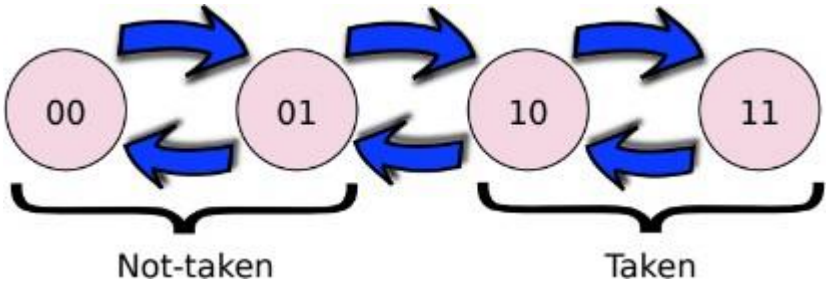
Branch Predictor

Branch prediction is a procedure to reduce the costs of branch instructions. It helps to increase the speed at which the branch instructions are processed in the CPU. When a conditional statement is about to be executed, the branch predictor guess the outcome of the conditional statement. It then processes the instruction ahead of the time. At runtime, if the guess is correct, the speed is increased. But if the guess turns out to be false, the other branch of the instruction is executed, which leads to delay in the circuit. Since the misprediction of the branch instructions leads to a delay, we need to improve the accuracy of the branch predictor in order to benefit from the branch prediction method.

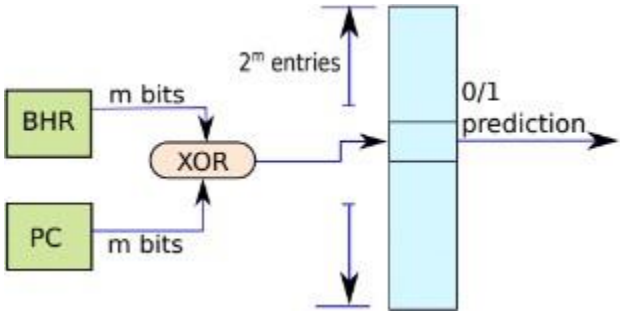
Saturating Counter - In a saturating counter, half of the states represent the "taken" and half of the states represents "not taken". If the branch is taken,



the counter moves the right, while if it is moves to the left when the counter is not taken. Here a state diagram for 2-bit saturating counter is given. For every two consecutive mispredictions, the prediction state changes. A 2-bit saturating counter provides better result than a 1-bit counter and thus it is used in our predictor.

For the implementation of the branch predictor, GShare predictor is used as it is proved to be the efficient one of the othe types of branch predictor.

GShare Predictor - Here m-bits pattern is extracted form the BHR and an XOR operation is performed between it and the m-bits of the PC. The XOR operation gives the address of the PHT entry. The PHT entry is referred for the branch prediction.



Implementation of 2400 bit -

```
F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace1 2400
Size of predictor: 1792
Total branches: 2213673
Predictor Accuracy: 0.9217675781382345

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace2 2400
Size of predictor: 1792
Total branches: 1792835
Predictor Accuracy: 0.9654641949761132

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace3 2400
Size of predictor: 1792
Total branches: 1546797
Predictor Accuracy: 0.9834916928336427

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace4 2400
Size of predictor: 1792
Total branches: 895842
Predictor Accuracy: 0.9760627432069494

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace5 2400
Size of predictor: 1792
Total branches: 2422049
Predictor Accuracy: 0.9293998593752645
```

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MAX SIZE = 2400
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file = Predictor2400


TRACE: trace1
size = 1792
accuracy = 0.921767578138

TRACE: trace2
size = 1792
accuracy = 0.965464194976

TRACE: trace3
size = 1792
accuracy = 0.983491692834

TRACE: trace4
size = 1792
accuracy = 0.976062743207

TRACE: trace5
size = 1792
accuracy = 0.929399859375


average predictor accuracy = 0.955237213706
expected average accuracy  = 0.9484
```

Implementation of 6400 bit -

```
F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace1 6400
Size of predictor: 6144
Total branches: 2213673
Predictor Accuracy: 0.9357831983314608

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace2 6400
Size of predictor: 6144
Total branches: 1792835
Predictor Accuracy: 0.9701701495118067

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace3 6400
Size of predictor: 6144
Total branches: 1546797
Predictor Accuracy: 0.9873144310468666

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace4 6400
Size of predictor: 6144
Total branches: 895842
Predictor Accuracy: 0.9770818961379351

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace5 6400
Size of predictor: 6144
Total branches: 2422049
Predictor Accuracy: 0.9552308809607072
```

```
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MAX SIZE = 6400
-------------------------

file = Predictor6400


TRACE: trace1
size = 6144
accuracy = 0.935783198331

TRACE: trace2
size = 6144
accuracy = 0.970170149512

TRACE: trace3
size = 6144
accuracy = 0.987314431047

TRACE: trace4
size = 6144
accuracy = 0.977081896138

TRACE: trace5
size = 6144
accuracy = 0.955230880961


average predictor accuracy = 0.965116111198
expected average accuracy  = 0.9513
```

Implementation of 9999 bit -

```
F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace1 9999
Size of predictor: 8192
Total branches: 2213673
Predictor Accuracy: 0.9427611937264447

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace2 9999
Size of predictor: 8192
Total branches: 1792835
Predictor Accuracy: 0.9691393798090734

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace3 9999
Size of predictor: 8192
Total branches: 1546797
Predictor Accuracy: 0.9855352706269795

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace4 9999
Size of predictor: 8192
Total branches: 895842
Predictor Accuracy: 0.9877779787060664

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace5 9999
Size of predictor: 8192
Total branches: 2422049
Predictor Accuracy: 0.9625725986551057
```

```
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MAX SIZE = 9999
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file = Predictor9999


TRACE: trace1
size = 8192
accuracy = 0.942761193726

TRACE: trace2
size = 8192
accuracy = 0.969139379809

TRACE: trace3
size = 8192
accuracy = 0.985535270627

TRACE: trace4
size = 8192
accuracy = 0.987777978706

TRACE: trace5
size = 8192
accuracy = 0.962572598655


average predictor accuracy = 0.969557284305
expected average accuracy  = 0.9531
```

Implementation of 32000 bit -

```
F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace1 32000
Size of predictor: 26624
Total branches: 2213673
Predictor Accuracy: 0.9302810306671311

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace2 32000
Size of predictor: 26624
Total branches: 1792835
Predictor Accuracy: 0.9577780442706663

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace3 32000
Size of predictor: 26624
Total branches: 1546797
Predictor Accuracy: 0.9878477912744853

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace4 32000
Size of predictor: 26624
Total branches: 895842
Predictor Accuracy: 0.9874486795662628

F:\Coding\Java\Assignment_2\assignment2_v2>java -jar jar/BranchPredictor.jar traces/trace5 32000
Size of predictor: 26624
Total branches: 2422049
Predictor Accuracy: 0.9772287843887552
```

```
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MAX SIZE = 32000
-------------------------

file = Predictor32000


TRACE: trace1
size = 26624
accuracy = 0.930281030667

TRACE: trace2
size = 26624
accuracy = 0.957778044271

TRACE: trace3
size = 26624
accuracy = 0.987847791274

TRACE: trace4
size = 26624
accuracy = 0.987448679566

TRACE: trace5
size = 26624
accuracy = 0.977228784389


average predictor accuracy = 0.968116866033
expected average accuracy  = 0.9512
```