Neural networks design and implementation flowchart for monitoring and visualising wormholes and foamy oil in heavy oil cold production

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Introduction

a. Heavy oil production causes wormholes and foamy oil

b. How wormholes and foamy oil look like

c. Lab experiment

Figure 1 A schematic diagram of a cold production oil pump (courtesy of Kudu Oil Well Pumps)

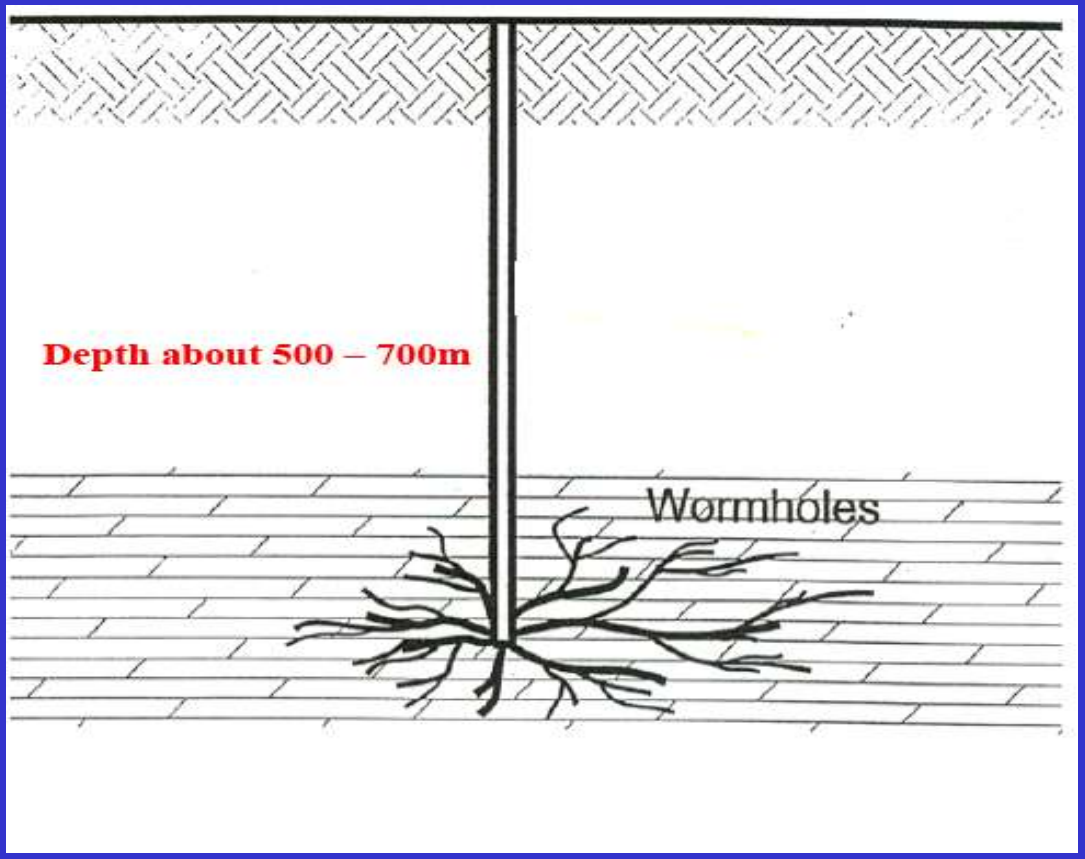
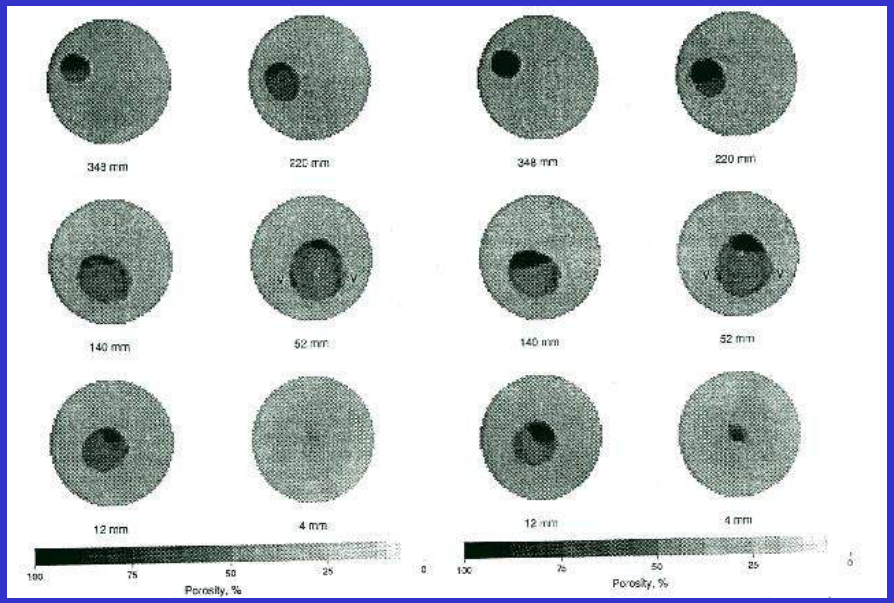


Figure 2 Wormhole growing pattern in the reservoir (modified after Miller, et al. 2001)

Figure 3 Foamy oil (D. Greenidge, ESSO, private communication)



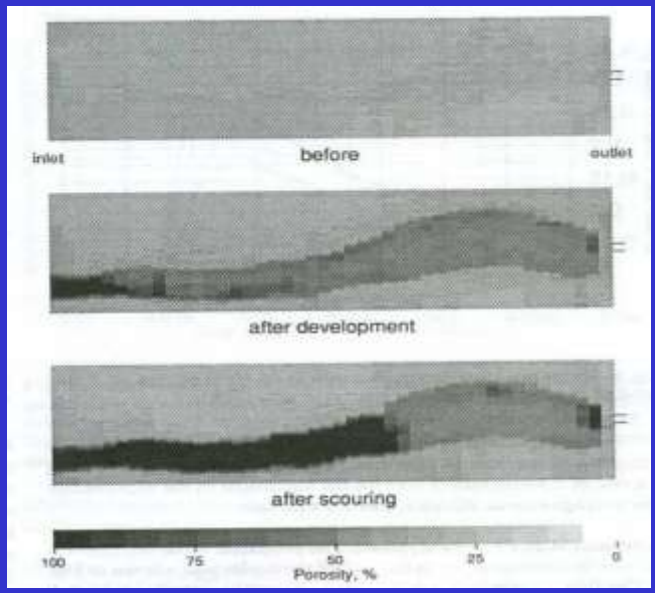


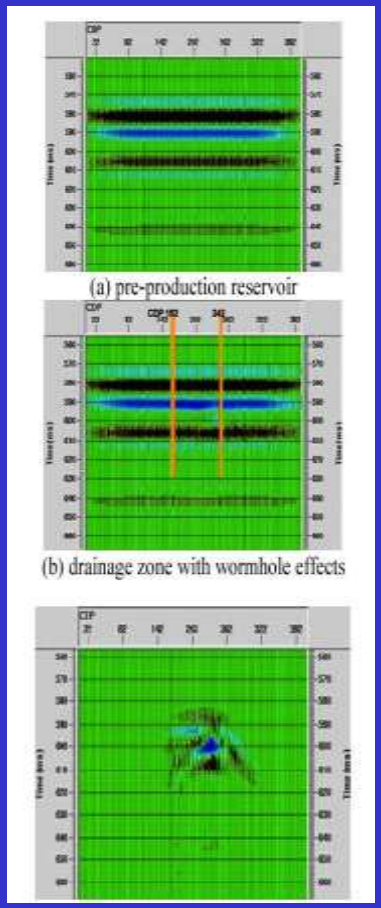
Figure 4 Cross-sections and Horizontal section of the sandpack (Tremblay et al, 1997)

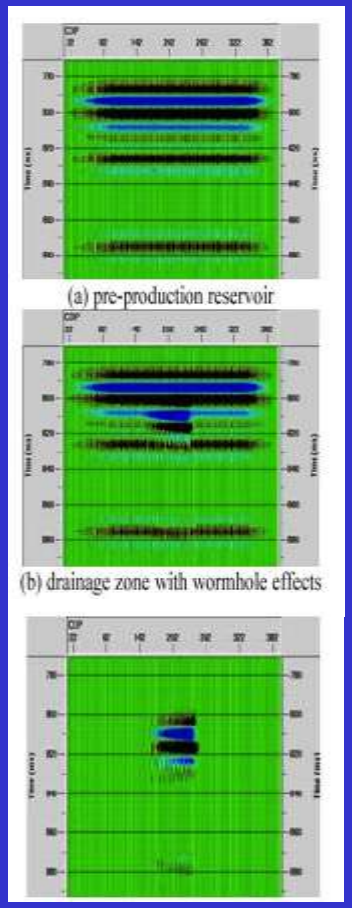
Previous related work

1. Model studies

2. Field data examples

Model studies





PP sections

PS sections

Figure 5 PP&PS stacking sections of the initial geological model, the post-production sections and differences (Chen et al., 2004)

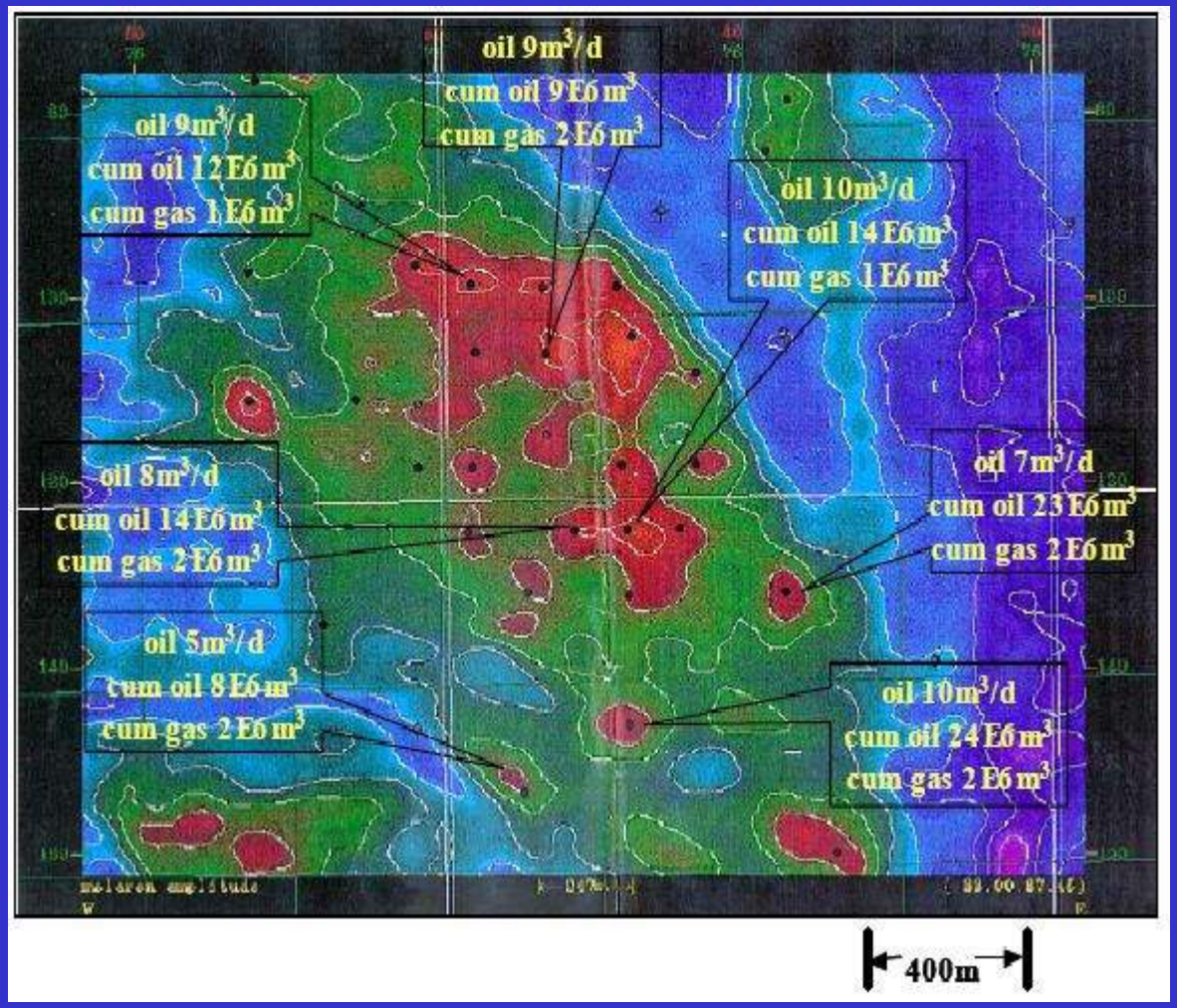


Figure 6 3D horizon amplitude map in Provost Upper Mannville BB Pool, Lloydminster after 9-year of production. Red coloring represents strongly negative amplitude anomalies due to sand production. (modified after Mayo, 1996).

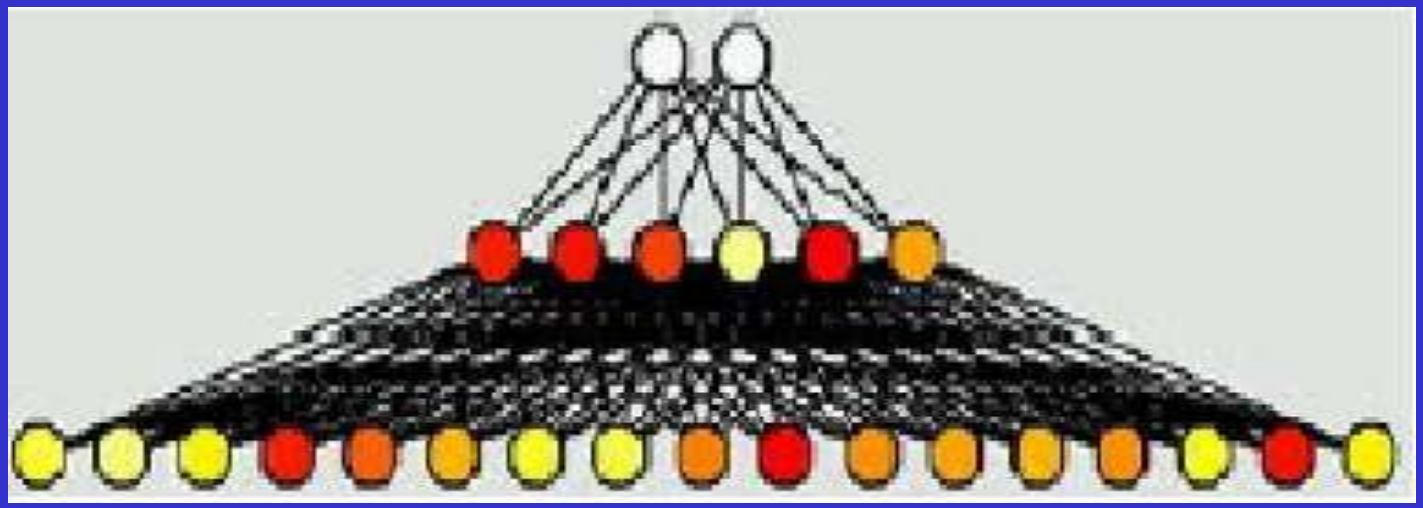


Figure 7 Neural works used in the anomaly prediction and intra-reservoir horizon mapping (Oldenziel et al, 2002)

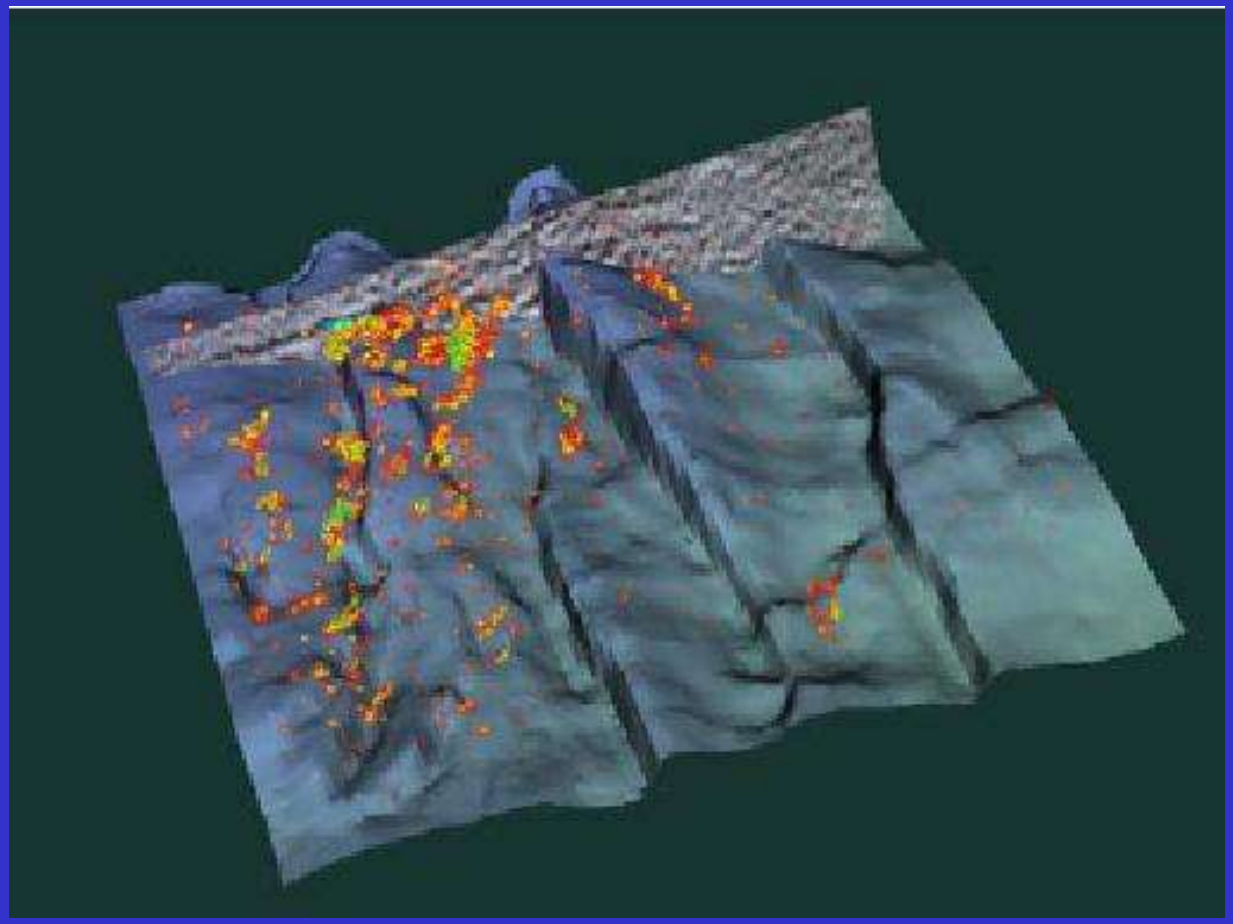


Figure 8 Neural network predicted 4D anomalies and mapped intra-reservoir horizon (5x4.4 km), Oldenziel et al, 2002

Neural network design

1. Network design

2. The advantages for the network

3. Network convergence experiment

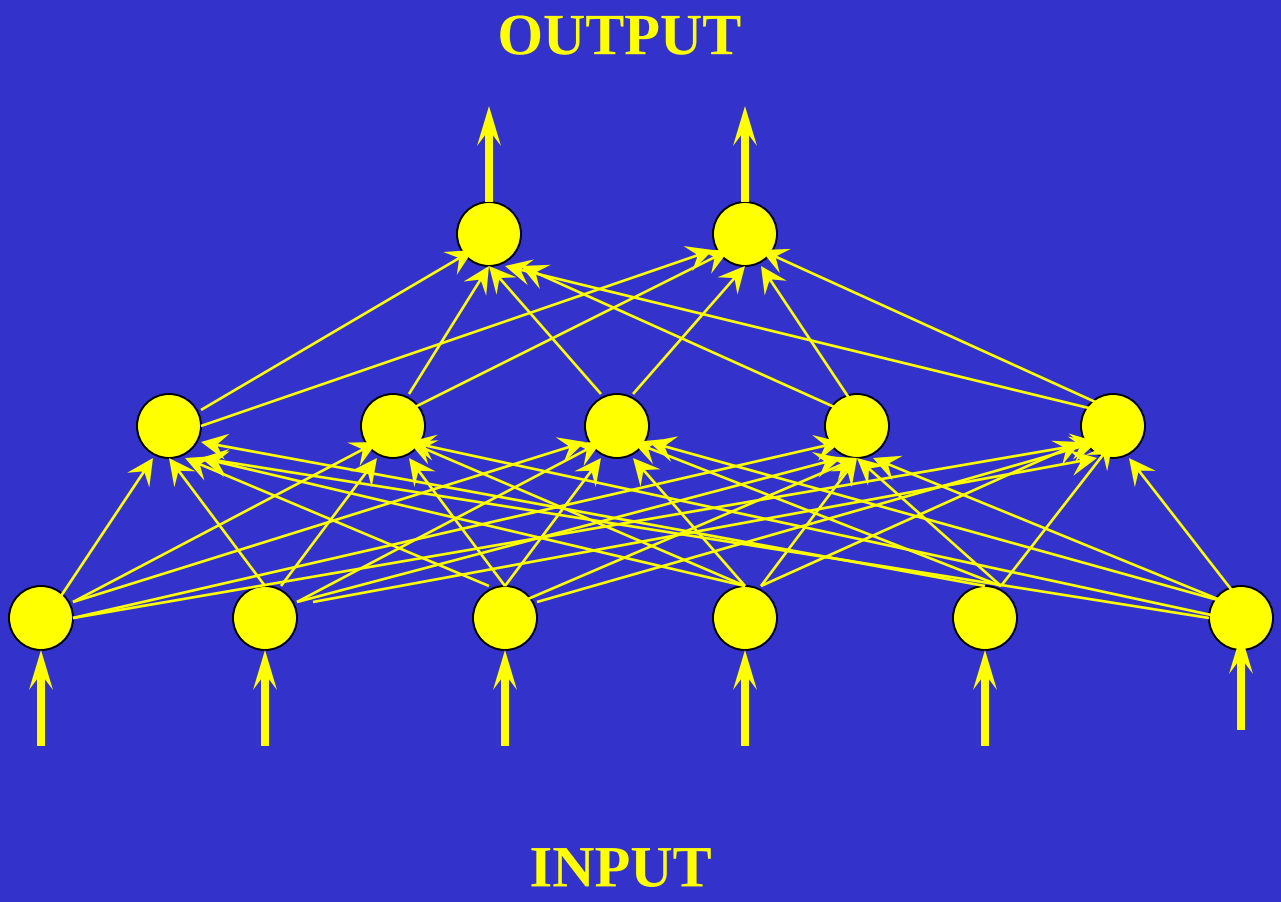


Figure 9 The BP neural work design for this project

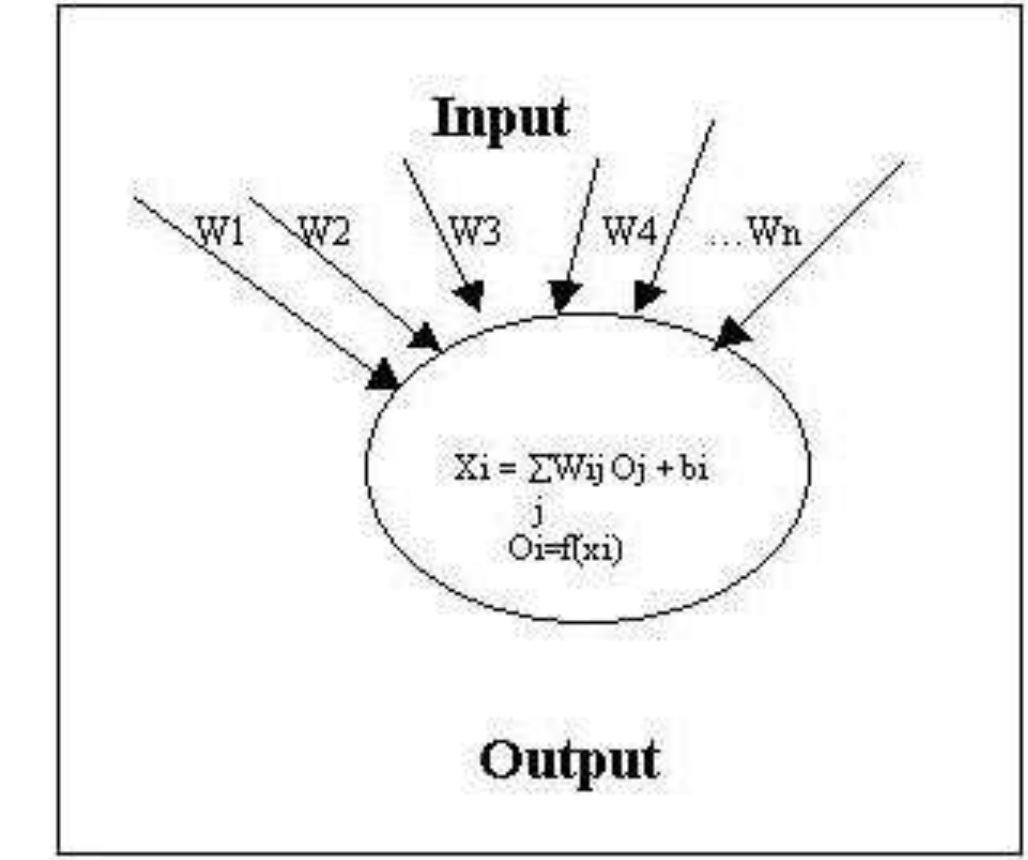


Figure 10 A node of the neural network

The advantages for the network

1. 3 layers design can solve non-linear problem,
2. The node numbers in input layer and hidden layers are adjustable,
3. Added Momentum factor in the network makes faster convergence.

Network convergence experiment

Network input

1, 0
0, 0
1, 0
0, 1

Network training

Training times	Iterative error
1	0.58921640
2	0.56497320
4586	0.02000236
4587	0.01999968

Network output

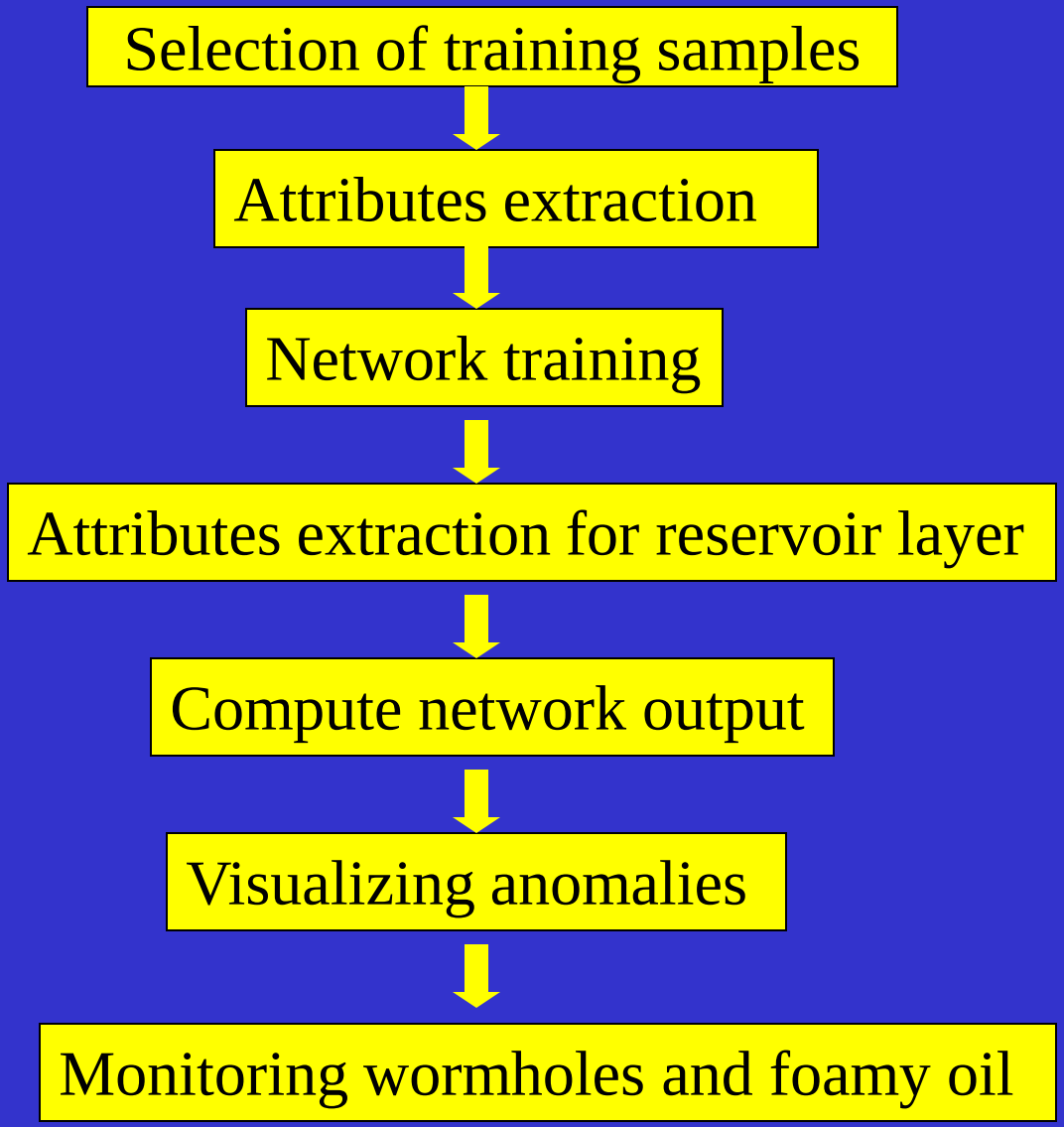
0.98143010	0.01851029
0.98234850	0.01759673
0.01999968	0.98006360
0.01999505	0.98006830

Potential seismic attributes

(4D P wave and PS wave)

1. Velocity
2. Travel time delay
3. Porosity
4. Energy (amplitude)
5. Frequency
6. Phase

Implementation flowchart



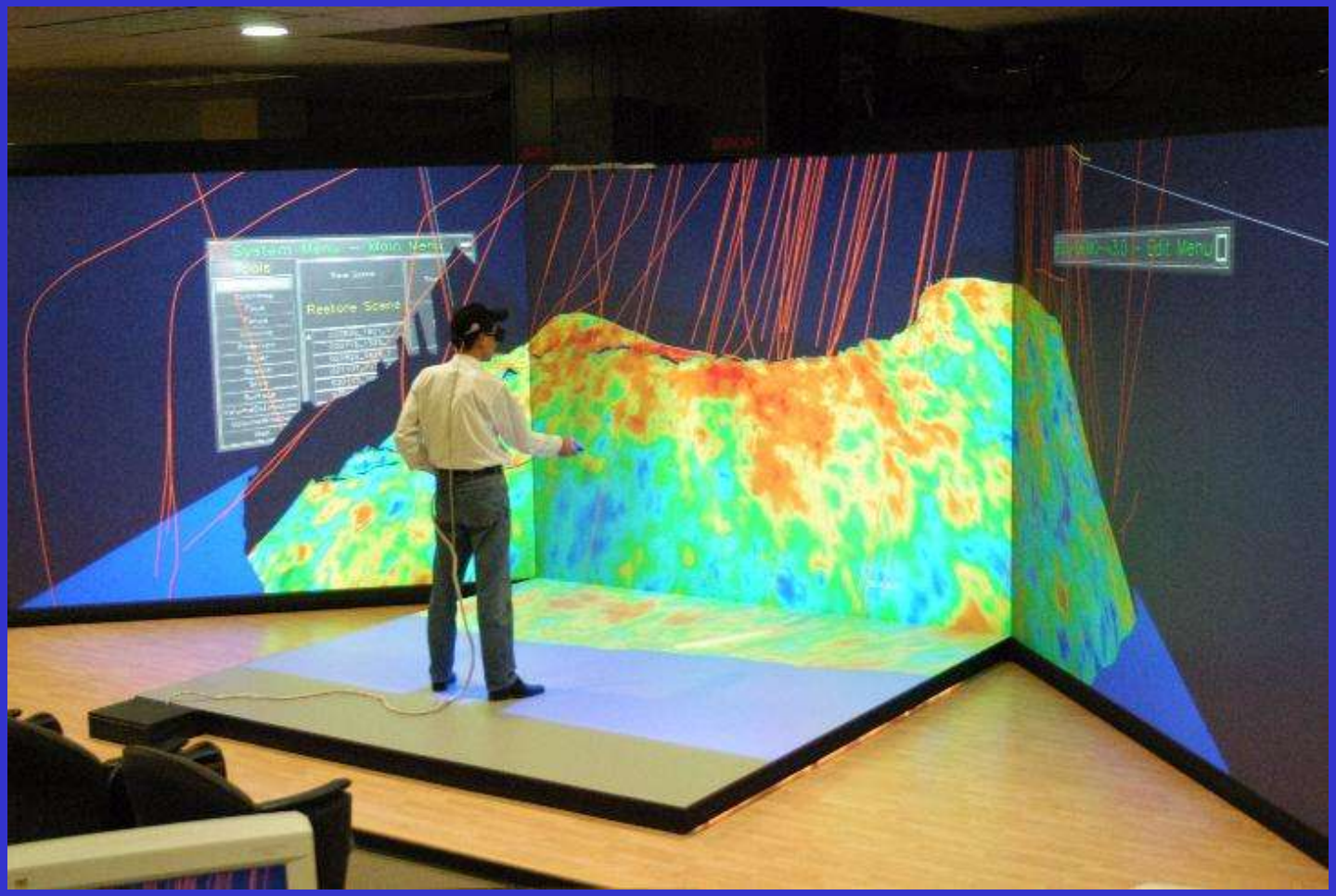
Conclusions

1. Anomalies caused by wormholes and foamy oil can be observed in both laboratory experiments and in the field data,
2. Neural network is a useful tools in searching for seismic anomalies,
3. A 3-layer BP neural networks designed, and passed convergence experiment,
4. 4D P wave and PS wave data could be useful in monitoring wormholes and foamy oil in heavy oil cold production,
5. Visualization system could be useful in visualizing and monitoring the wormholes and foamy oil.

Future works

1. Time-lapse and multi-component seismic data will be available soon,
2. Selection of favorite seismic attributes and seismic attributes extraction,
3. Recognition of seismic anomalies caused by wormholes and foamy oil,
4. Seismic anomalies visualization implementation.

Thank you!



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