Viterbi Decoding Algorithm
Convolutional Codes
An Example – (rate=1/2 with K=2)

State Diagram

<table>
<thead>
<tr>
<th>Present</th>
<th>Next</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>00</td>
<td>00</td>
</tr>
<tr>
<td>1</td>
<td>00</td>
<td>11</td>
</tr>
<tr>
<td>0</td>
<td>01</td>
<td>11</td>
</tr>
<tr>
<td>1</td>
<td>01</td>
<td>00</td>
</tr>
<tr>
<td>0</td>
<td>10</td>
<td>01</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>0</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>1</td>
<td>11</td>
<td>01</td>
</tr>
</tbody>
</table>
Trellis Diagram Representation

Trellis termination: K tail bits with value 0 are usually added to the end of the code.
Encoding Process

Input:  1  0  1  1  1  0  0
Output: 11  01  00  10  01  10  11

The diagram shows the encoding process for the given inputs and outputs.
Viterbi Decoding Algorithm

- Maximum Likelihood (ML) decoding rule

\[ \text{received sequence } r \xrightarrow{\text{ML}} \text{detected sequence } d \]
\[ \text{min}(d,r) !! \]

- Viterbi Decoding Algorithm
  - An efficient search algorithm
    - Performing ML decoding rule.
    - Reducing the computational complexity.
Viterbi Decoding Algorithm

Basic concept

- Generate the code trellis at the decoder
- The decoder penetrates through the code trellis *level by level* in search for the transmitted code sequence
- At each level of the trellis, the decoder computes and compares the metrics of all the partial paths entering a node
- The decoder *stores* the partial path with the larger metric and *eliminates* all the other partial paths. The stored partial path is called the *survivor*. 
Viterbi Decoding Process

Output: 11 01 00 10 01 10 11
Receive: 11 11 00 10 01 11 11

Diagram: (Diagram showing the Viterbi decoding process with states and transitions, illustrating the path through the graph.)
Viterbi Decoding Process

Output: 11  01  00  10  01  10  11
Receive: 11  11  00  10  01  11  11

Diagram showing the Viterbi decoding process with states 00, 01, 10, and 11.
Viterbi Decoding Process

Output: 11 01 00 10 01 10 11
Receive: 11 11 00 10 01 11 11

Diagram showing the Viterbi decoding process with states and transitions.
Viterbi Decoding Process

Output: 11 01 00 10 01 10 11
Receive: 11 11 00 10 01 11 11

The diagram illustrates the Viterbi decoding process with a trellis structure. Each state represents a possible sequence of bits, and the transitions between states are labeled with the bit received and the state reached. The process involves comparing the received sequence with the possible output sequences and selecting the most likely path through the trellis, which corresponds to the decoded output sequence.
Viterbi Decoding Process

Output: 11 01 00 10 01 10 11
Receive: 11 11 00 10 01 11 11

Diagram of the Viterbi decoding process with states and transitions.
Viterbi Decoding Process

Output: 11 01 00 10 01 10 11
Receive: 11 11 00 10 01 11 11

Graph showing the Viterbi decoding process with states and transitions.
Viterbi Decoding Process

Output: 11 01 00 10 01 10 11
Receive: 11 11 00 10 01 11 11

Output: 00 00 00 00 00 00 00
Receive: 00 00 00 00 00 00 00

Diagram showing the Viterbi decoding process with states and transitions labeled.
Viterbi Decoding Process

Decision: 11 01 00 10 01 10 11
Receive: 11 11 00 10 01 11 11

Output: 10111(00)