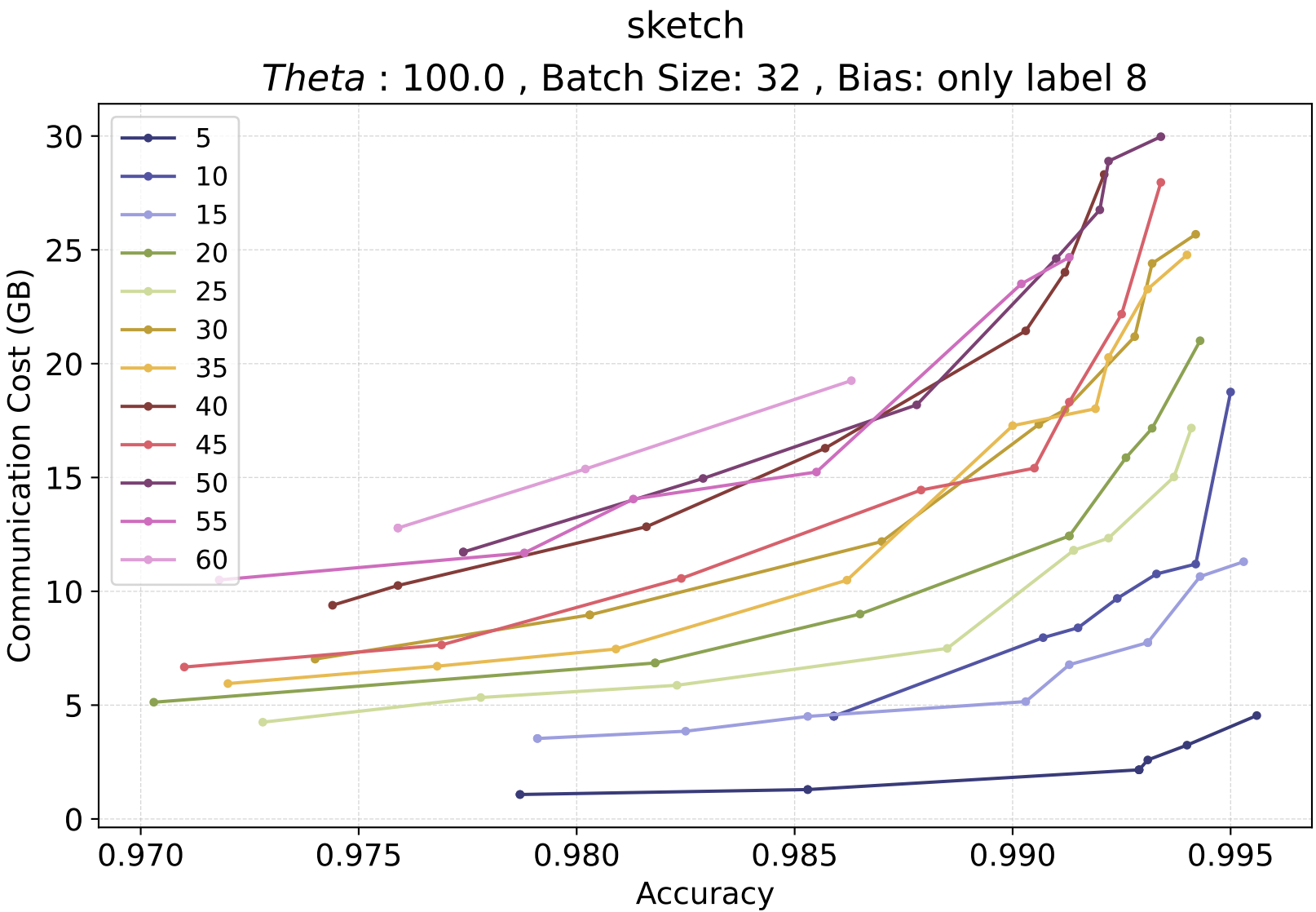
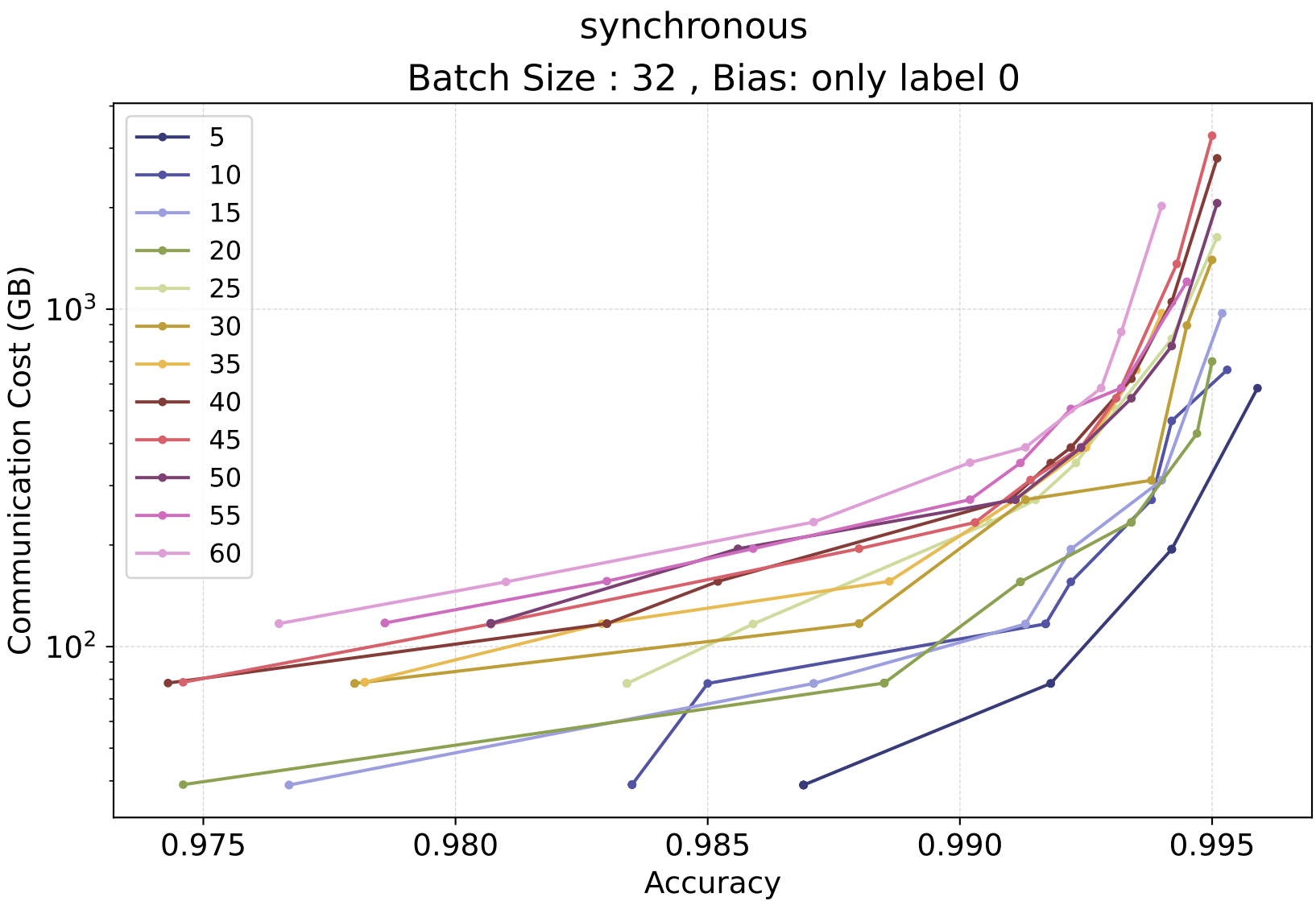
45
50
55
60

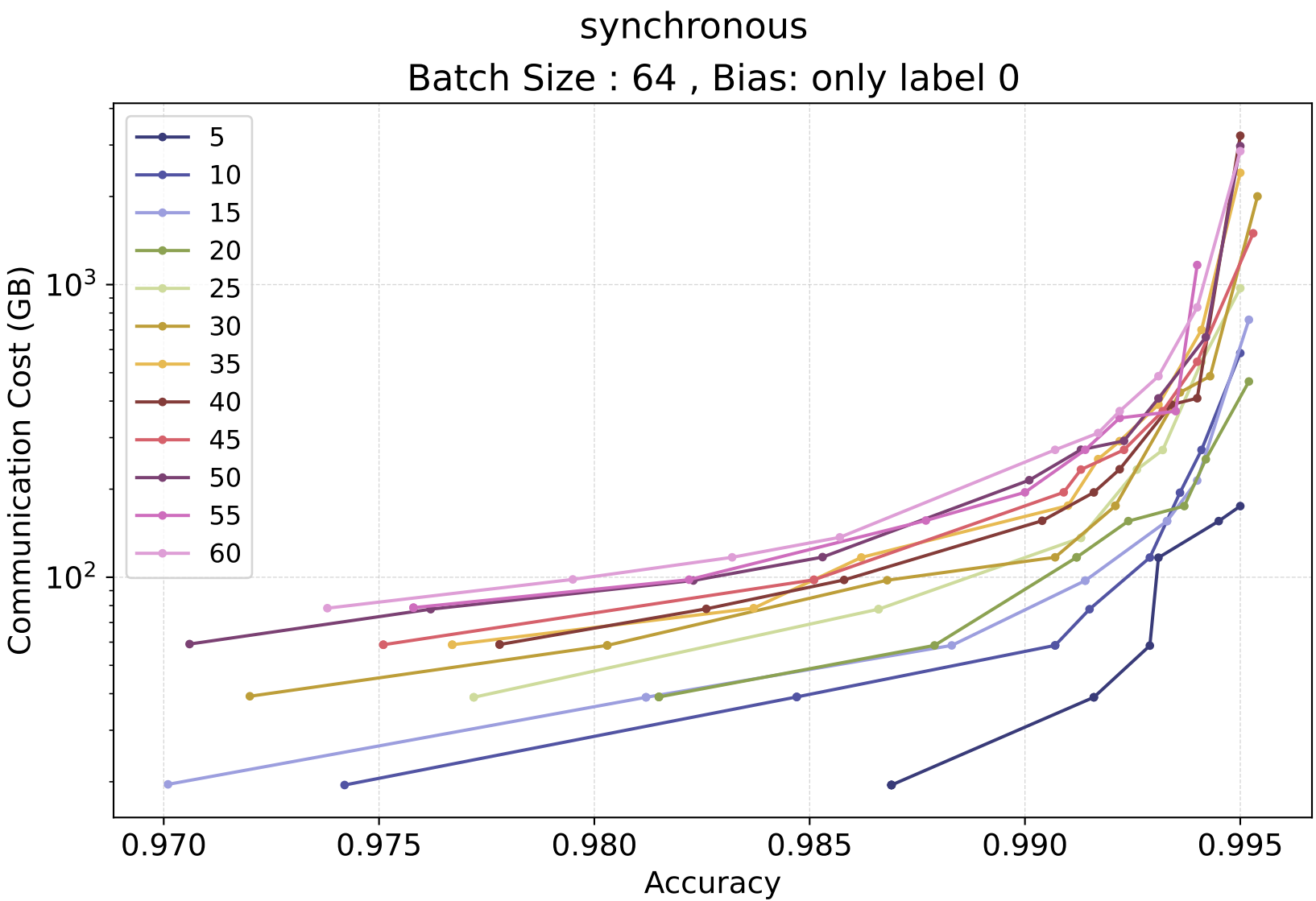

gm
Theta : 100.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

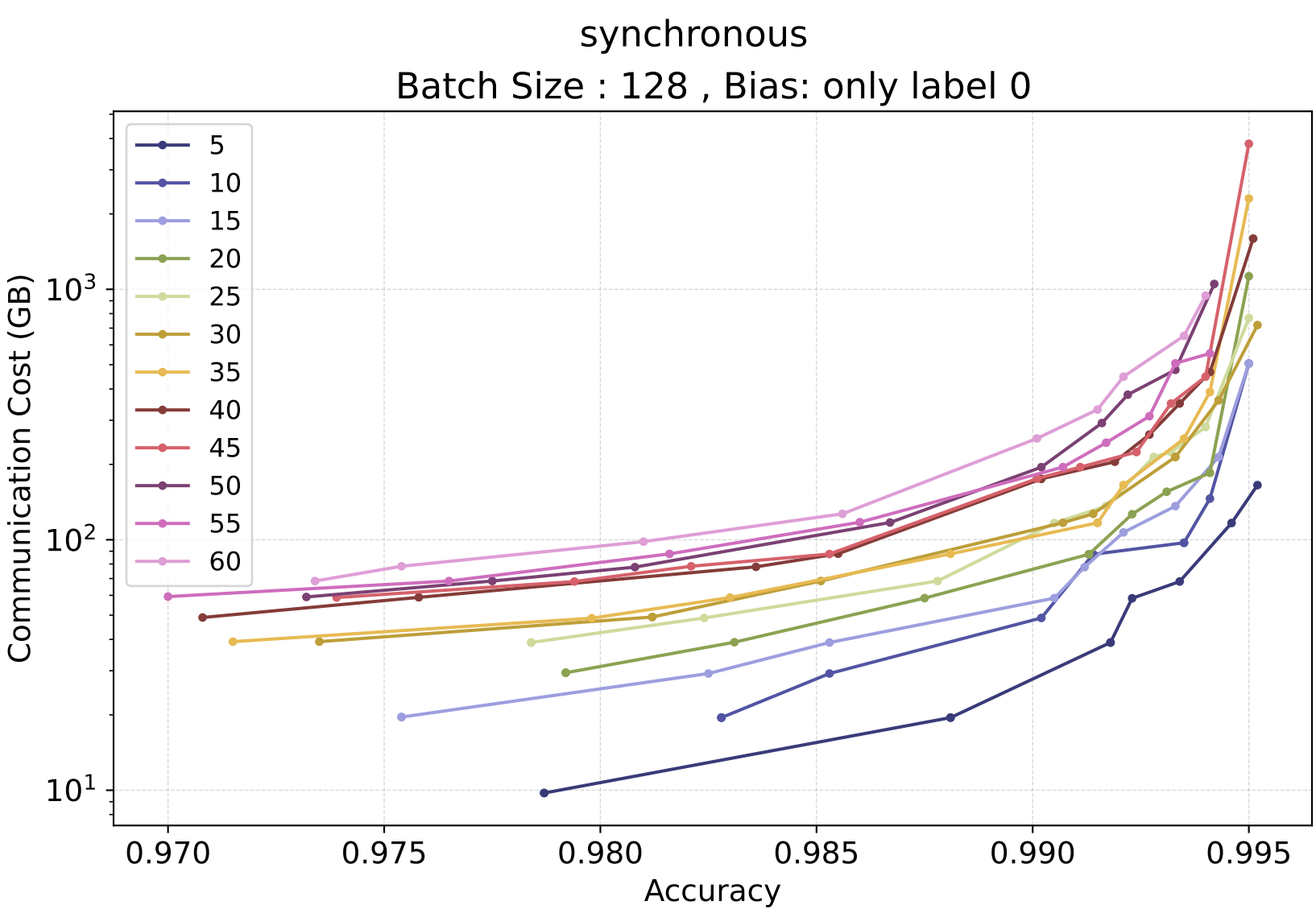

naive
Theta : 100.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
5
10
15
20
25
30
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

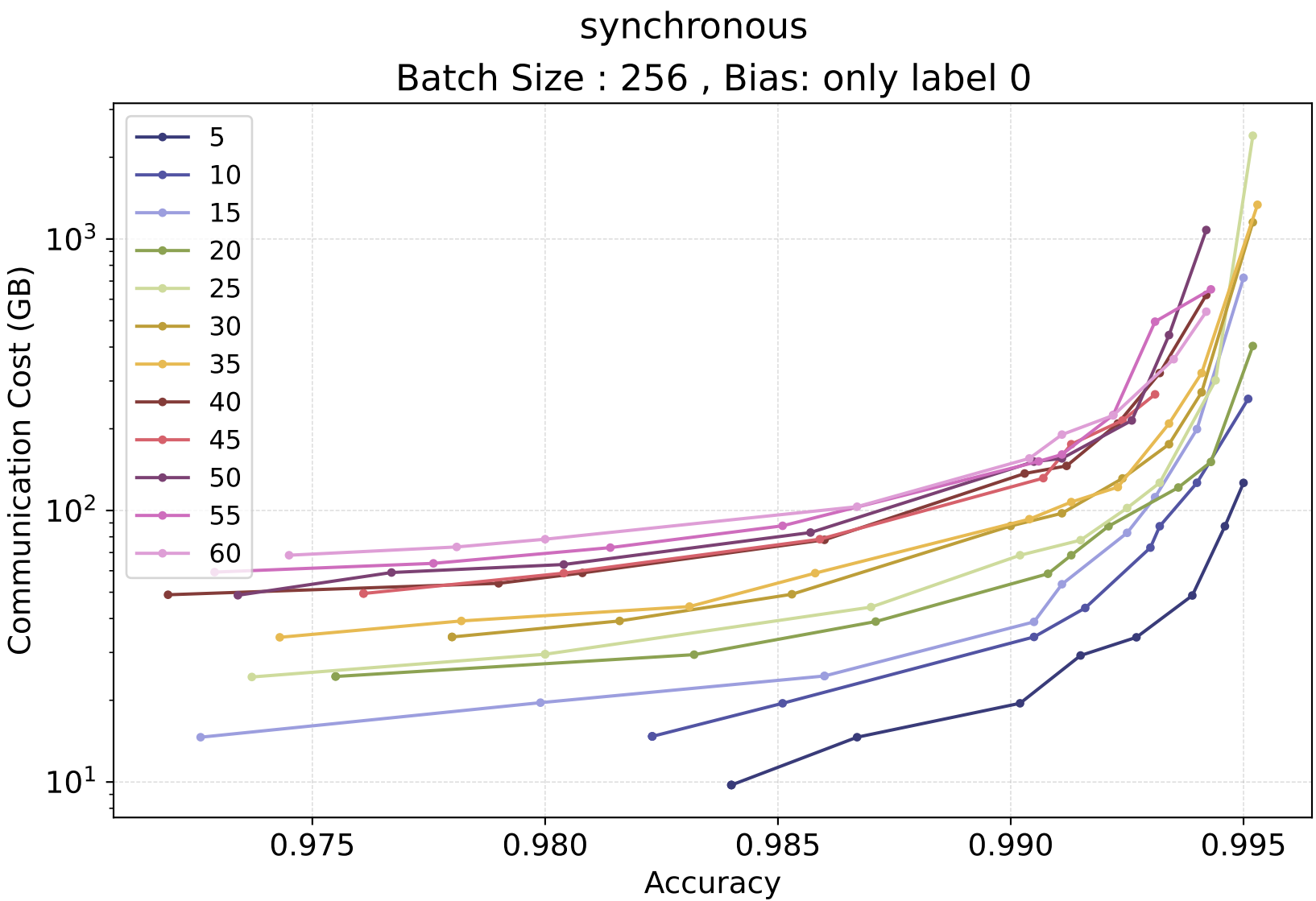

linear
Theta : 100.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
5
10
15
20
25
30
35
40
45
50
55
60
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25

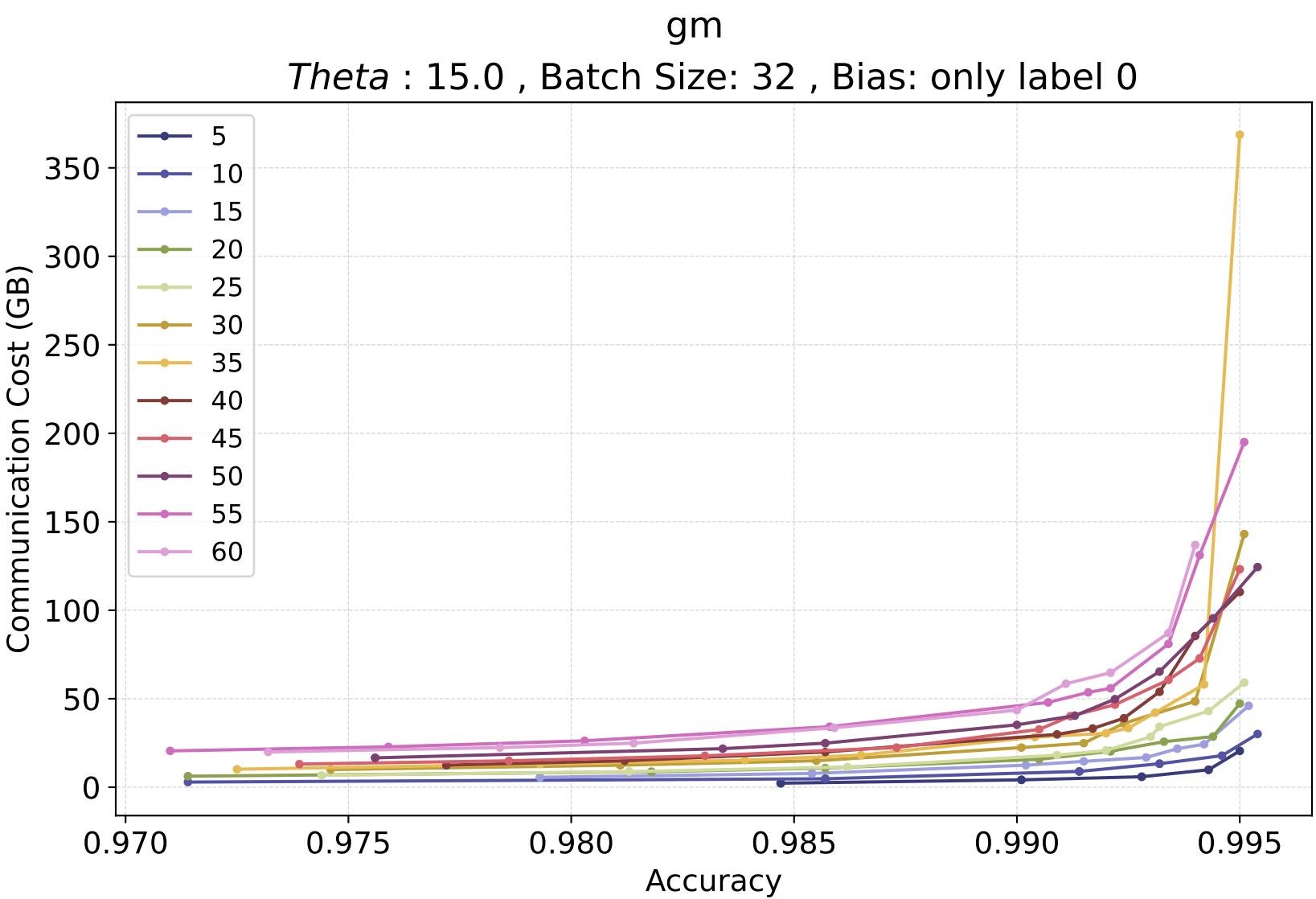

sketch
Theta : 100.0 , Batch Size: 32 , Bias: only label 8
Communication Cost (GB)
Accuracy
0
5
10
15
20
25
30
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60


synchronous
Batch Size : 32 , Bias: only label 0
Communication Cost (GB)
10^3
10^2
0.975
0.980
0.985
0.990
0.995
Accuracy
5
10
15
20
25
30
35
40
45
50
55
60


synchronous
Batch Size : 64 , Bias: only label 0
Communication Cost (GB)
10^3
10^2
5
10
15
20
25
30
35
40
45
50
55
60
0.970
0.975
0.980
0.985
0.990
0.995
Accuracy


synchronous
Batch Size : 128 , Bias: only label 0
Communication Cost (GB)
10^3
10^2
10^1
0.970
0.975
0.980
0.985
0.990
0.995
Accuracy
5
10
15
20
25
30
35
40
45
50
55
60


synchronous
Batch Size : 256 , Bias: only label 0
Communication Cost (GB)
10^3
10^2
10^1
0.975
0.980
0.985
0.990
0.995
Accuracy
5
10
15
20
25
30
35
40
45
50
55
60


gm
Theta : 15.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
50
100
150
200
250
300
350
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
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45
50
55
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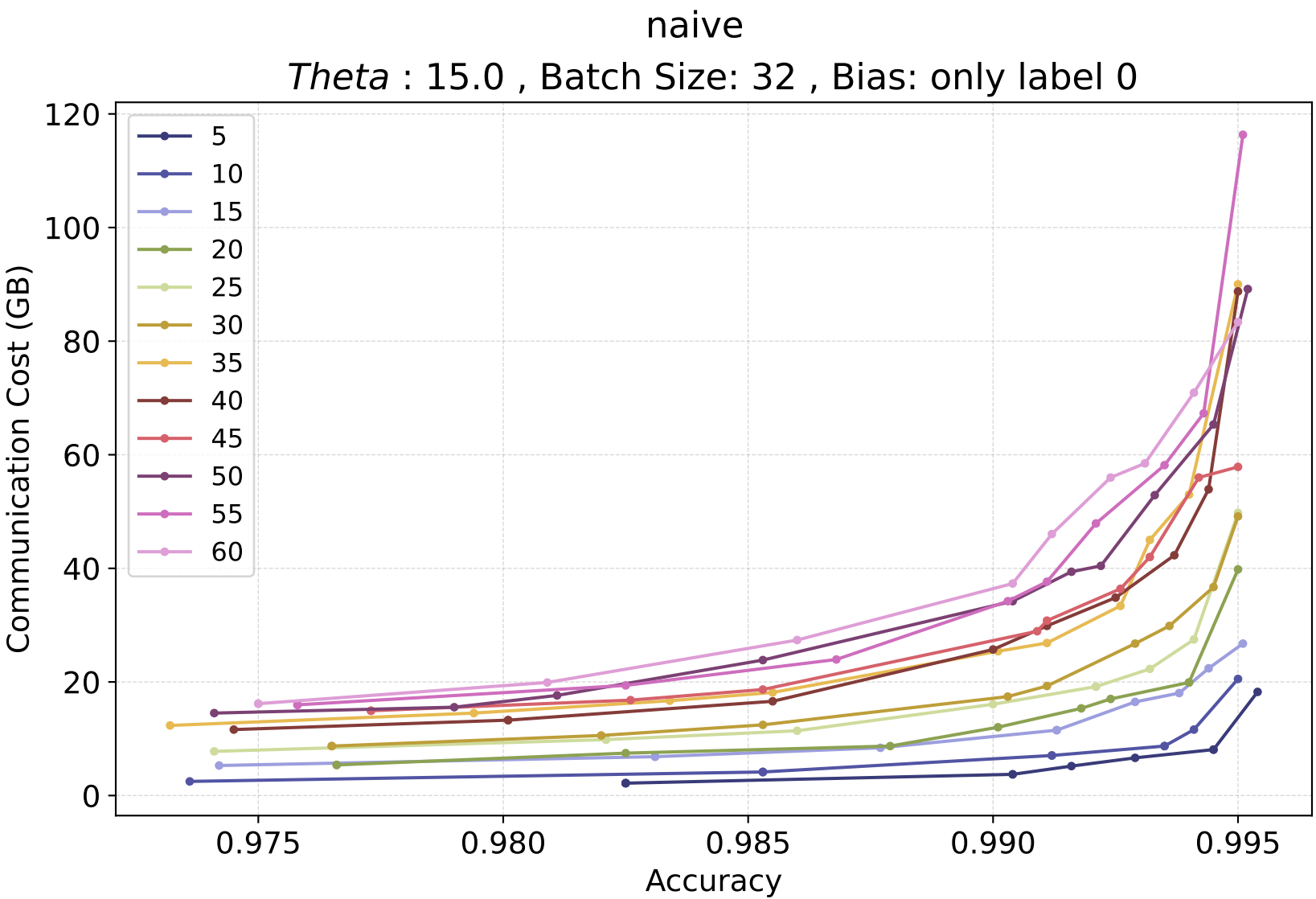
naive
Theta : 15.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
120
0.975
0.980
0.985
0.990
0.995
5
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25
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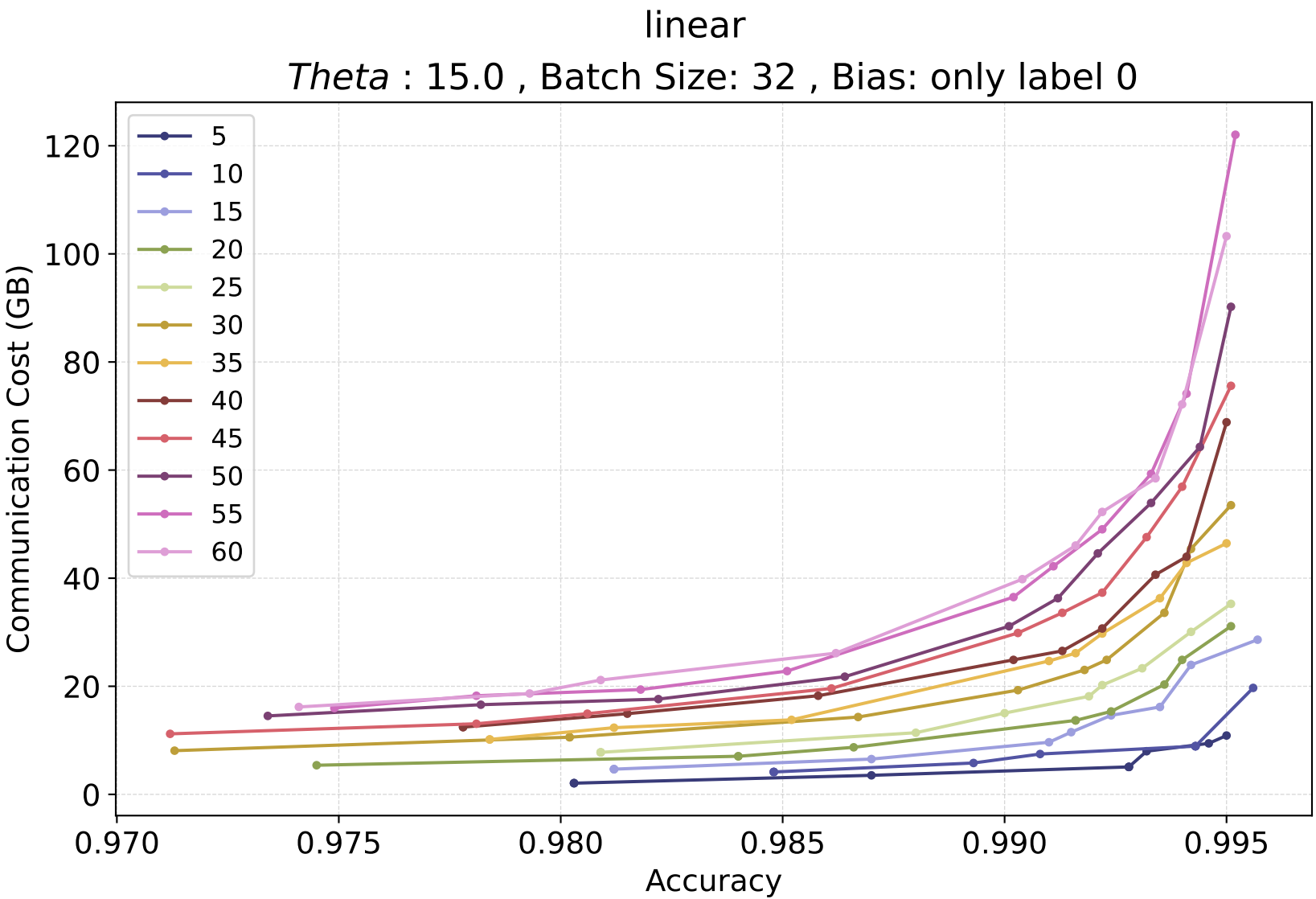
55
60


linear
Theta : 15.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
120
0.970
0.975
0.980
0.985
0.990
0.995
5
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55
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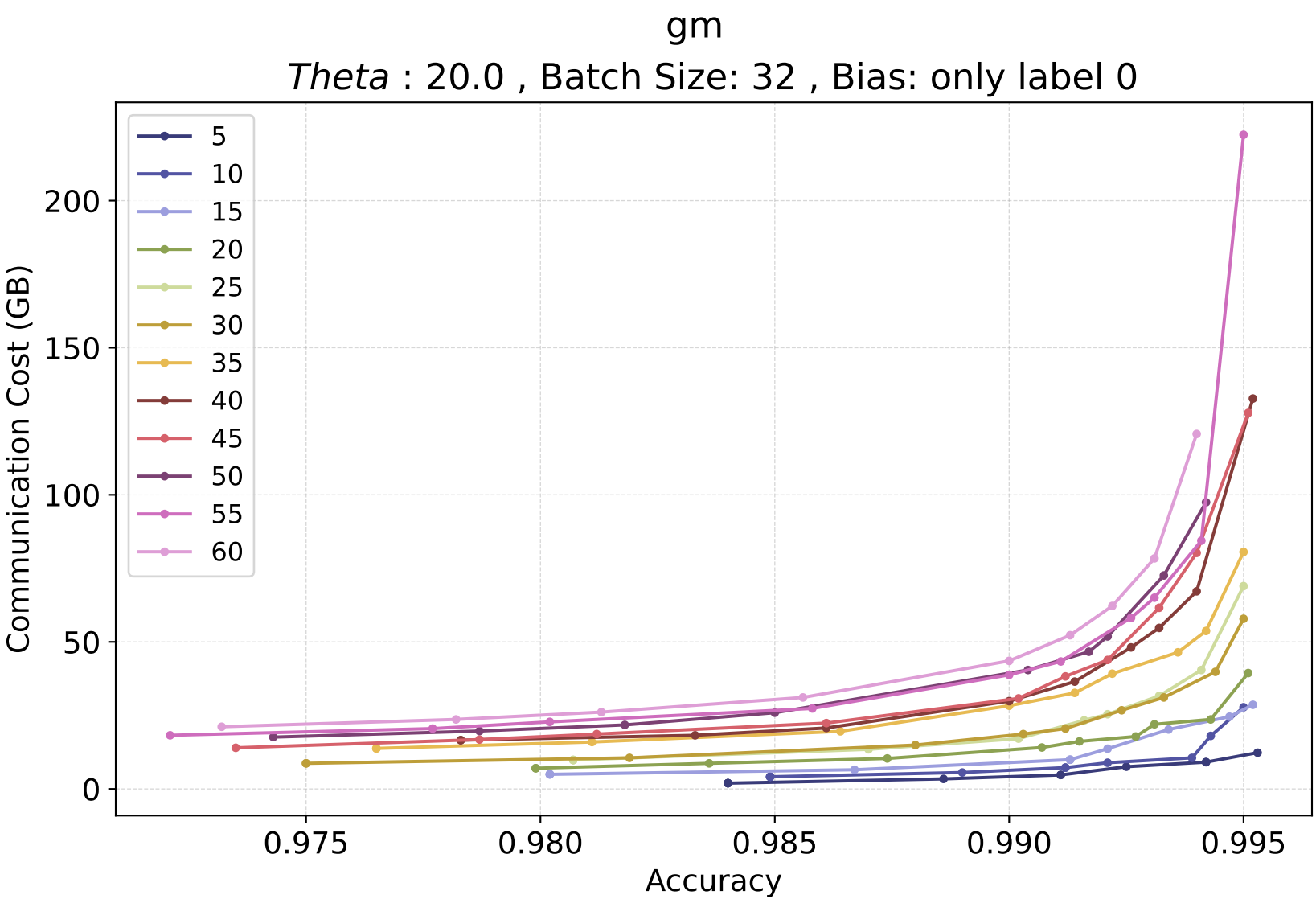
gm
Theta : 20.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
50
100
150
200
0.975
0.980
0.985
0.990
0.995
5
10
15
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25
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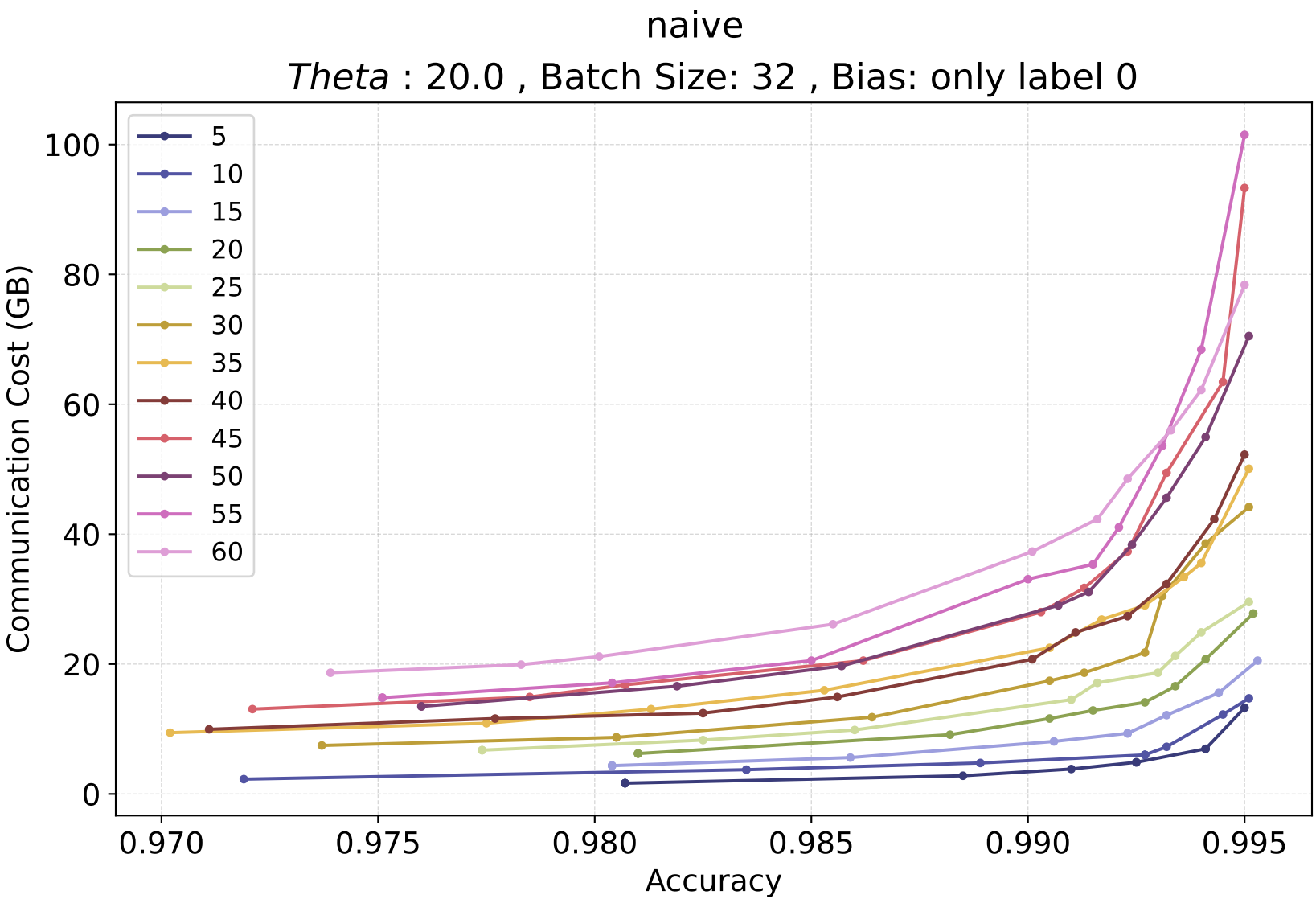
55
60


naive
Theta : 20.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
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55
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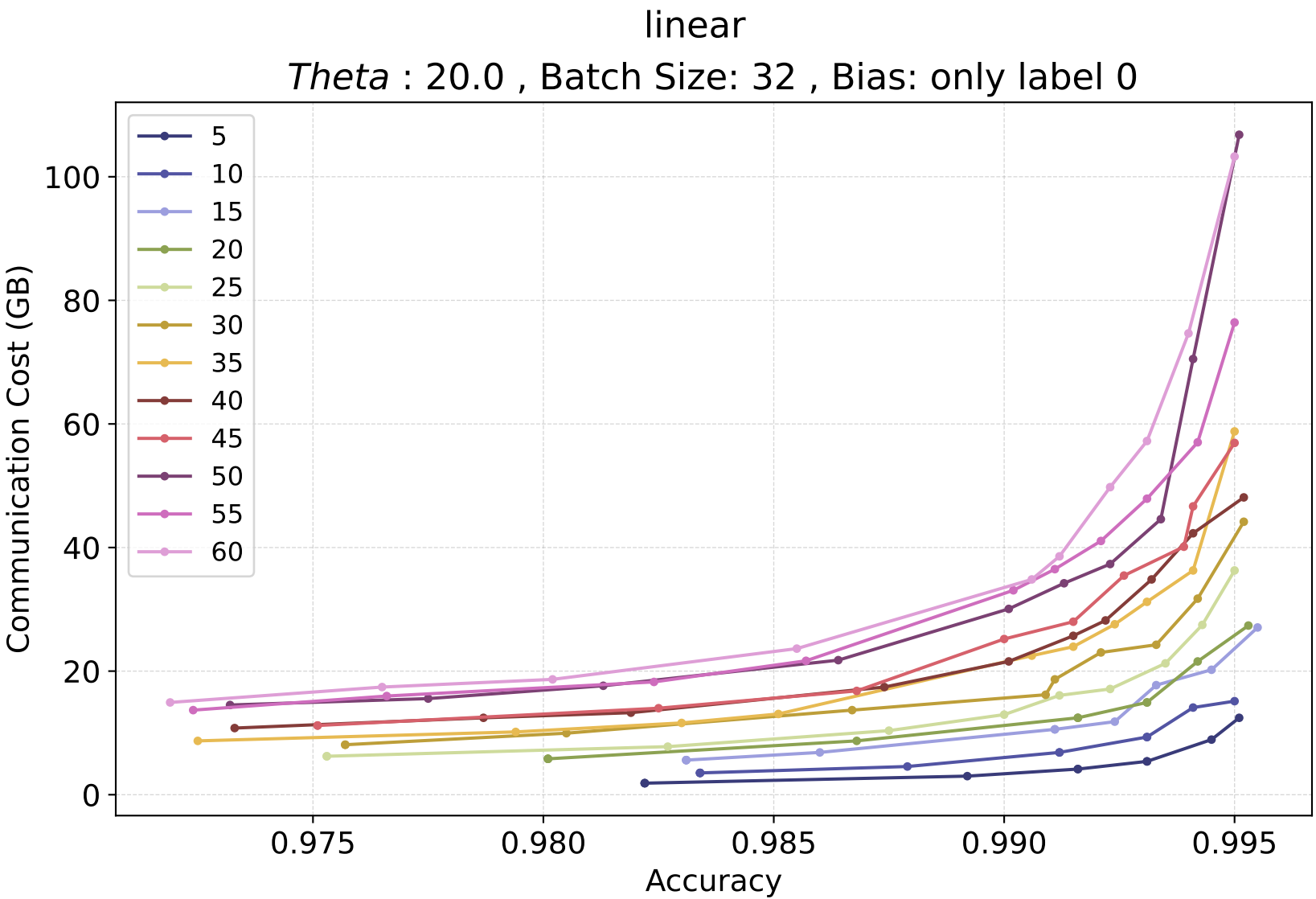
linear
Theta : 20.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
0.975
0.980
0.985
0.990
0.995
5
10
15
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25
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55
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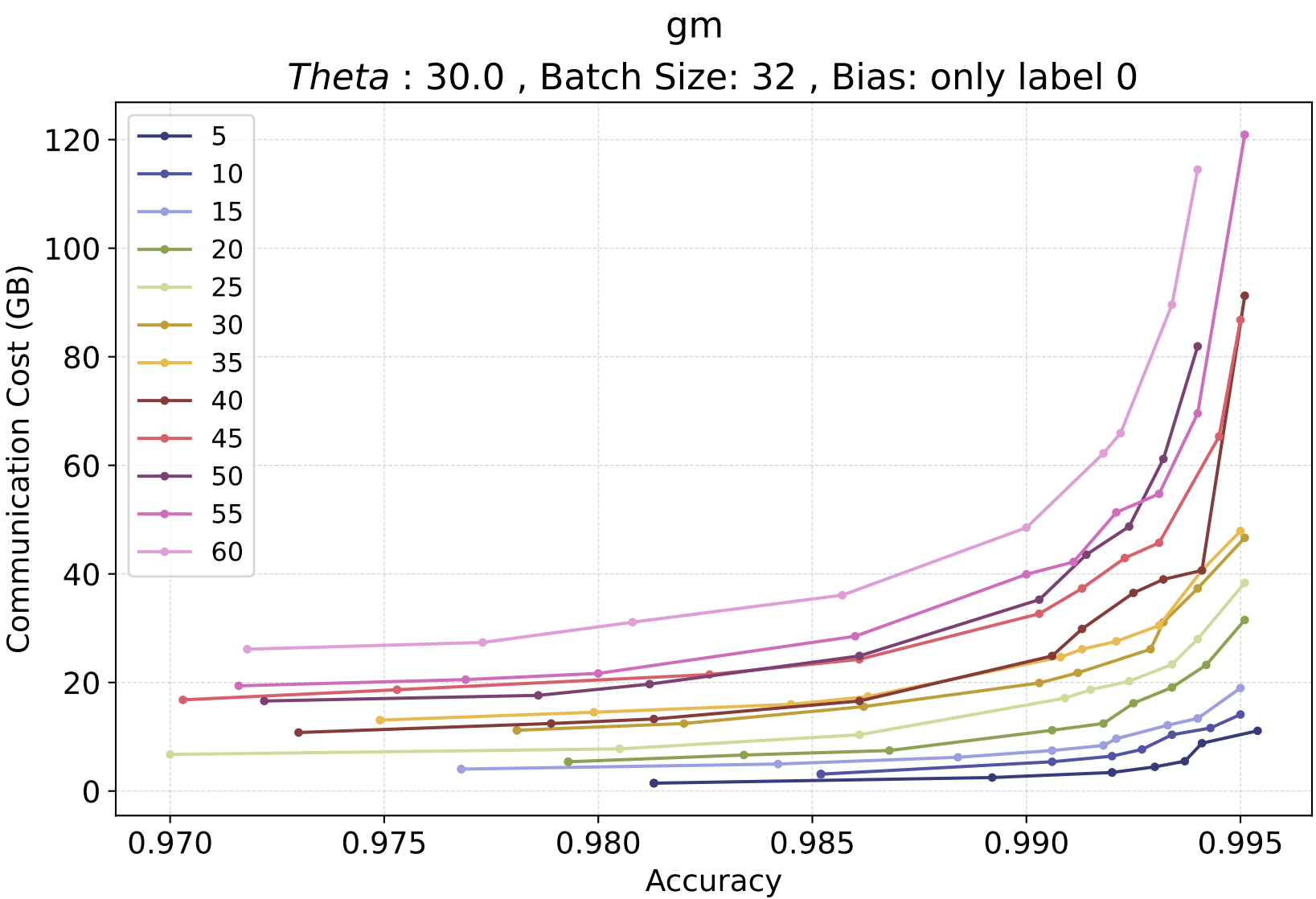
gm
Theta : 30.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
120
0.970
0.975
0.980
0.985
0.990
0.995
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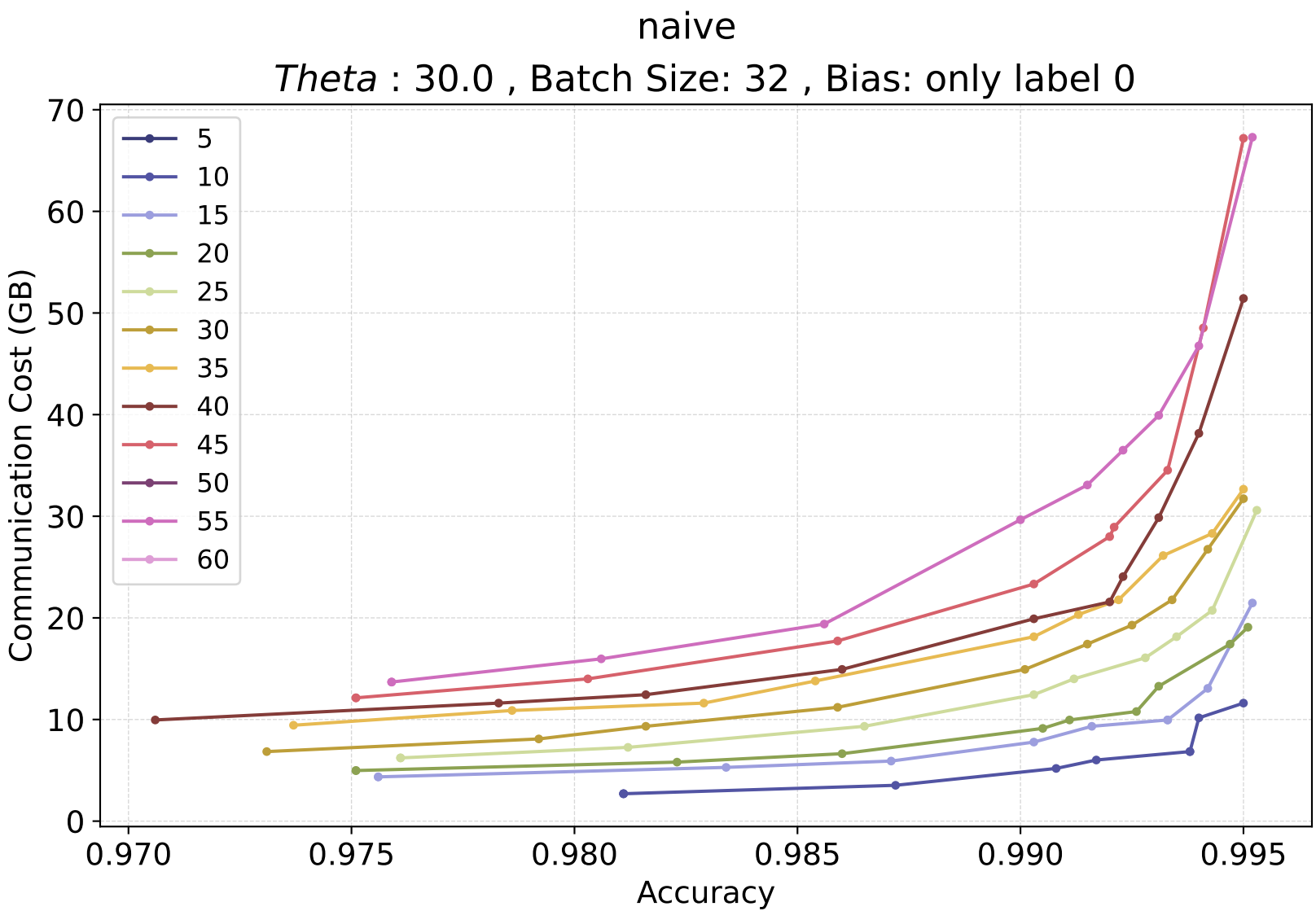
naive
Theta : 30.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
10
20
30
40
50
60
70
0.970
0.975
0.980
0.985
0.990
0.995
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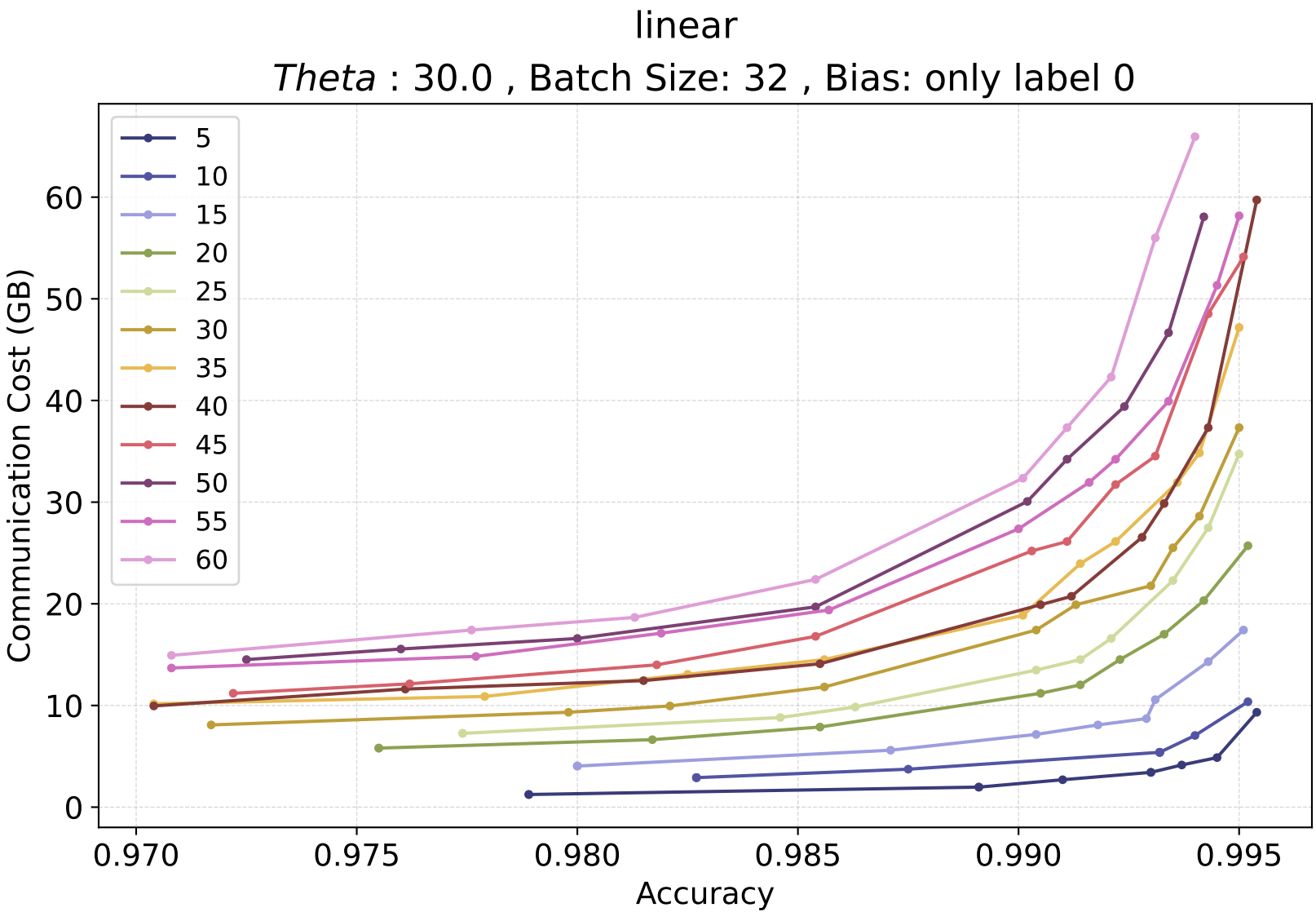
linear
Theta : 30.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
10
20
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40
50
60
0.970
0.975
0.980
0.985
0.990
0.995
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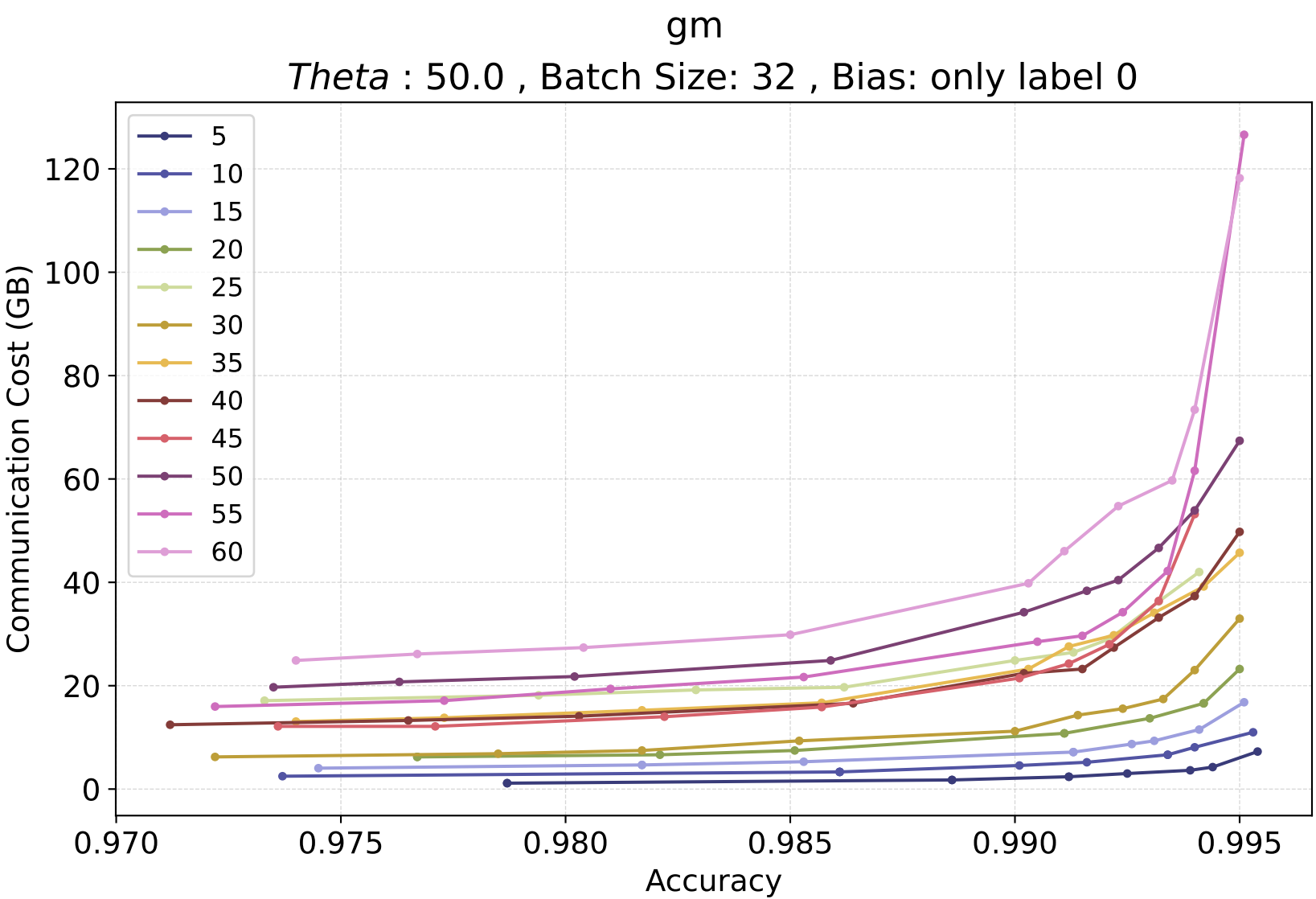
gm
Theta : 50.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
20
40
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80
100
120
0.970
0.975
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0.985
0.990
0.995
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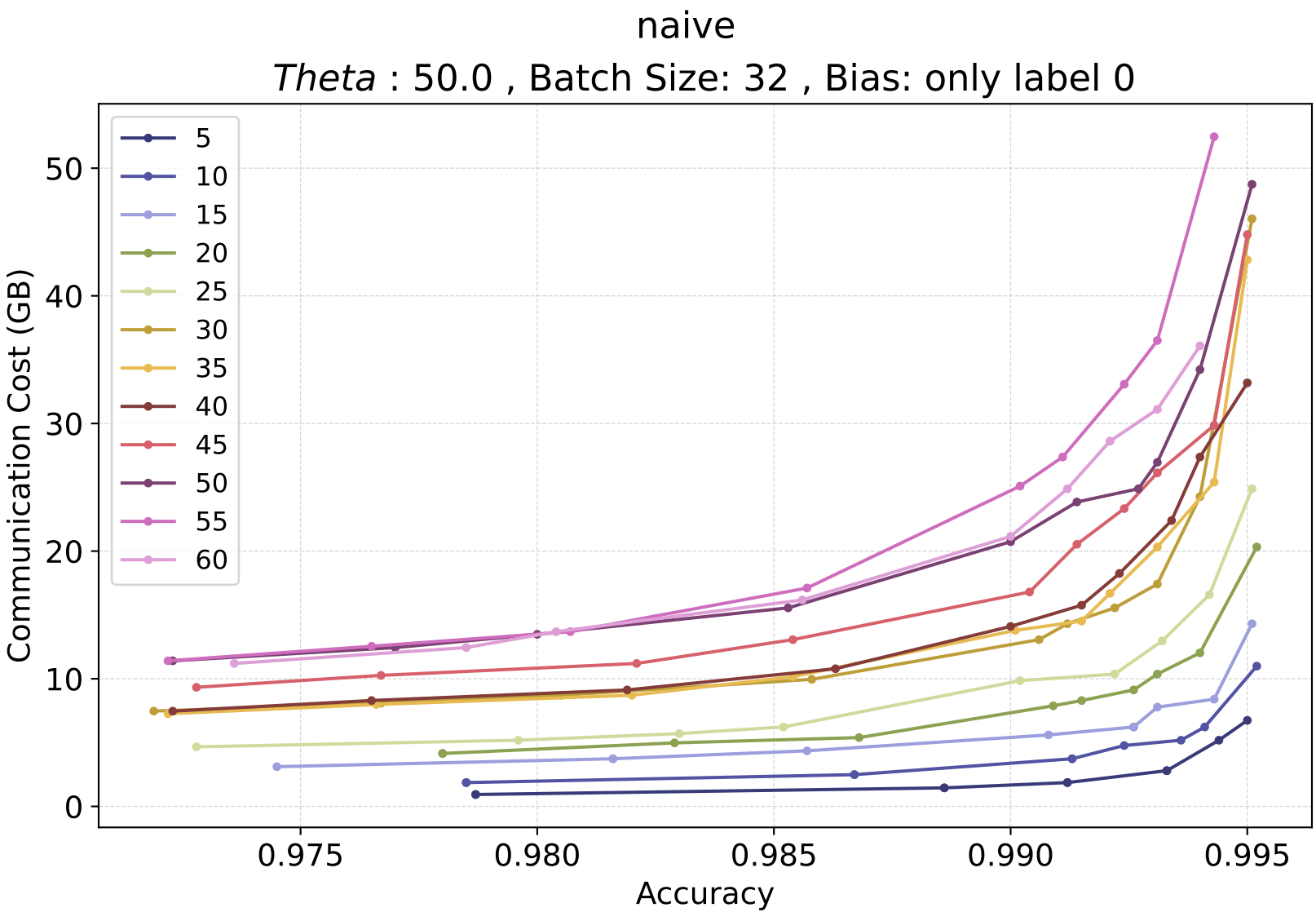
naive
Theta : 50.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
10
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50
0.975
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0.990
0.995
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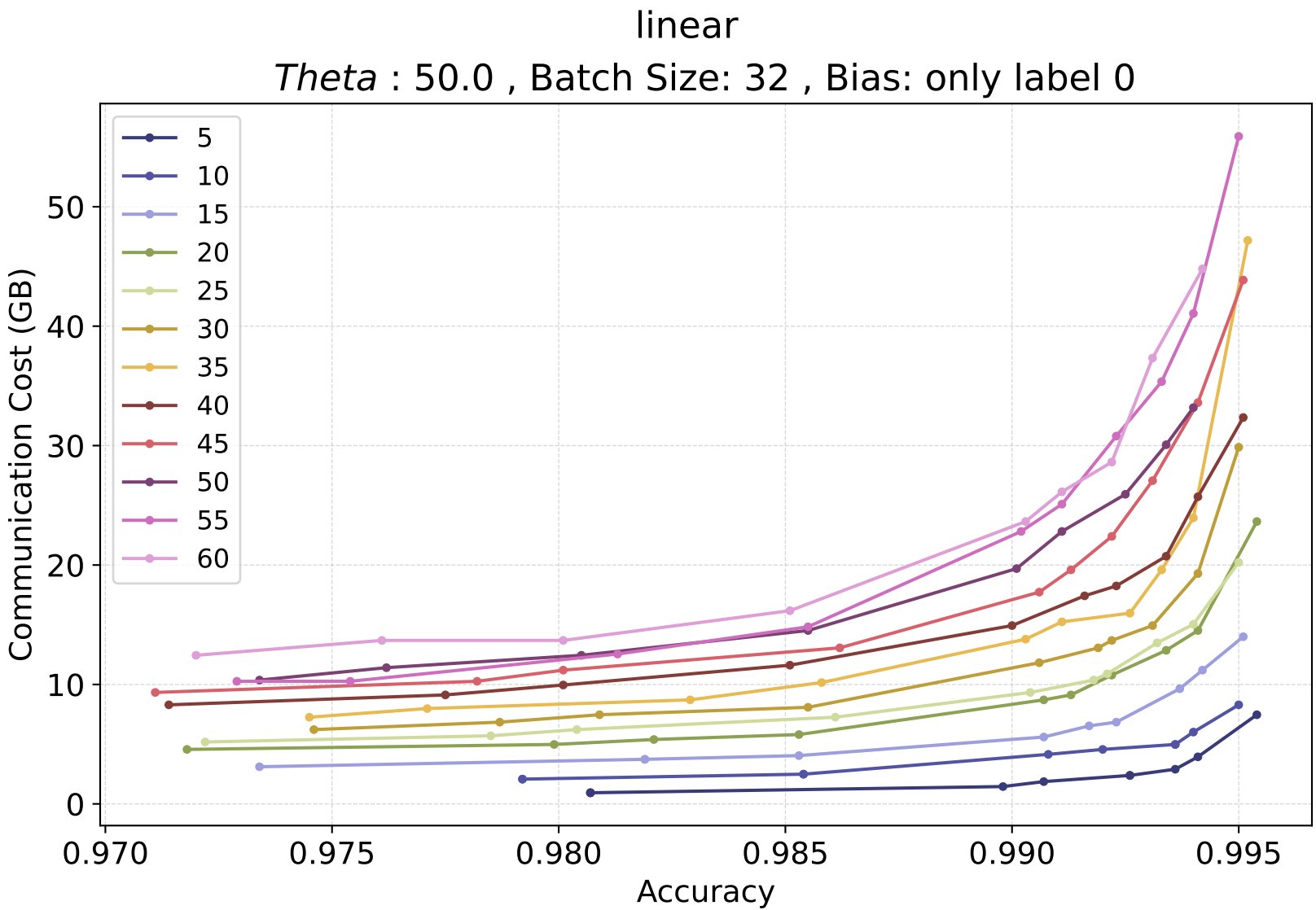
linear
Theta : 50.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
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10
20
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40
50
0.970
0.975
0.980
0.985
0.990
0.995
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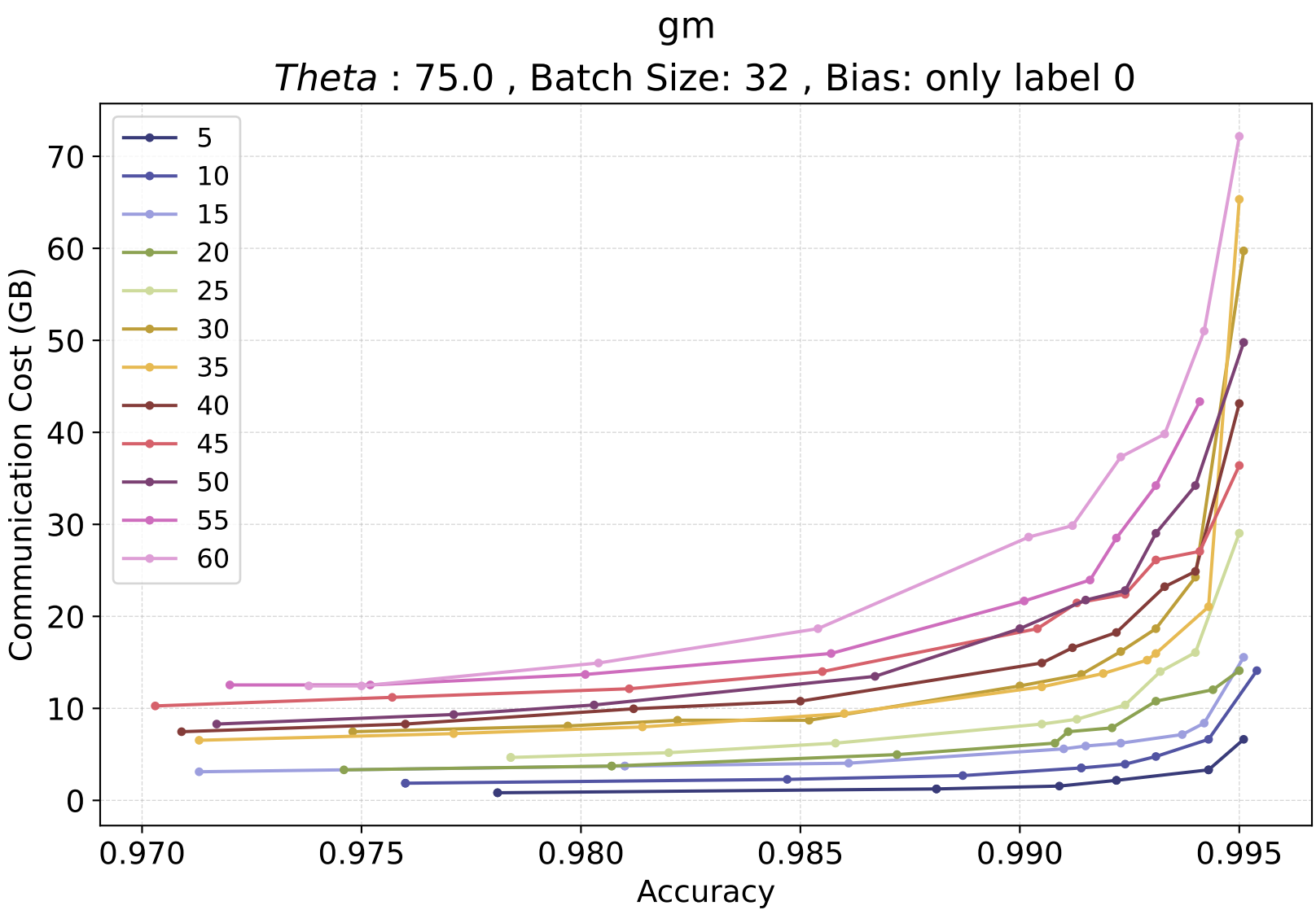
gm
Theta : 75.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
10
20
30
40
50
60
70
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
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35
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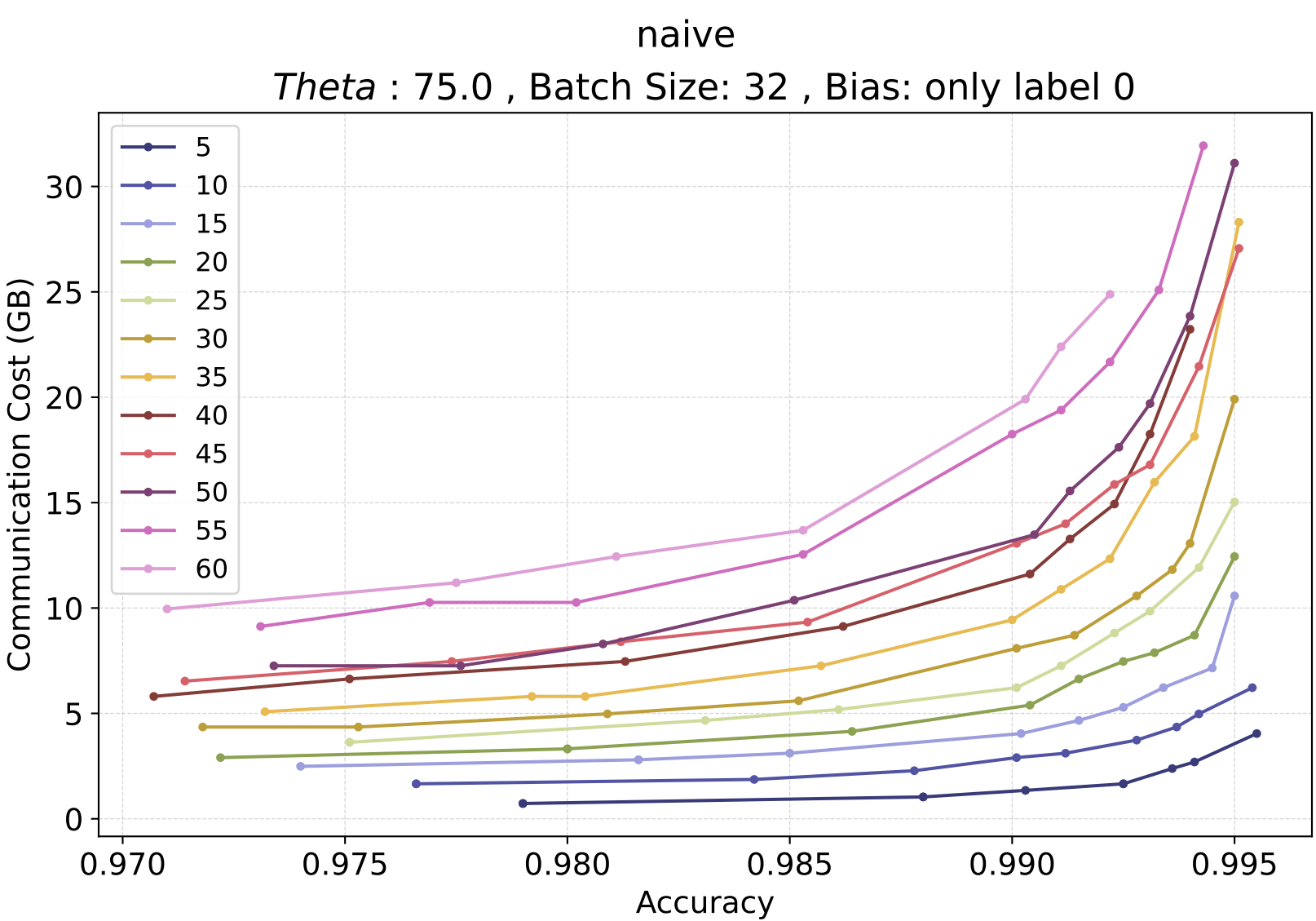
45
50
55
60


naive
Theta : 75.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
5
10
15
20
25
30
0.970
0.975
0.980
0.985
0.990
0.995
5
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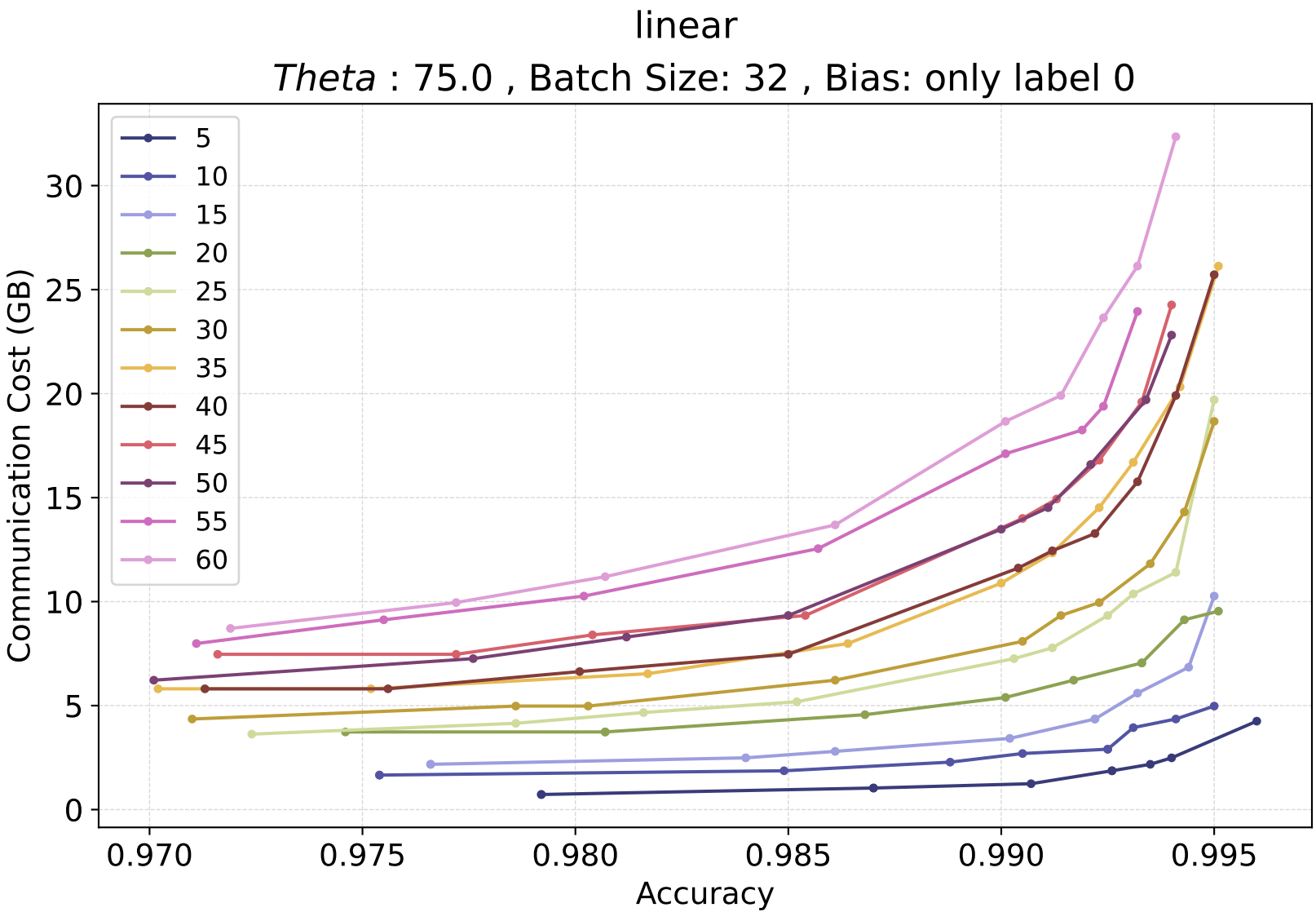
linear
Theta : 75.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
5
10
15
20
25
30
0.970
0.975
0.980
0.985
0.990
0.995
5
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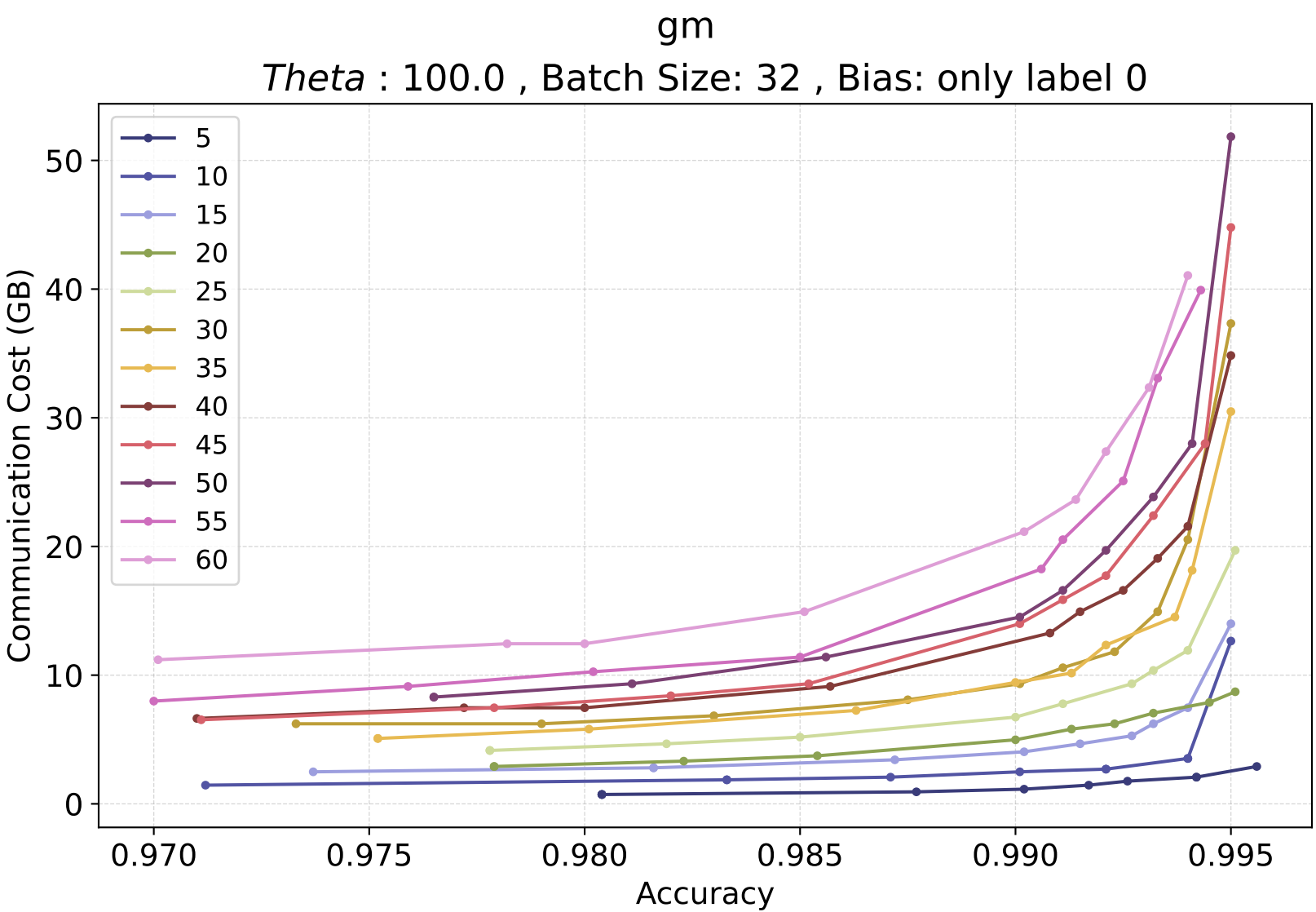
gm
Theta : 100.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
10
20
30
40
50
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
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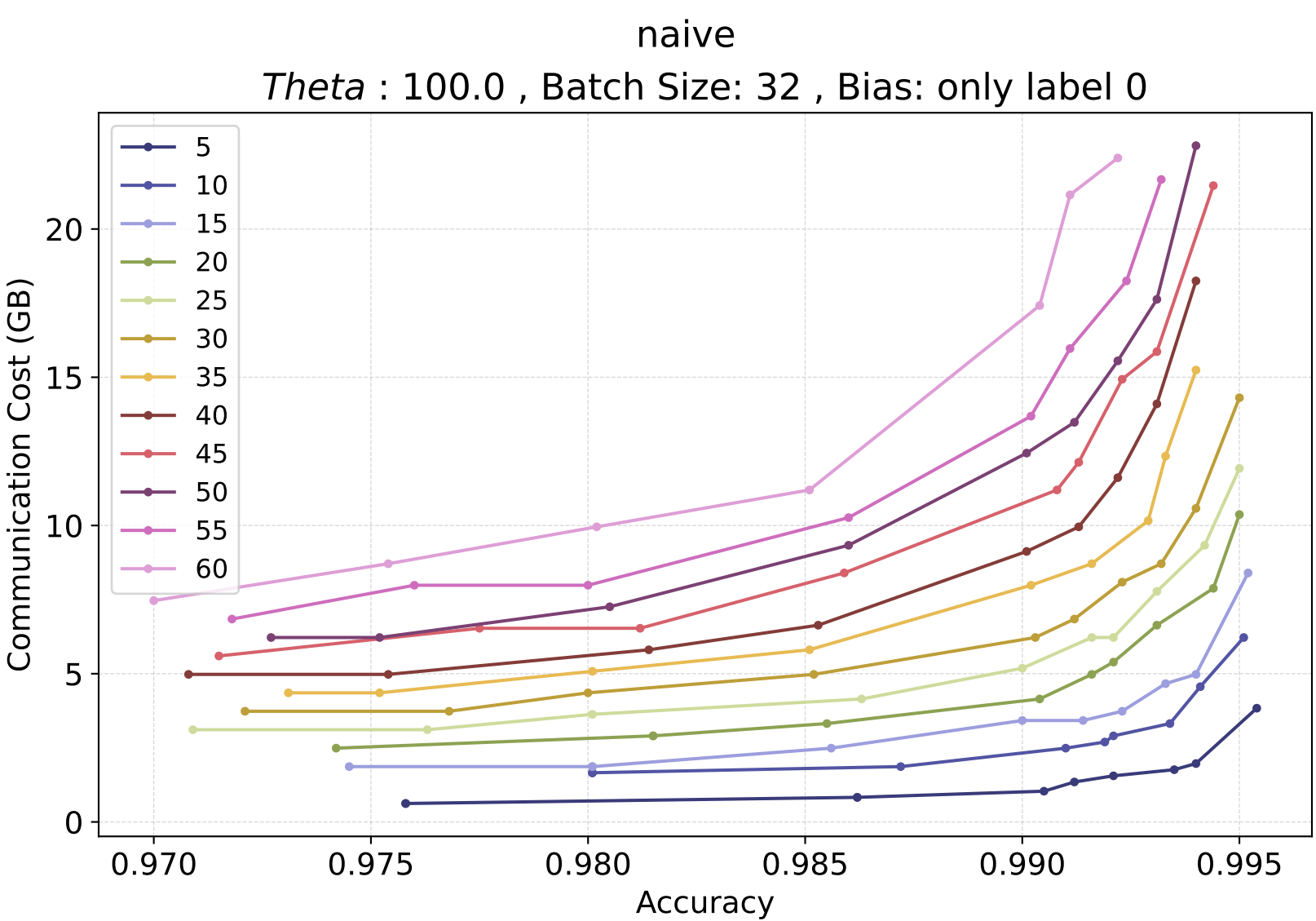
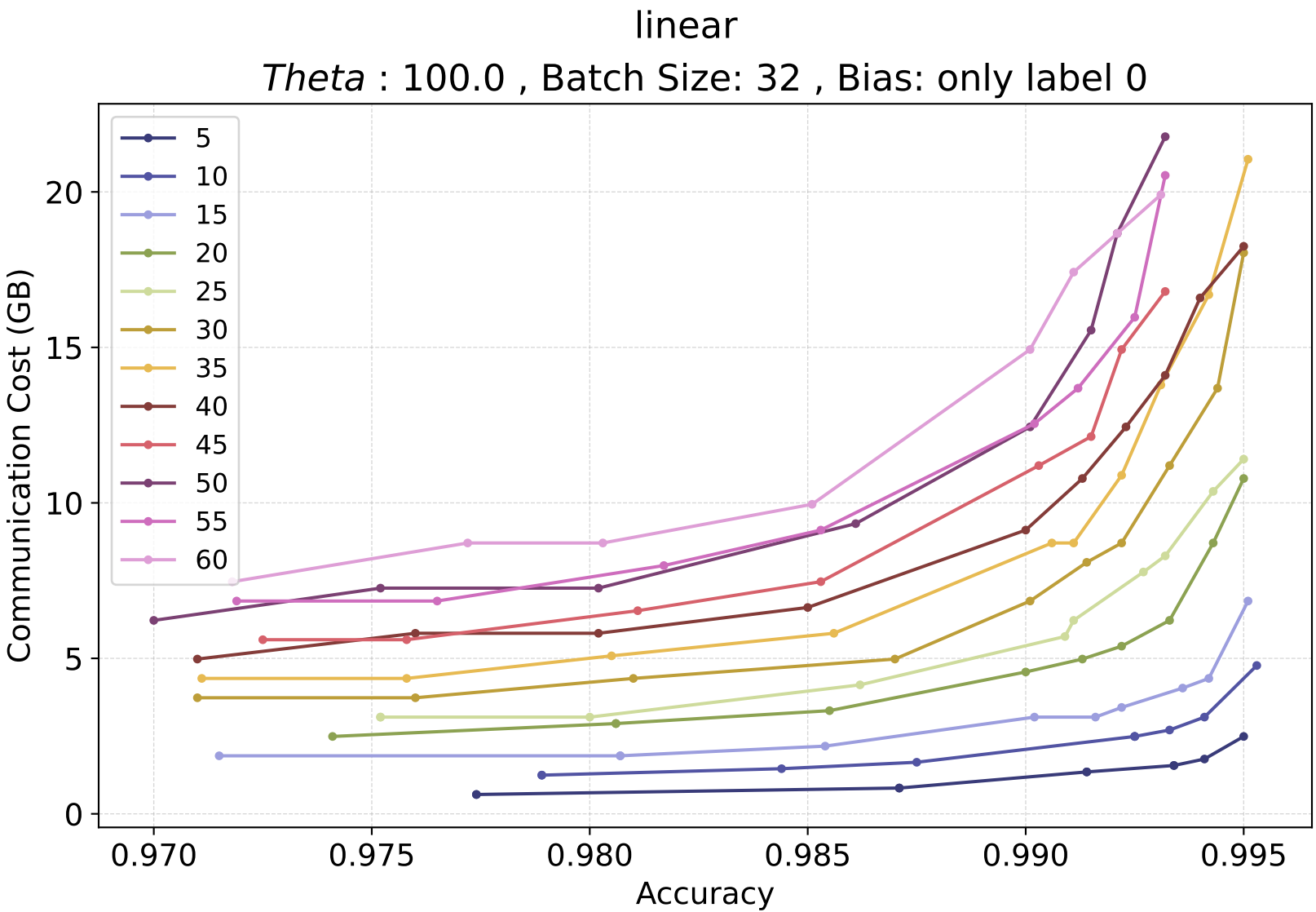
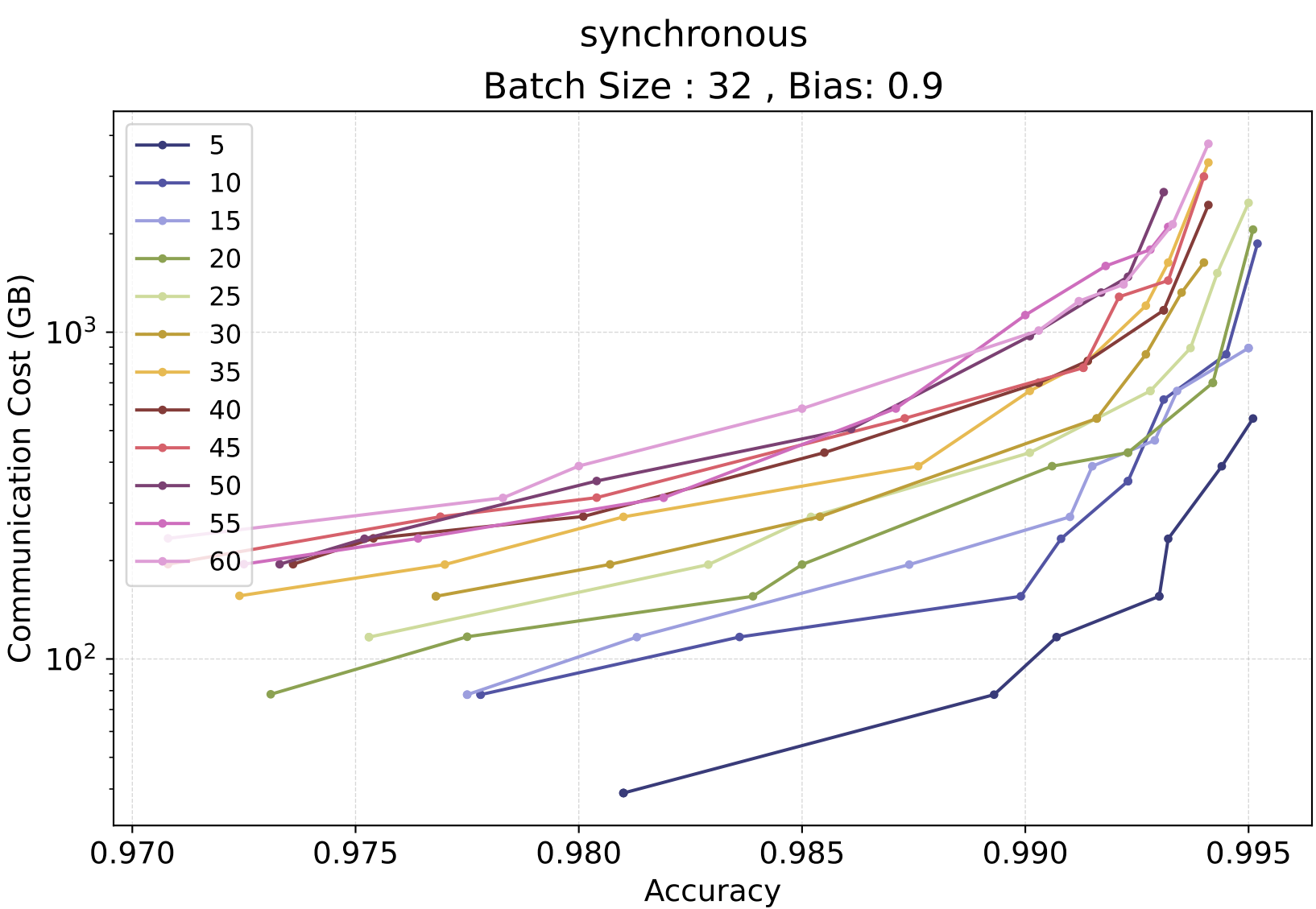
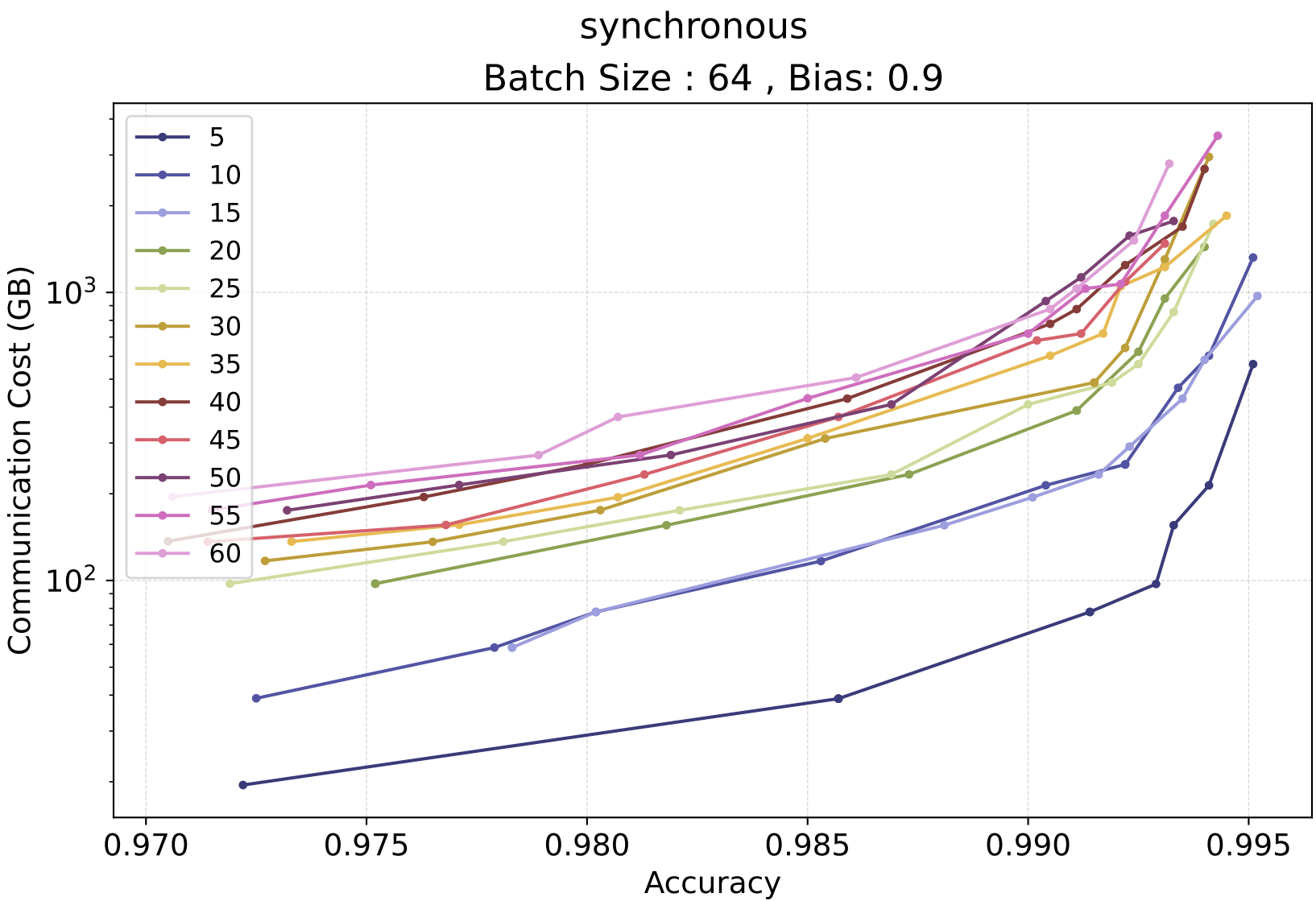
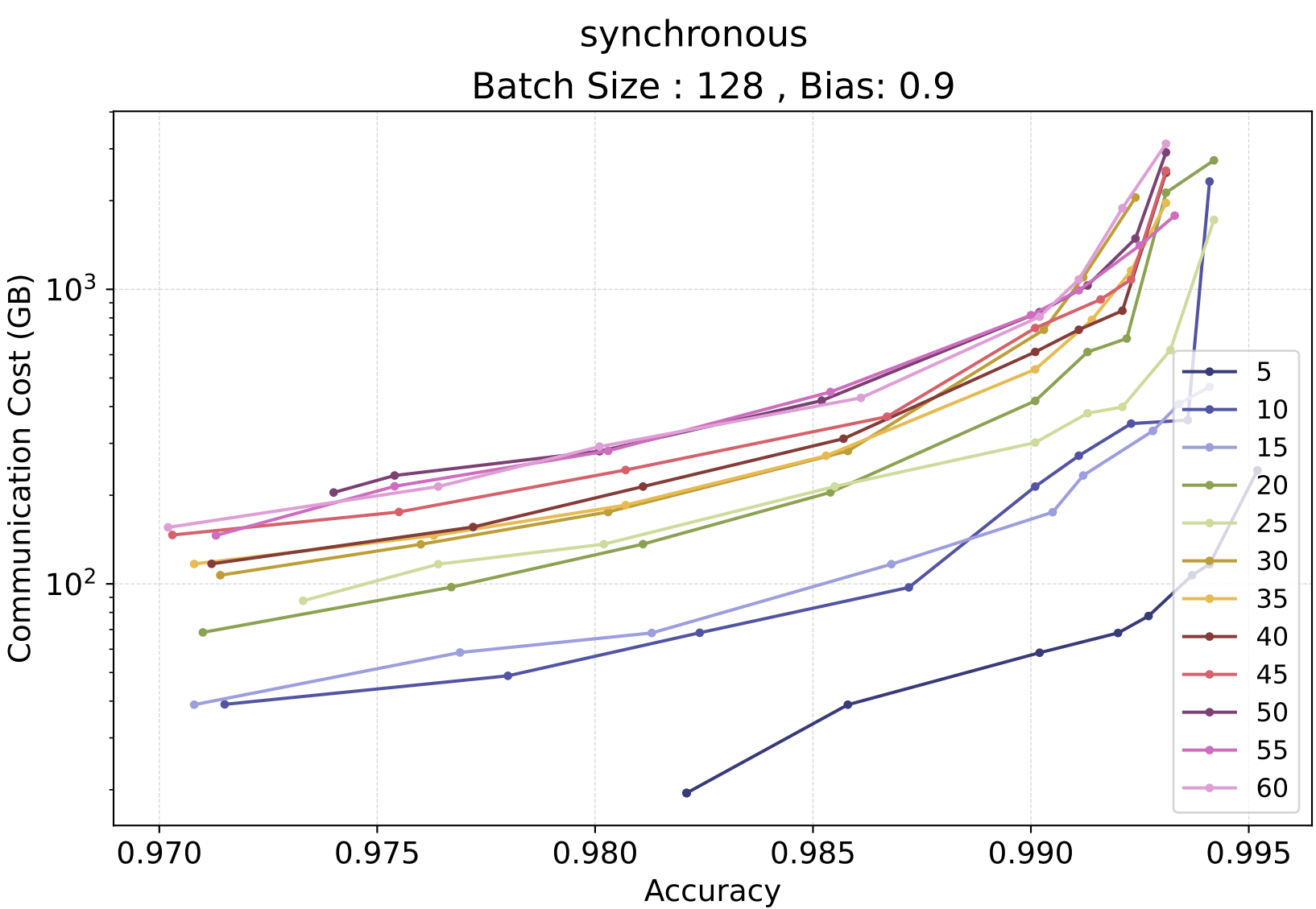
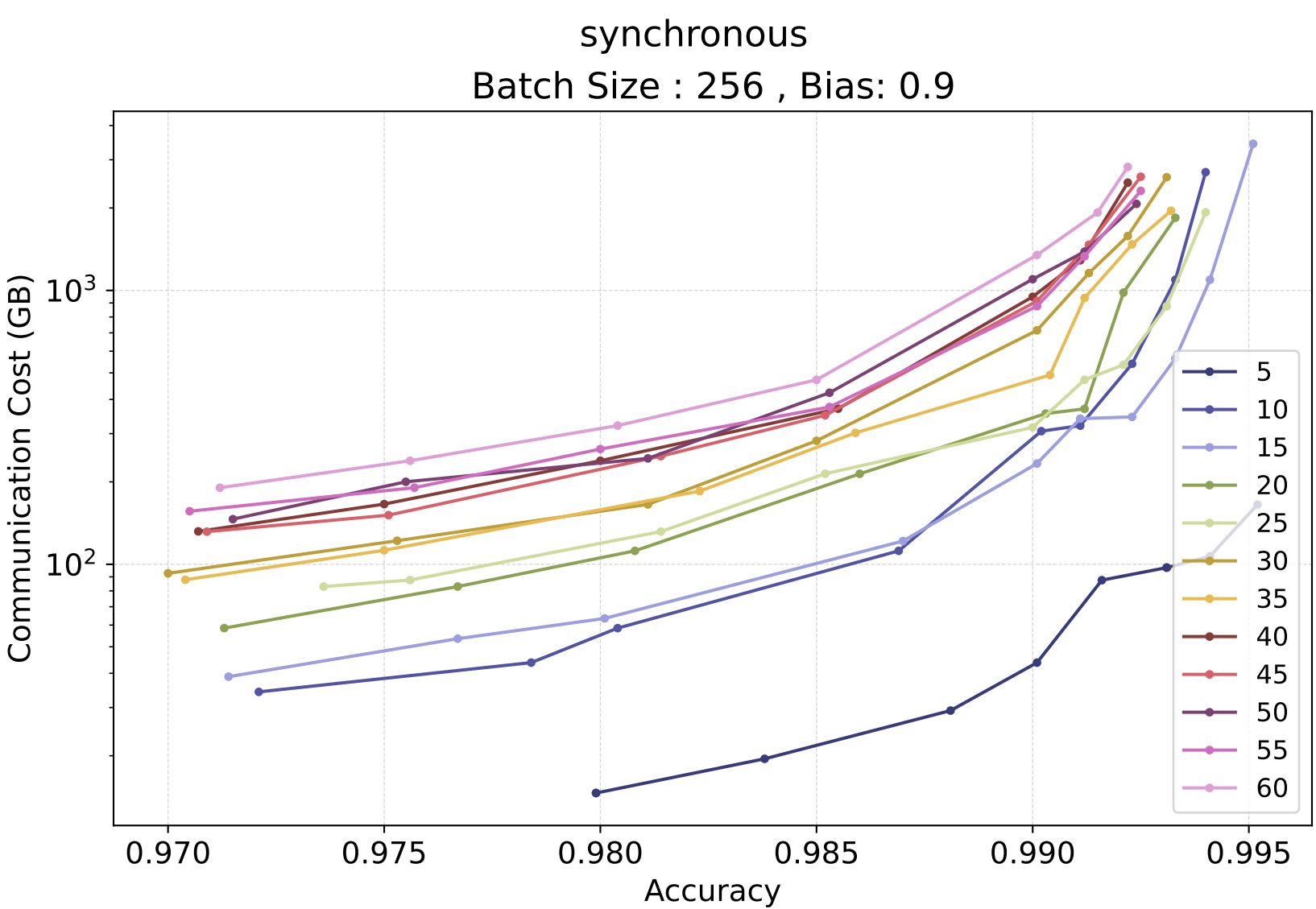

naive
Theta : 100.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
5
10
15
20
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

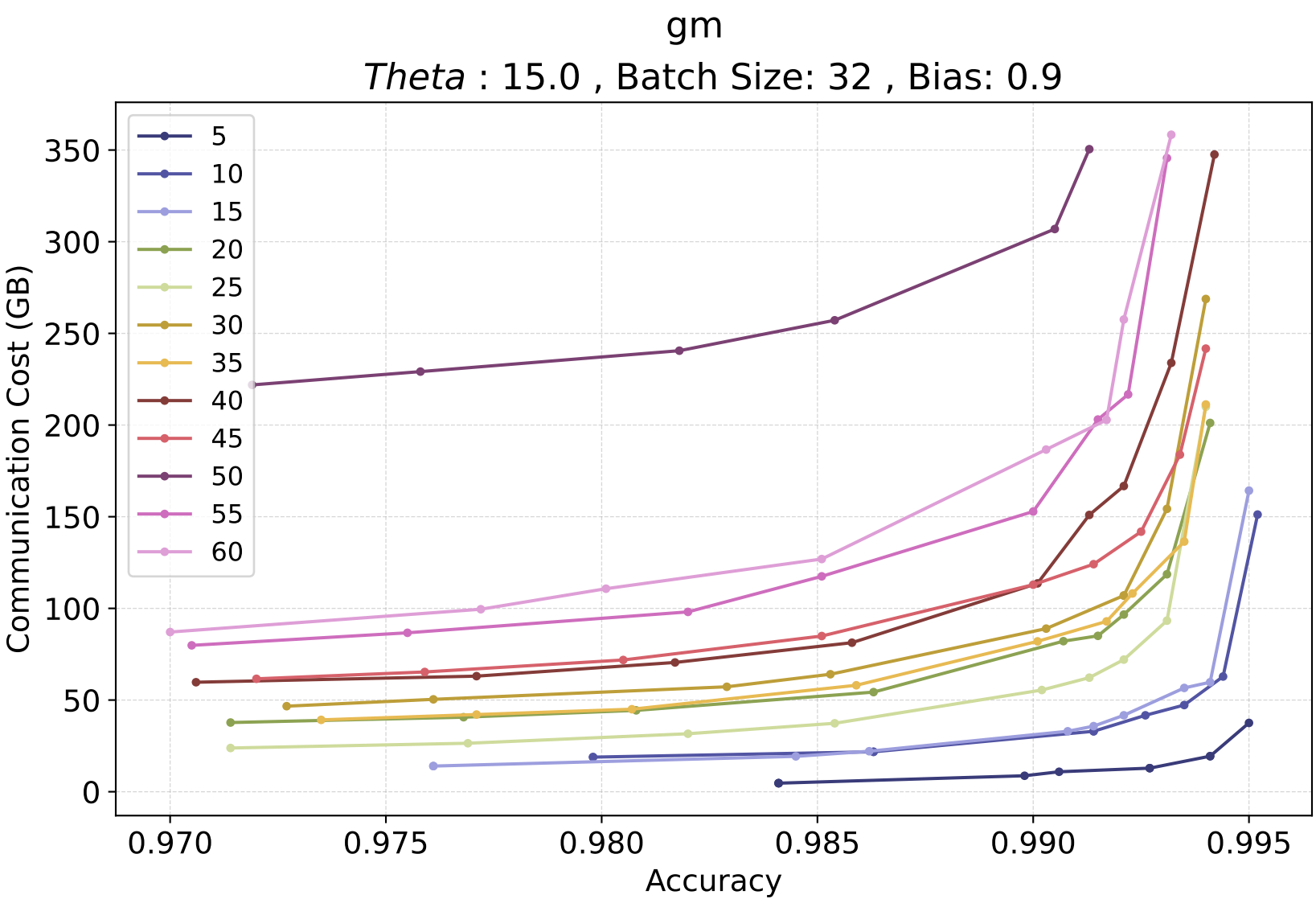

linear
Theta : 100.0 , Batch Size: 32 , Bias: only label 0
Communication Cost (GB)
Accuracy
0
5
10
15
20
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60

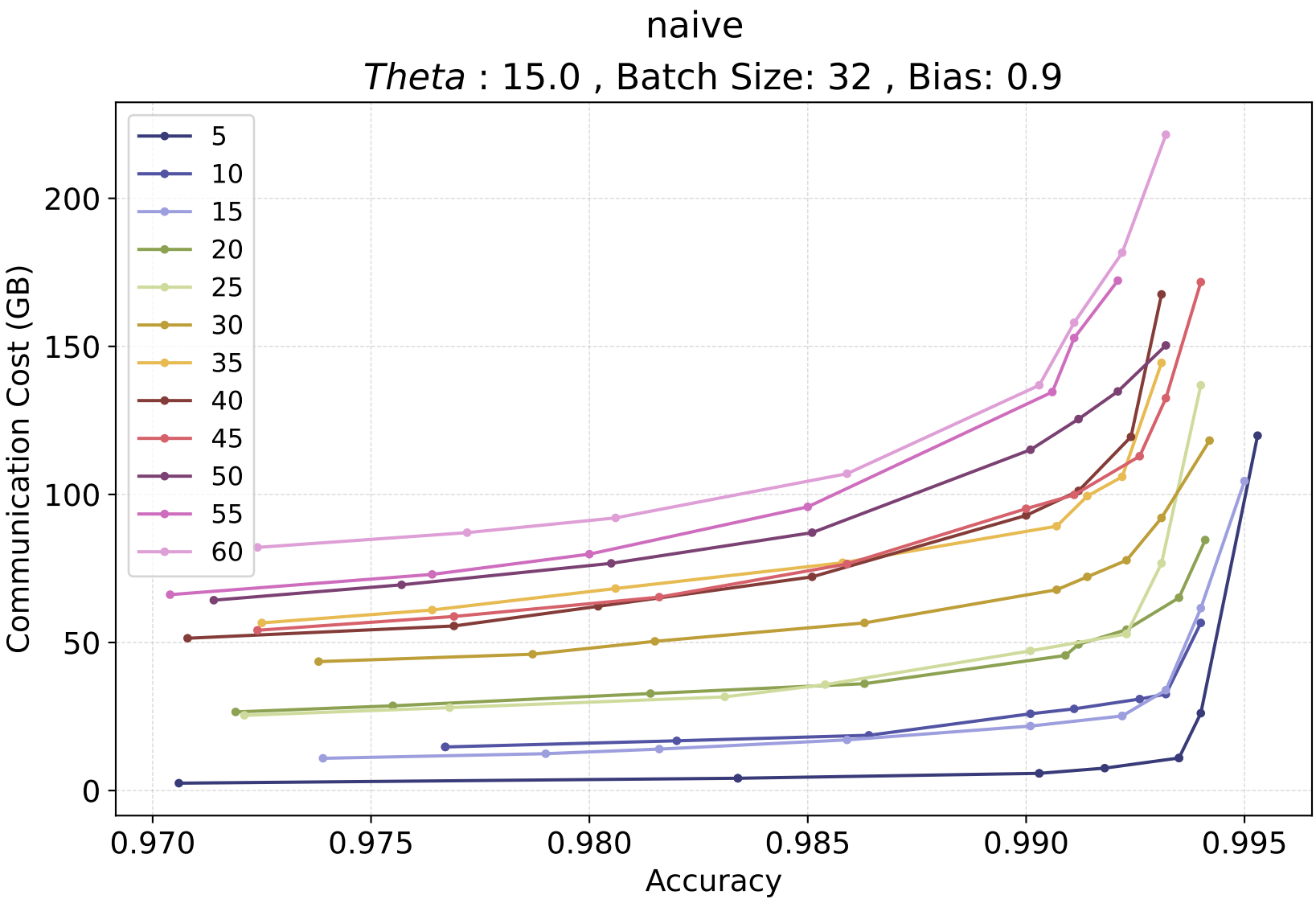

synchronous
Batch Size : 32 , Bias: 0.9
Communication Cost (GB)
10^3
10^2
0.970
0.975
0.980
0.985
0.990
0.995
Accuracy
5
10
15
20
25
30
35
40
45
50
55
60


synchronous
Batch Size : 64 , Bias: 0.9
Communication Cost (GB)
10^3
10^2
5
10
15
20
25
30
35
40
45
50
55
60
0.970
0.975
0.980
0.985
0.990
0.995
Accuracy


synchronous
Batch Size : 128 , Bias: 0.9
Communication Cost (GB)
10^3
10^2
0.970
0.975
0.980
0.985
0.990
0.995
Accuracy
5
10
15
20
25
30
35
40
45
50
55
60


synchronous
Batch Size : 256 , Bias: 0.9
Communication Cost (GB)
10^3
10^2
0.970
0.975
0.980
0.985
0.990
0.995
Accuracy
5
10
15
20
25
30
35
40
45
50
55
60


gm
Theta : 15.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
0
50
100
150
200
250
300
350
0.970
0.975
0.980
0.985
0.990
0.995
5
10
15
20
25
30
35
40
45
50
55
60


naive
Theta : 15.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
0
50
100
150
200
0.970
0.975
0.980
0.985
0.990
0.995
5
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15
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25
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35
40
45
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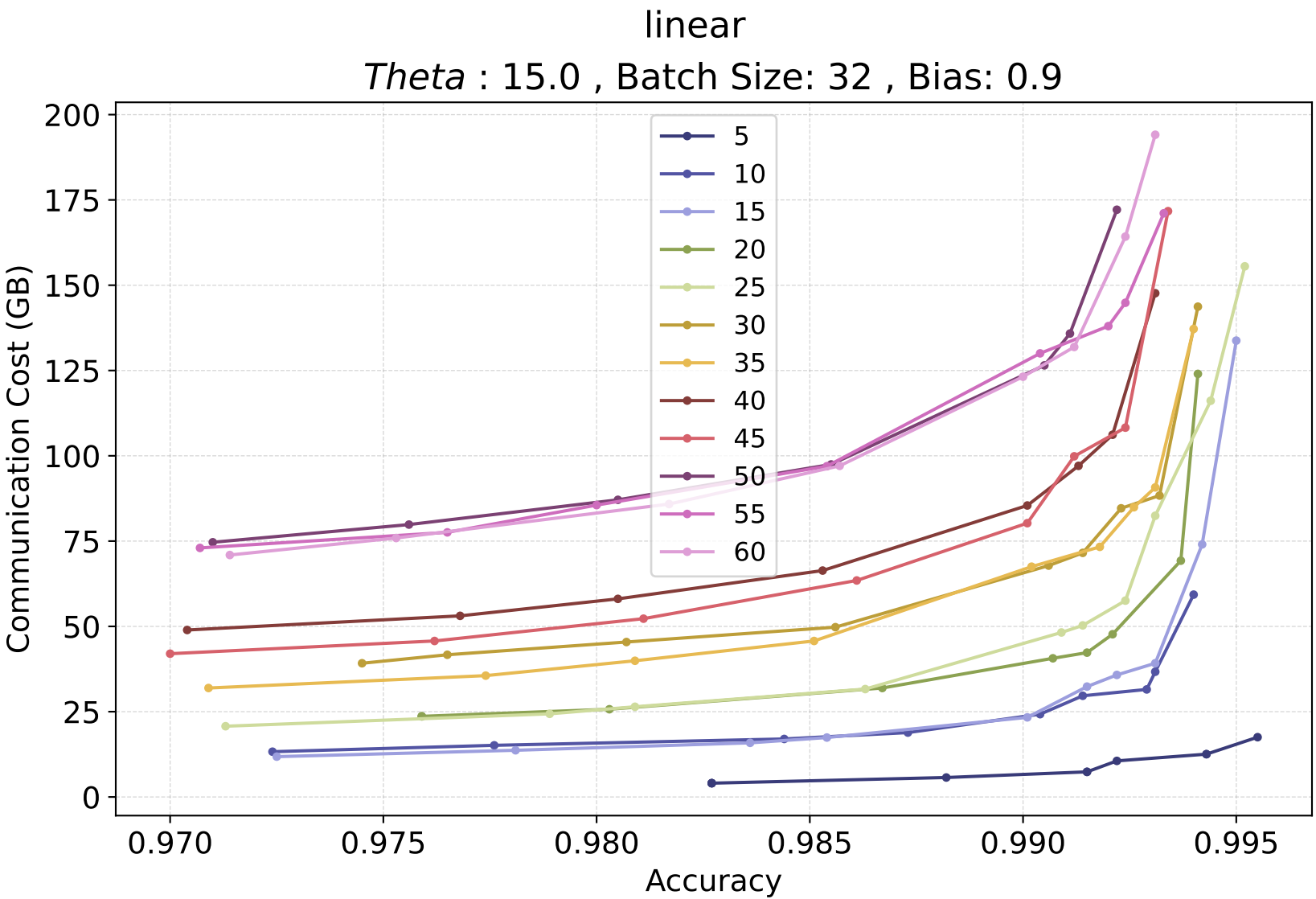
55
60


linear
Theta : 15.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
0
25
50
75
100
125
150
175
200
0.970
0.975
0.980
0.985
0.990
0.995
5
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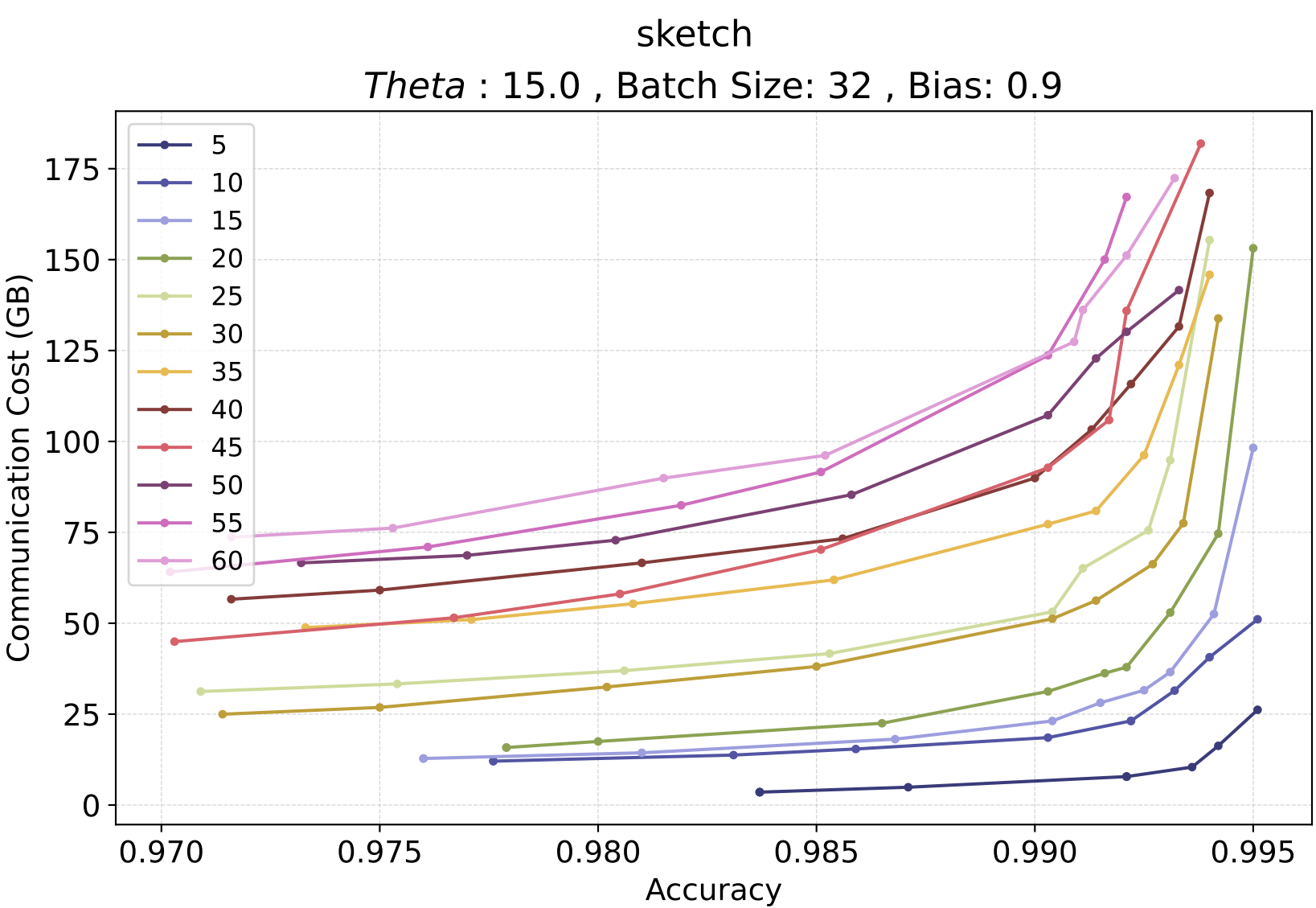
sketch
Theta : 15.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
0
25
50
75
100
125
150
175
0.970
0.975
0.980
0.985
0.990
0.995
5
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35
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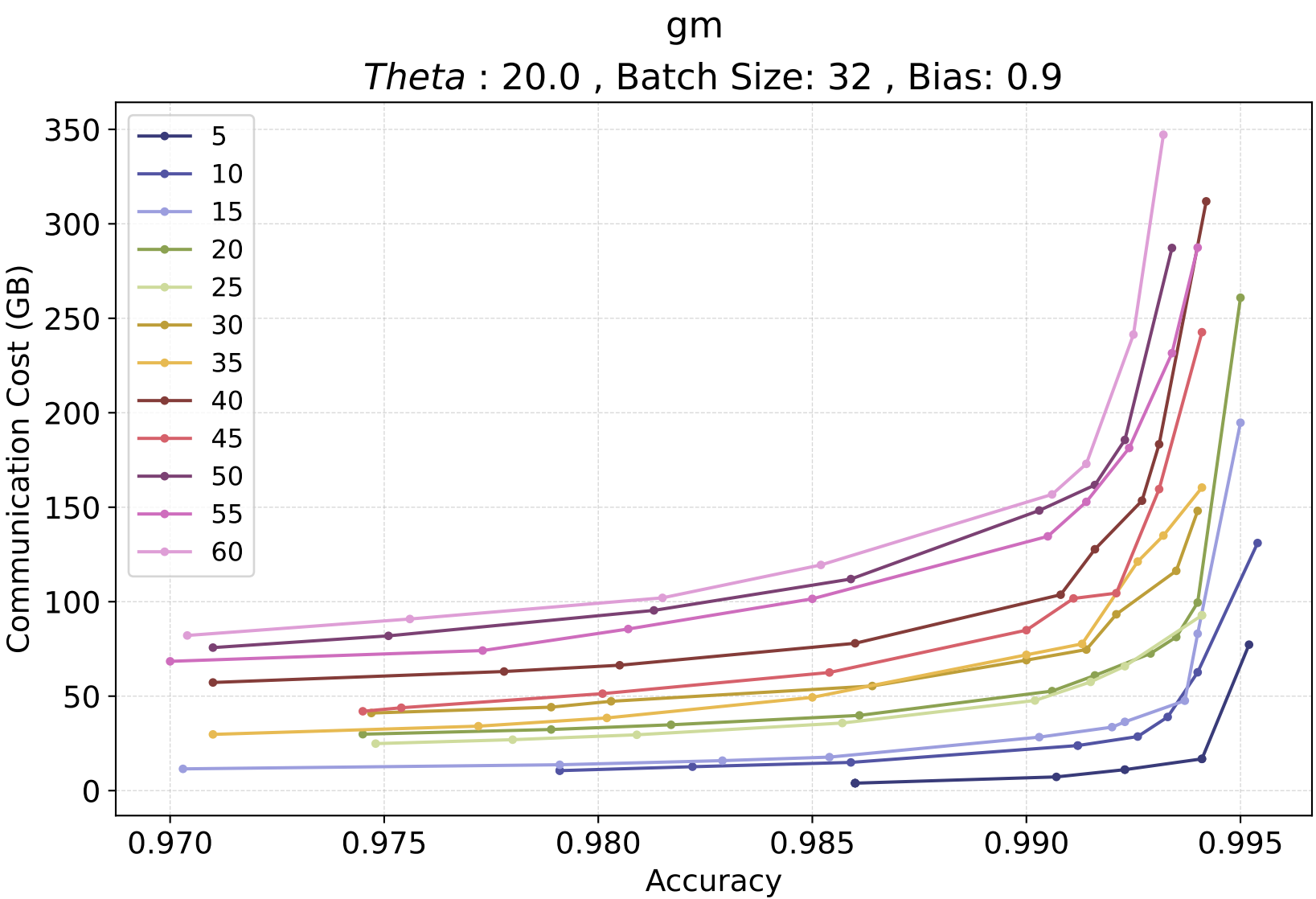
gm
Theta : 20.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
0
50
100
150
200
250
300
350
0.970
0.975
0.980
0.985
0.990
0.995
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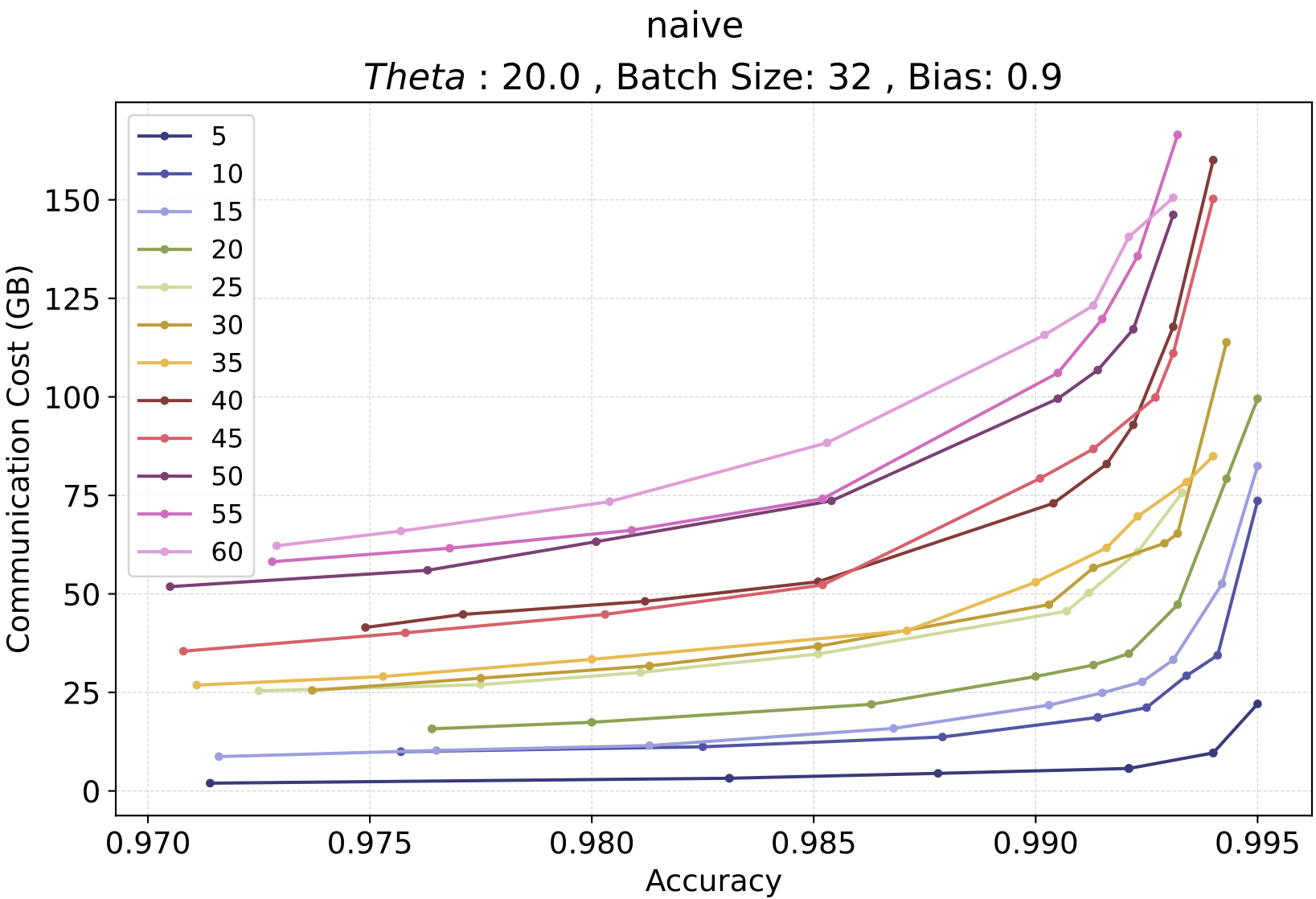
naive
Theta : 20.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
0
25
50
75
100
125
150
0.970
0.975
0.980
0.985
0.990
0.995
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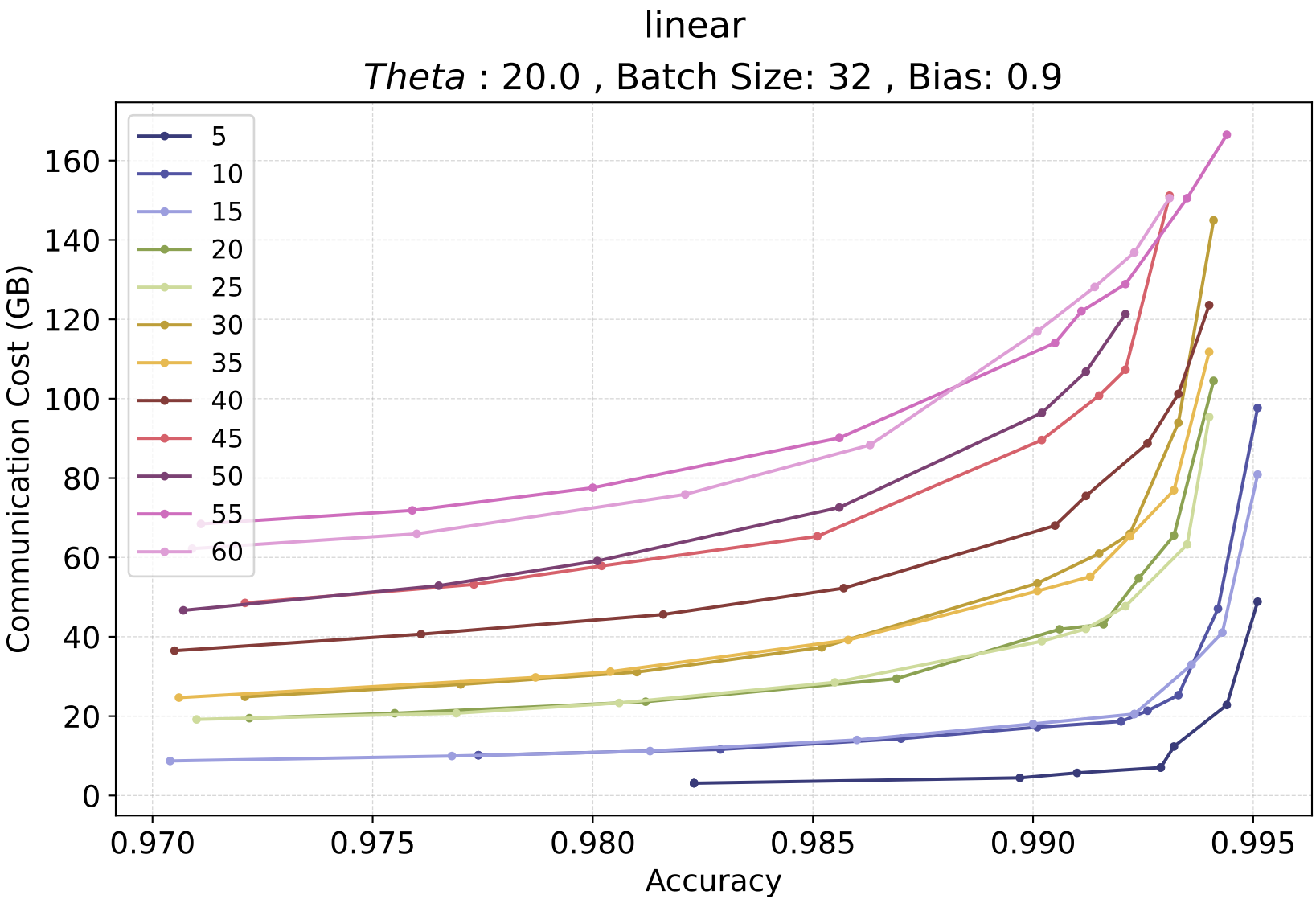
linear
Theta : 20.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
120
140
160
0.970
0.975
0.980
0.985
0.990
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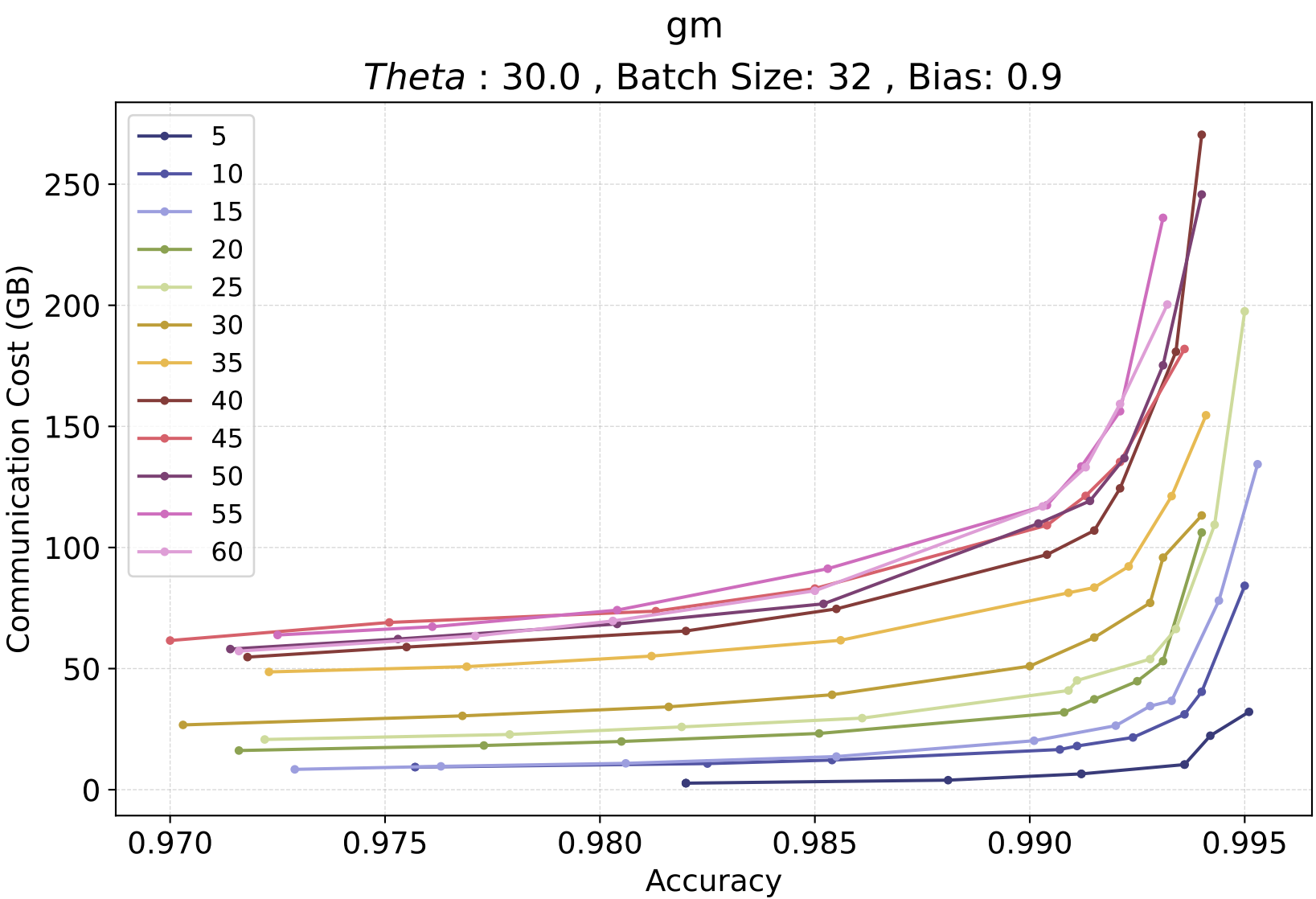
gm
Theta : 30.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
0
50
100
150
200
250
0.970
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0.980
0.985
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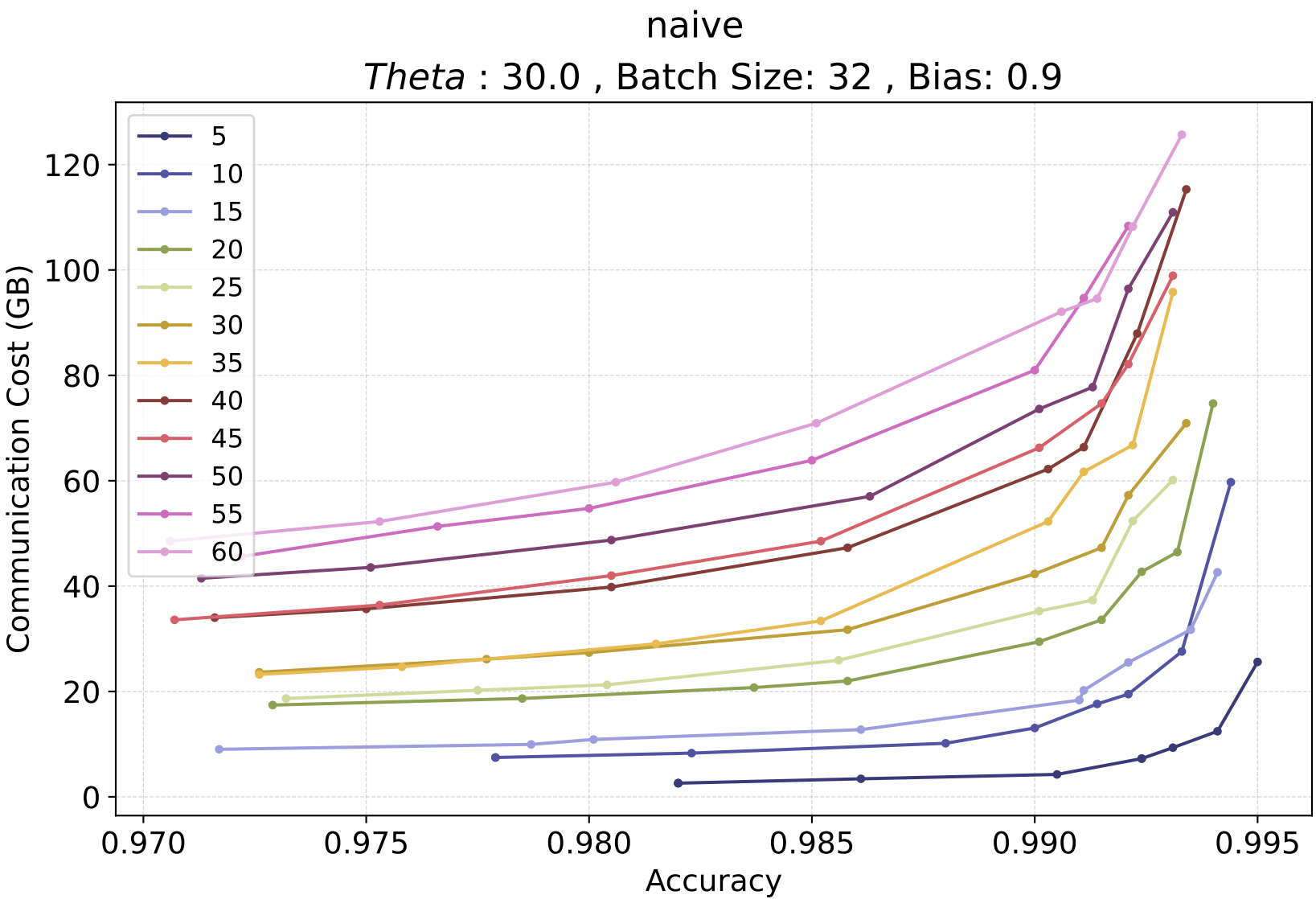
naive
Theta : 30.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
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0.970
0.975
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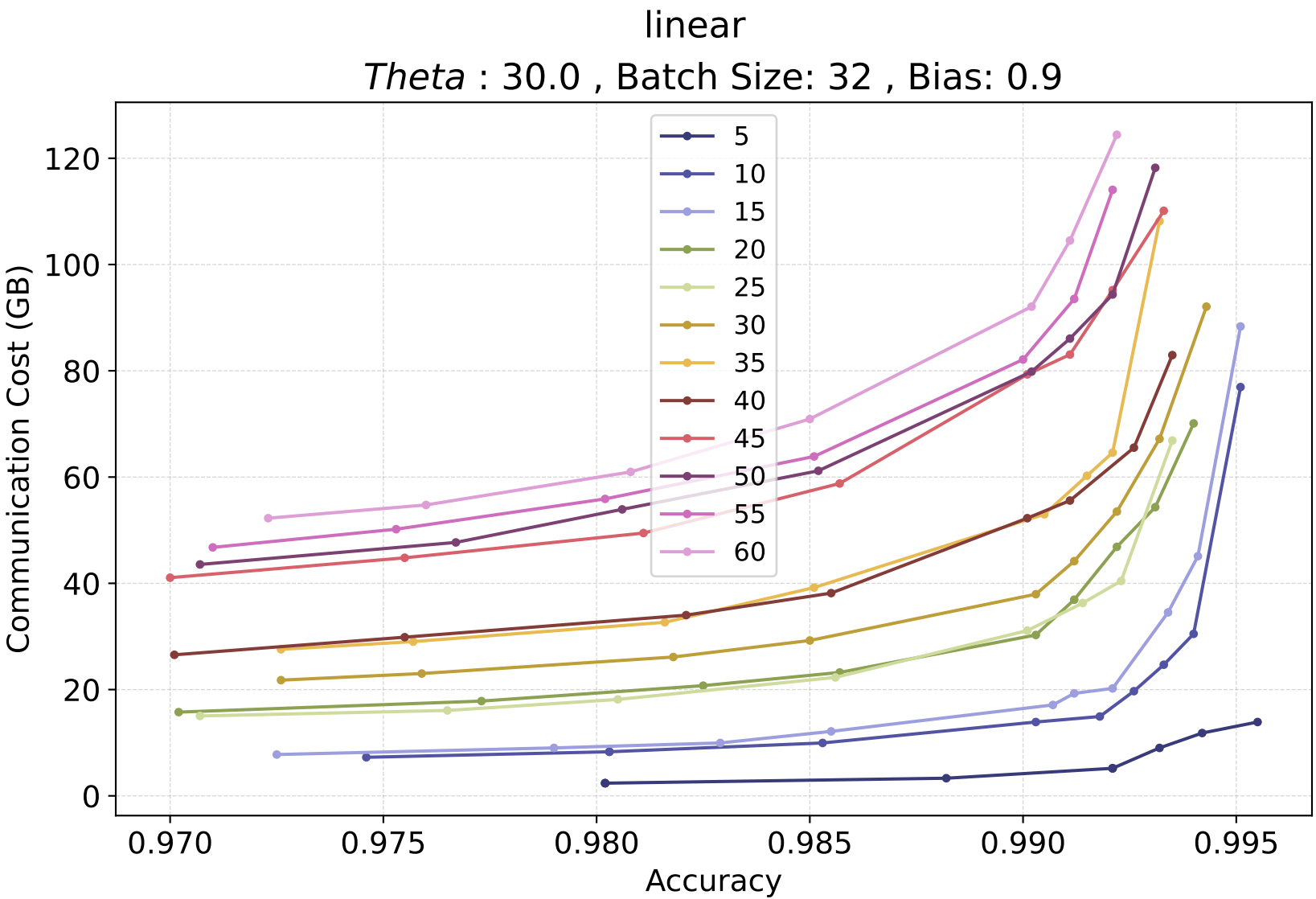
linear
Theta : 30.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
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0.970
0.975
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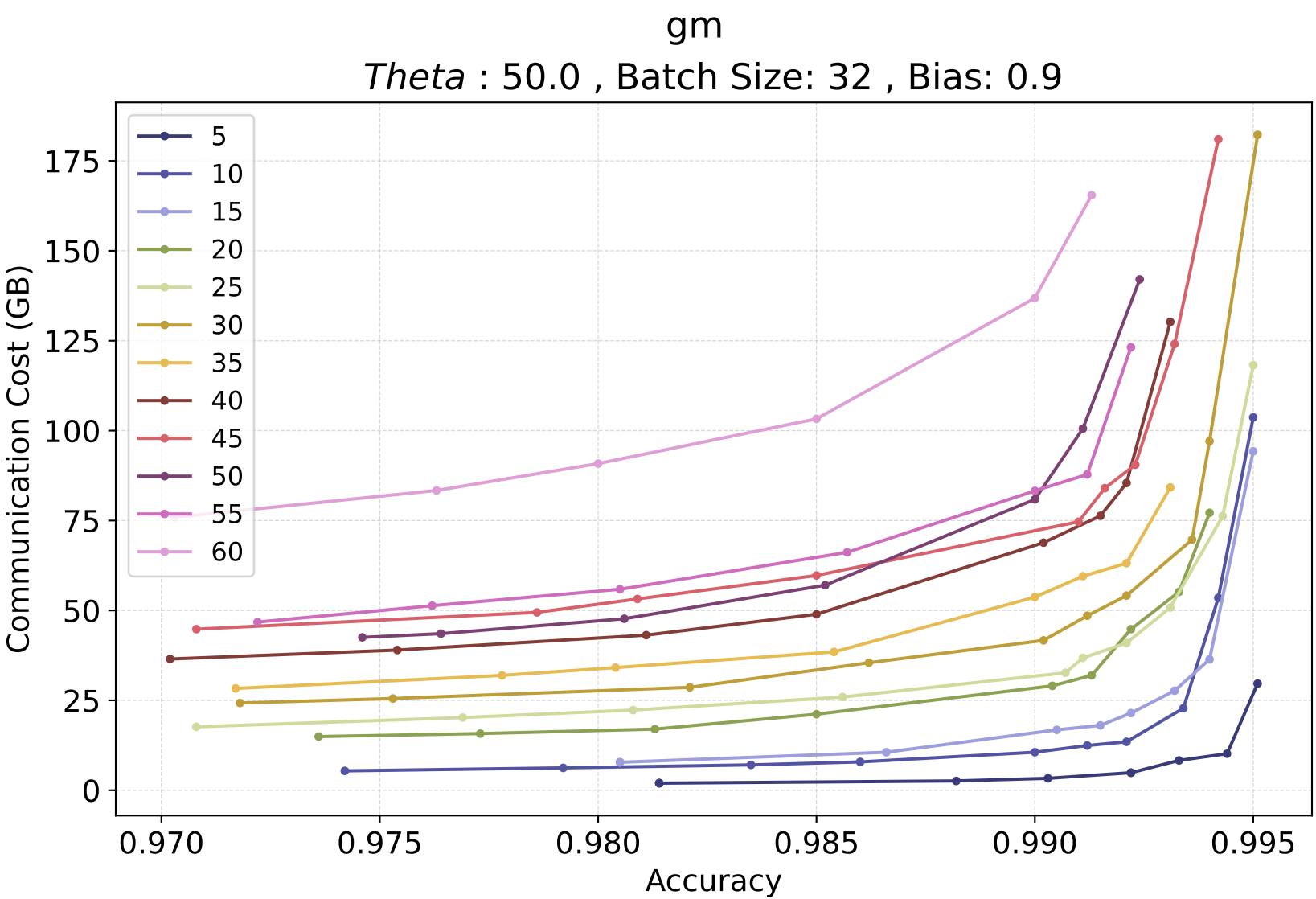
gm
Theta : 50.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
0
25
50
75
100
125
150
175
0.970
0.975
0.980
0.985
0.990
0.995
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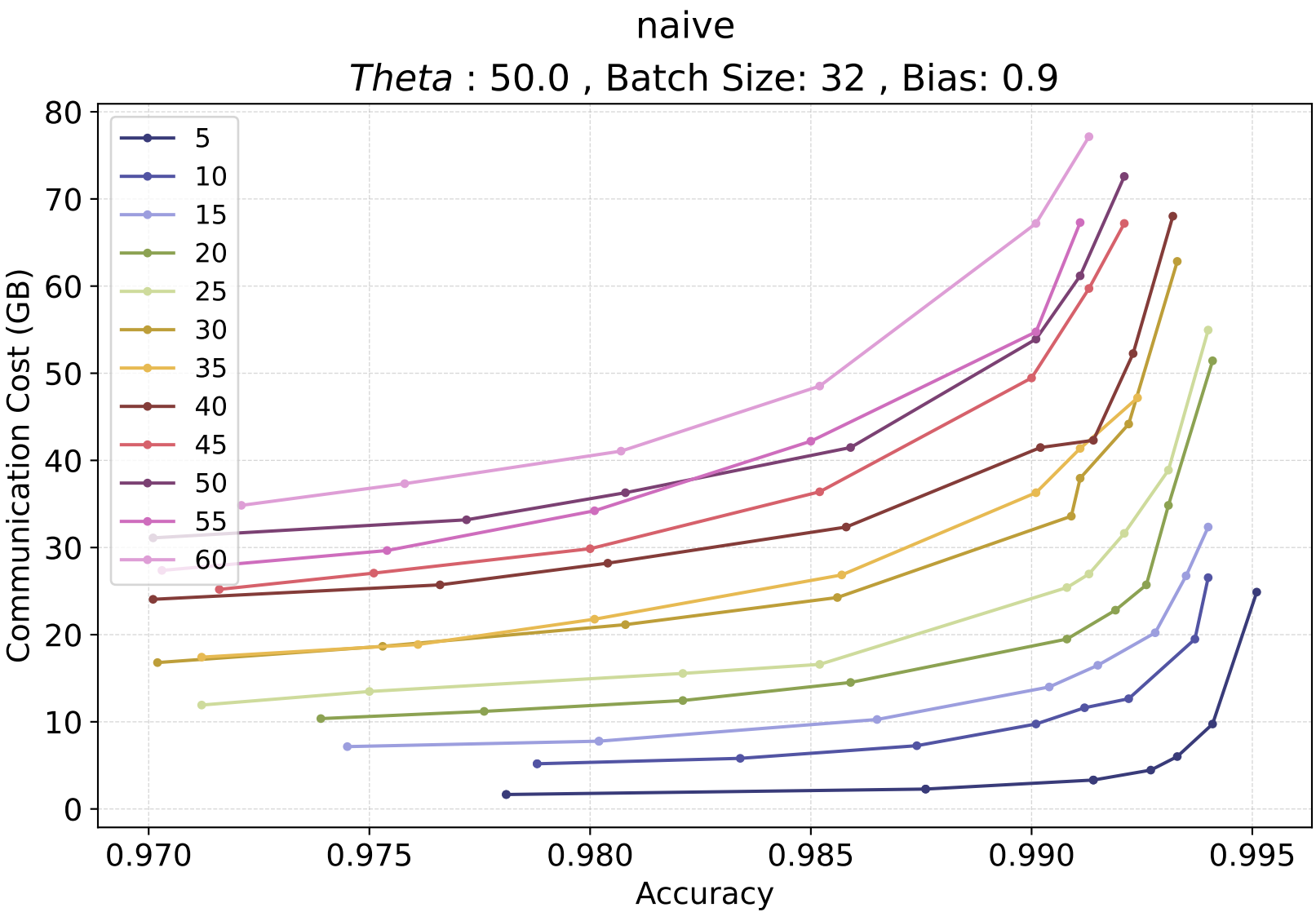
naive
Theta : 50.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
0
10
20
30
40
50
60
70
80
0.970
0.975
0.980
0.985
0.990
0.995
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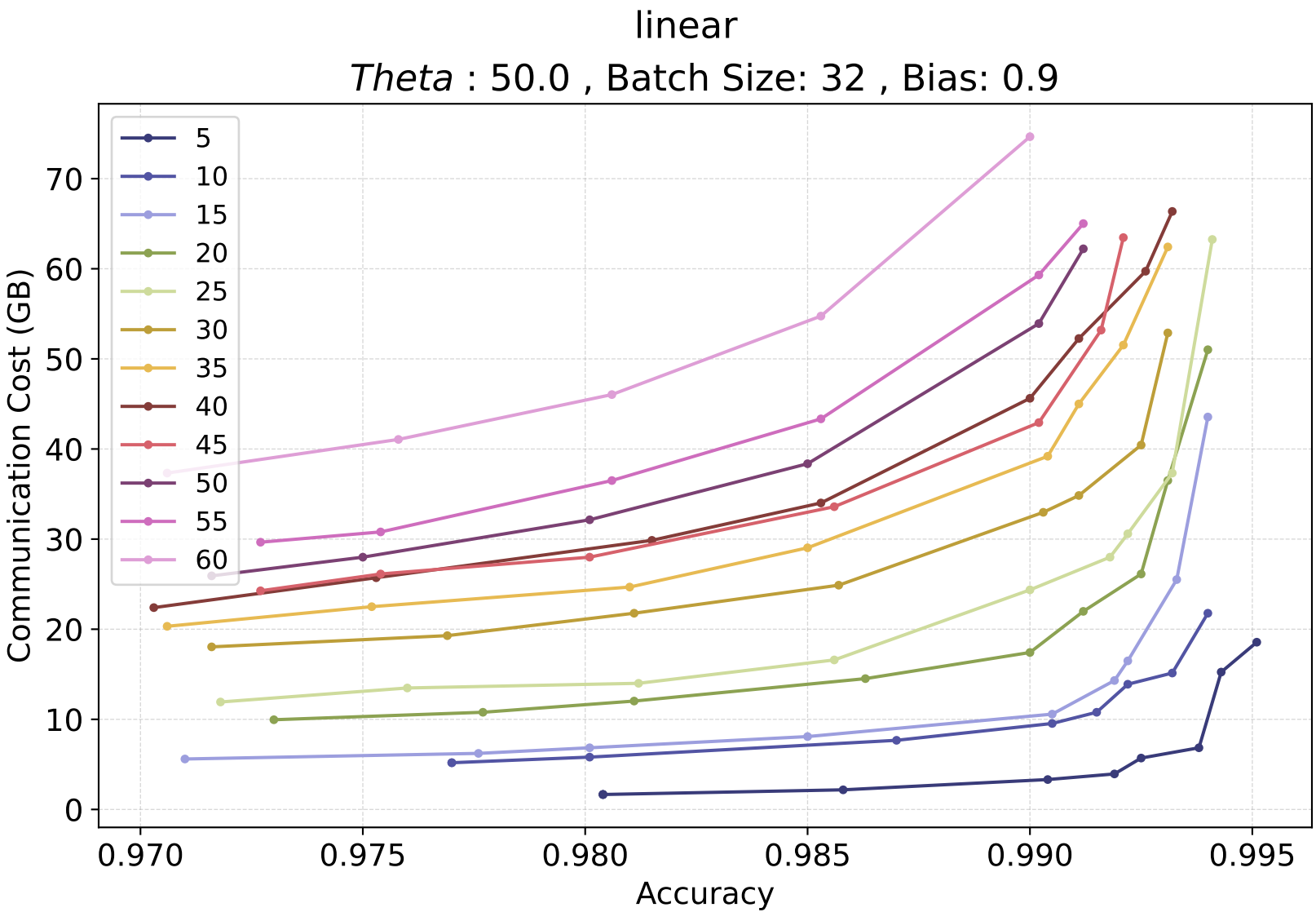
linear
Theta : 50.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
0
10
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70
0.970
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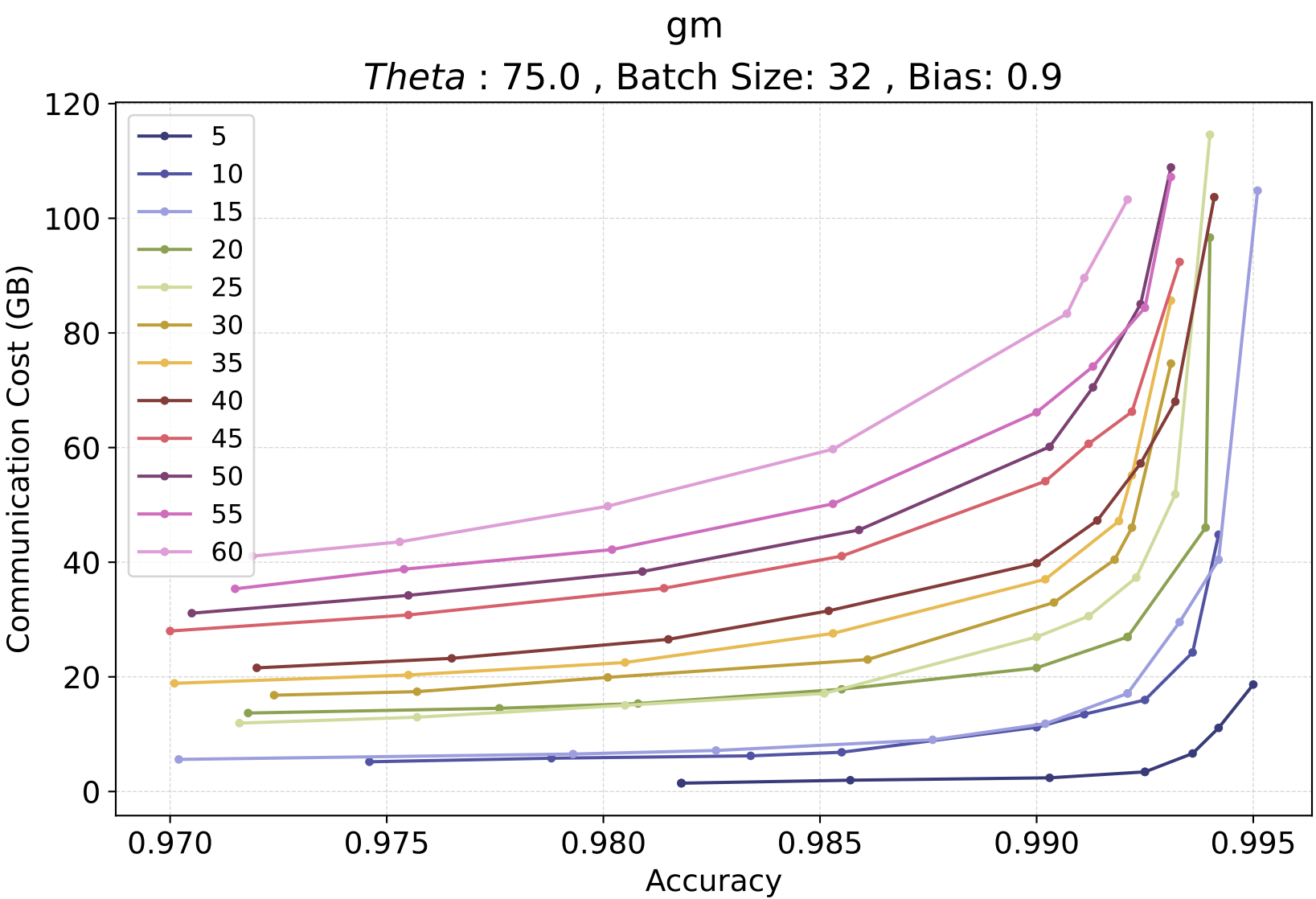
gm
Theta : 75.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
0
20
40
60
80
100
120
0.970
0.975
0.980
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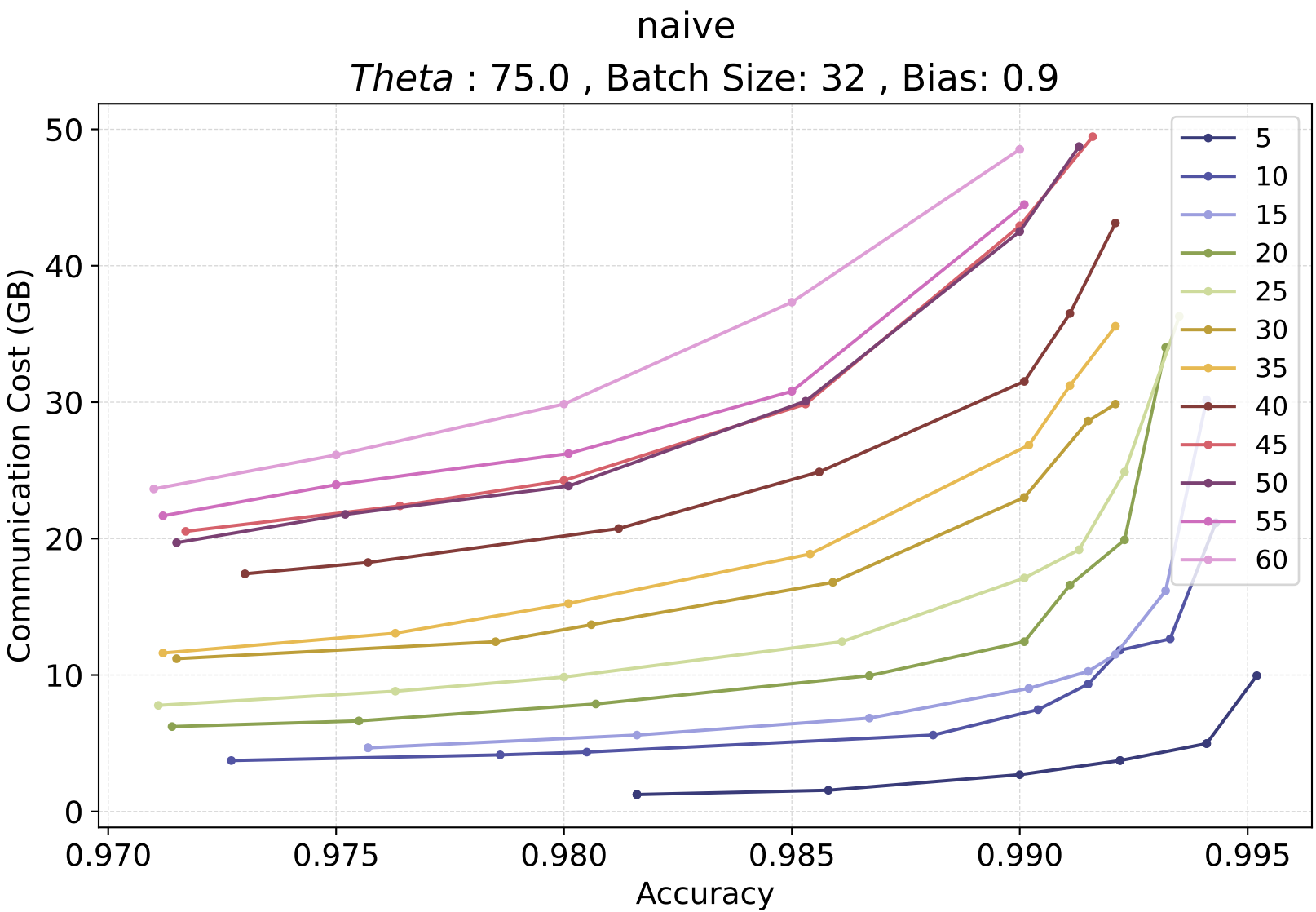
naive
Theta : 75.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
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0.970
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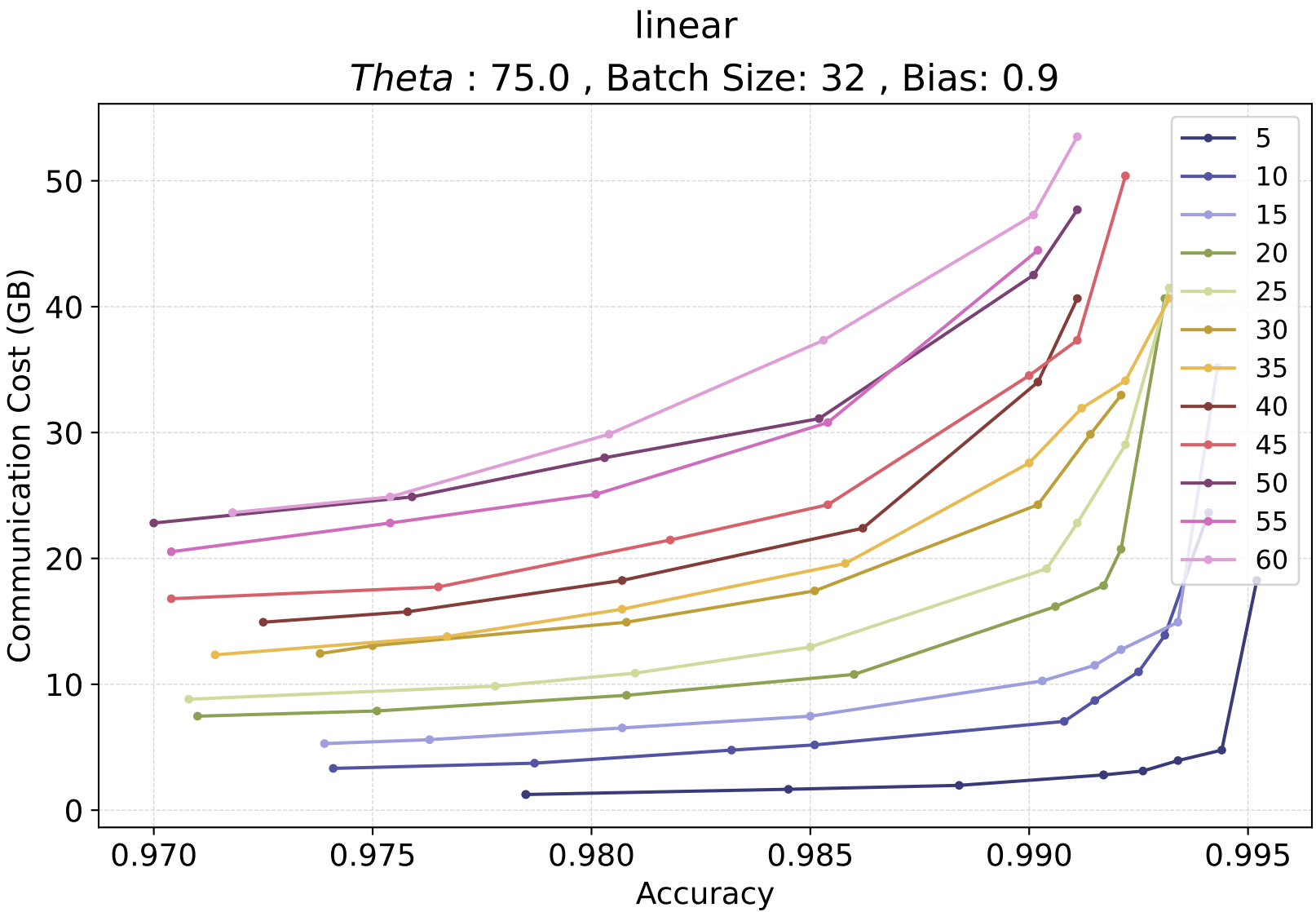
linear
Theta : 75.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
0
10
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0.970
0.975
0.980
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0.995
Accuracy
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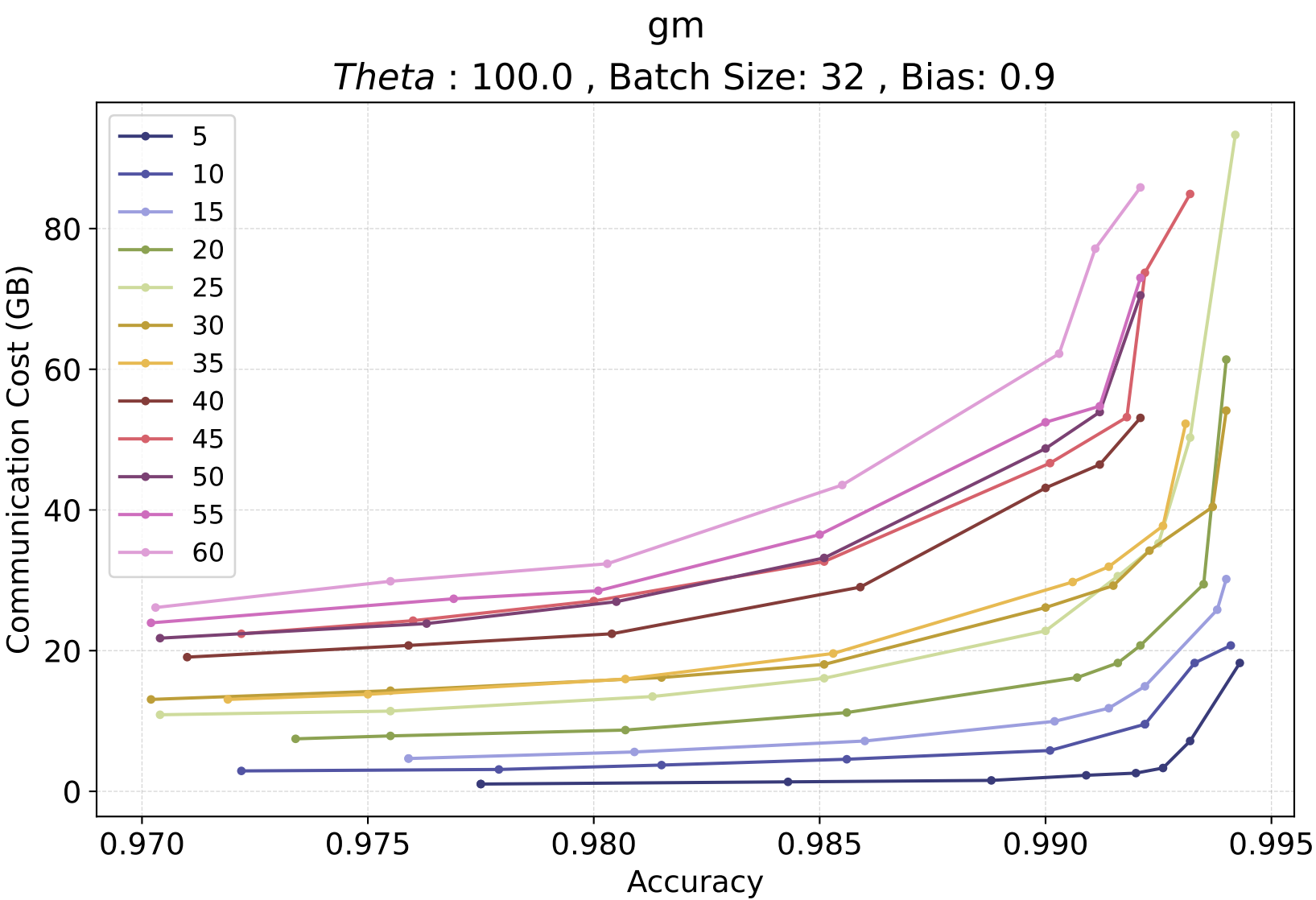
gm
Theta : 100.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
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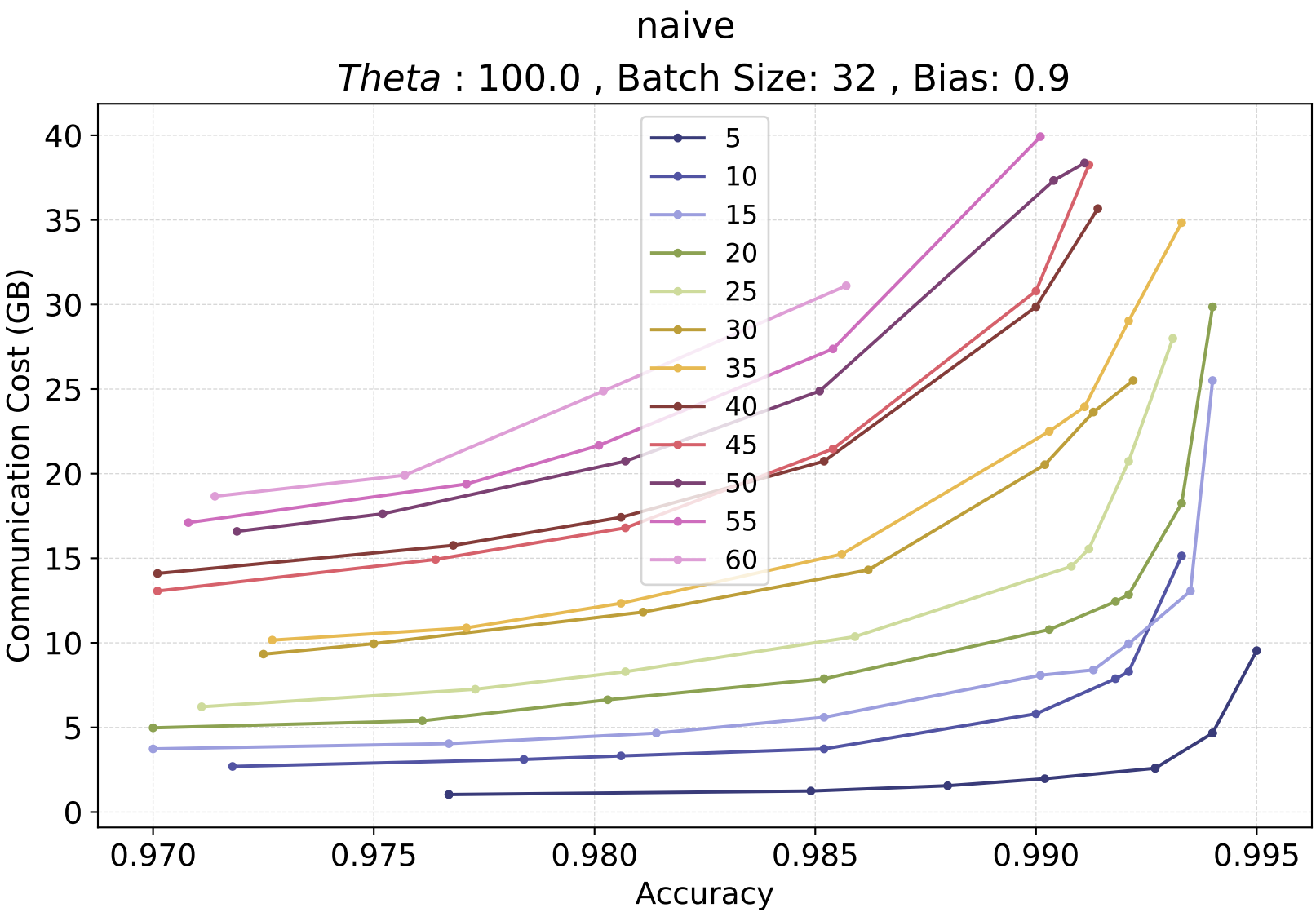
naive
Theta : 100.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
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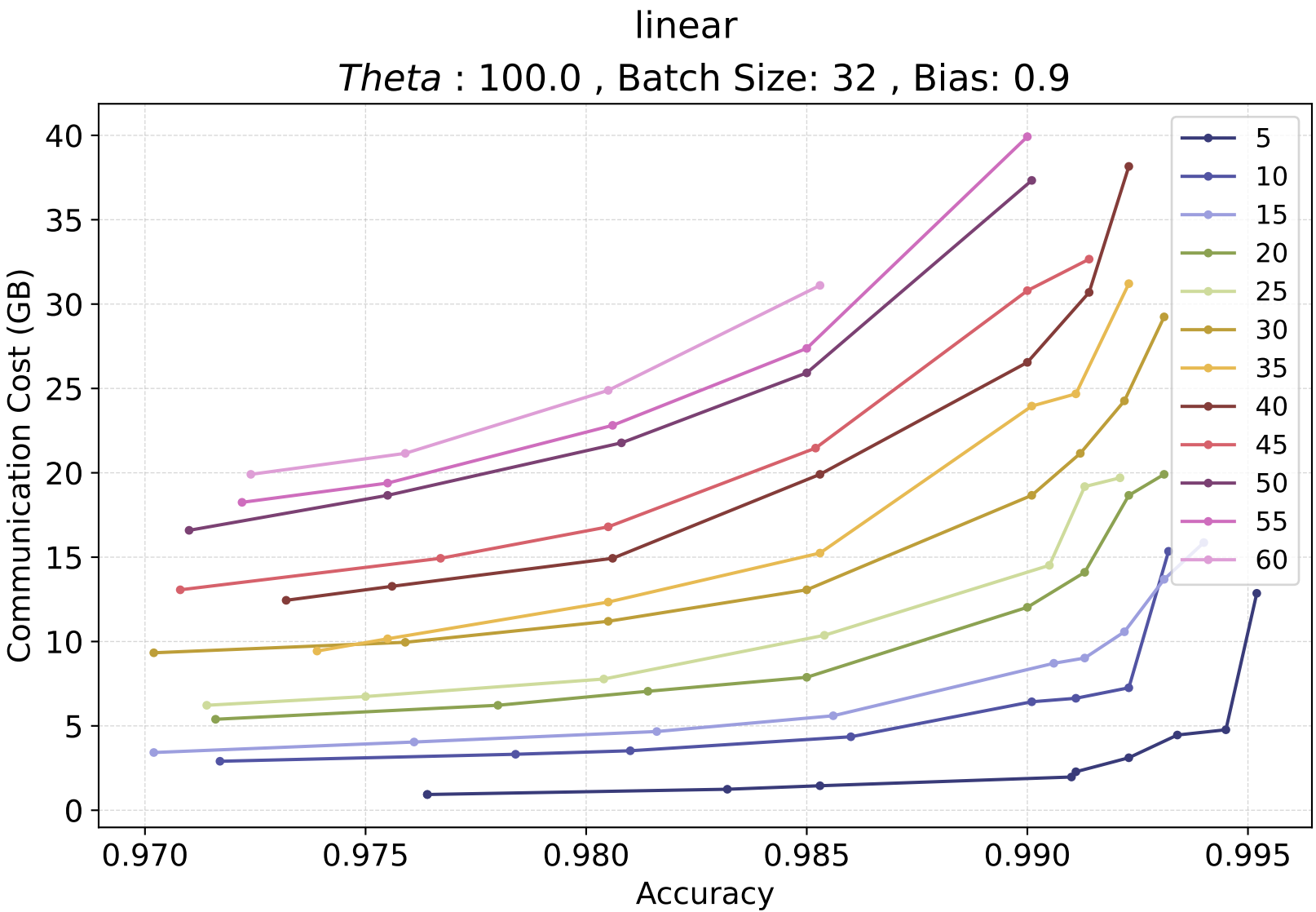
linear
Theta : 100.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
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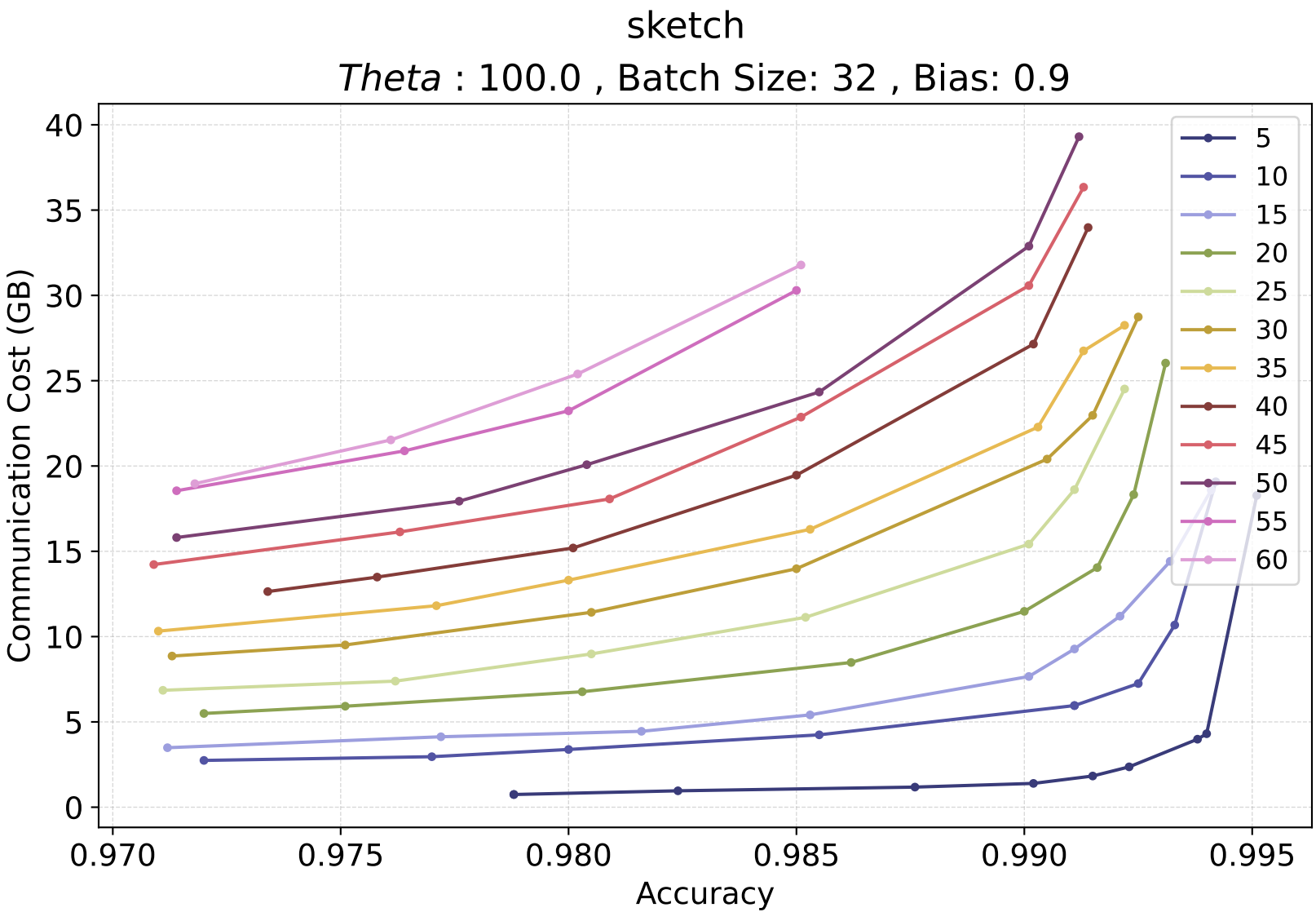
sketch
Theta : 100.0 , Batch Size: 32 , Bias: 0.9
Communication Cost (GB)
Accuracy
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0.975
0.980
0.985
0.990
0.995
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