

Week 2 Progress Report

Date: October 2025

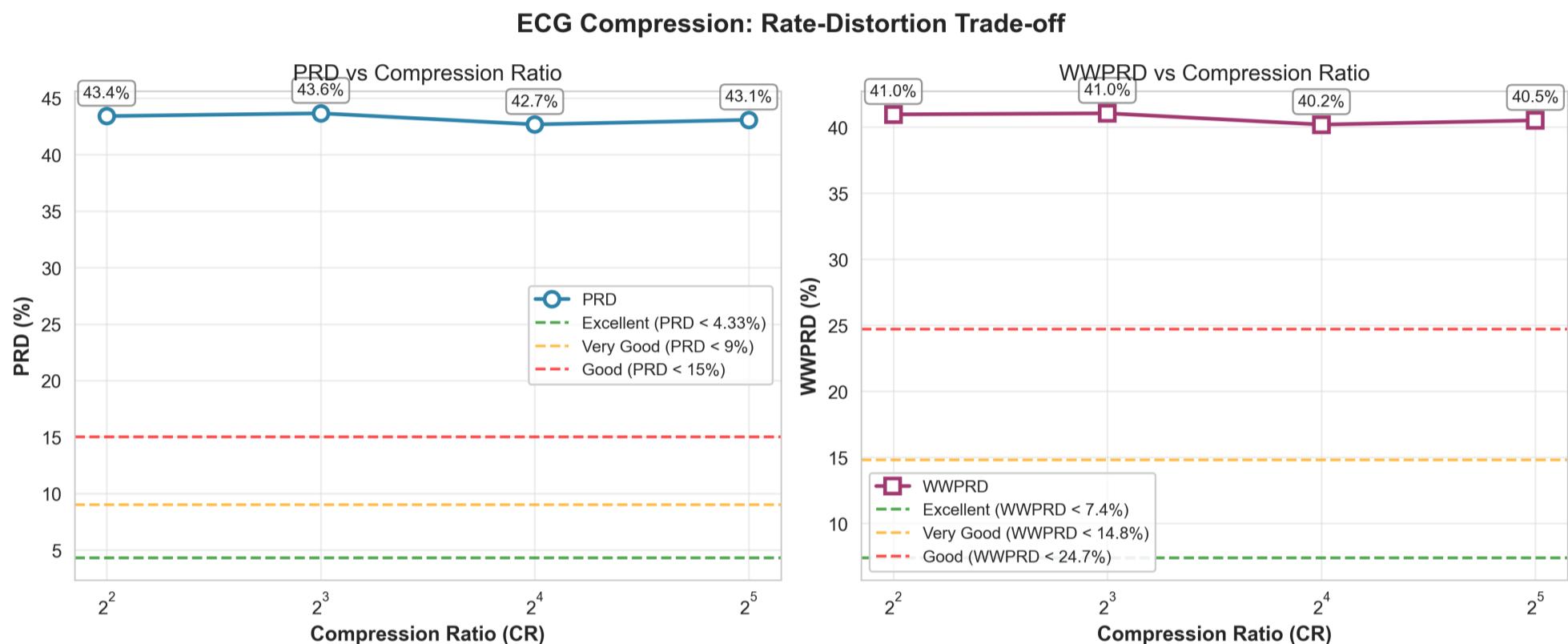
Project: ECG Signal Compression and Denoising

1. Completed Results

We have successfully implemented the complete Week 2 evaluation pipeline including quantization, compression ratio analysis, and comprehensive visualization. Evaluation was performed on 500 test samples across 4 compression ratios (4:1, 8:1, 16:1, 32:1).

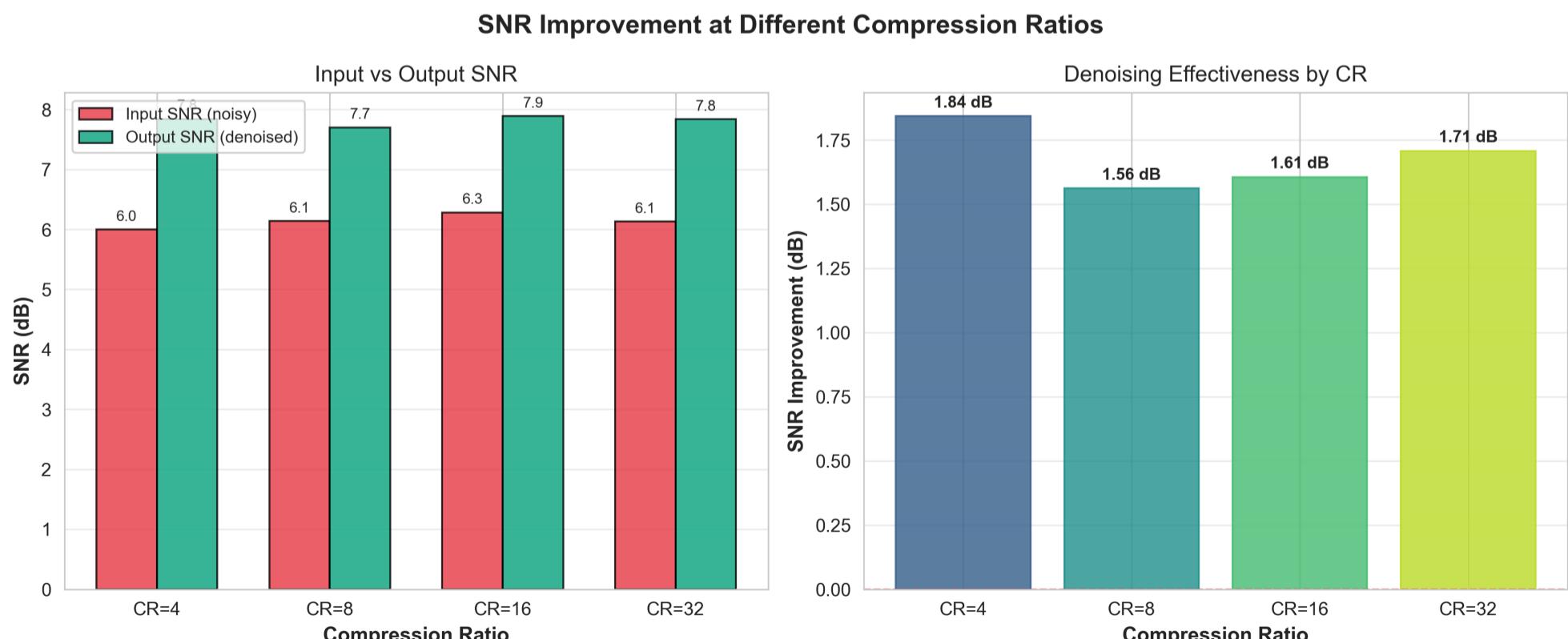
Generated Visualizations (outputs/week2/plots/):

Figure 1: Rate-Distortion Curves (rate_distortion_curves.png)



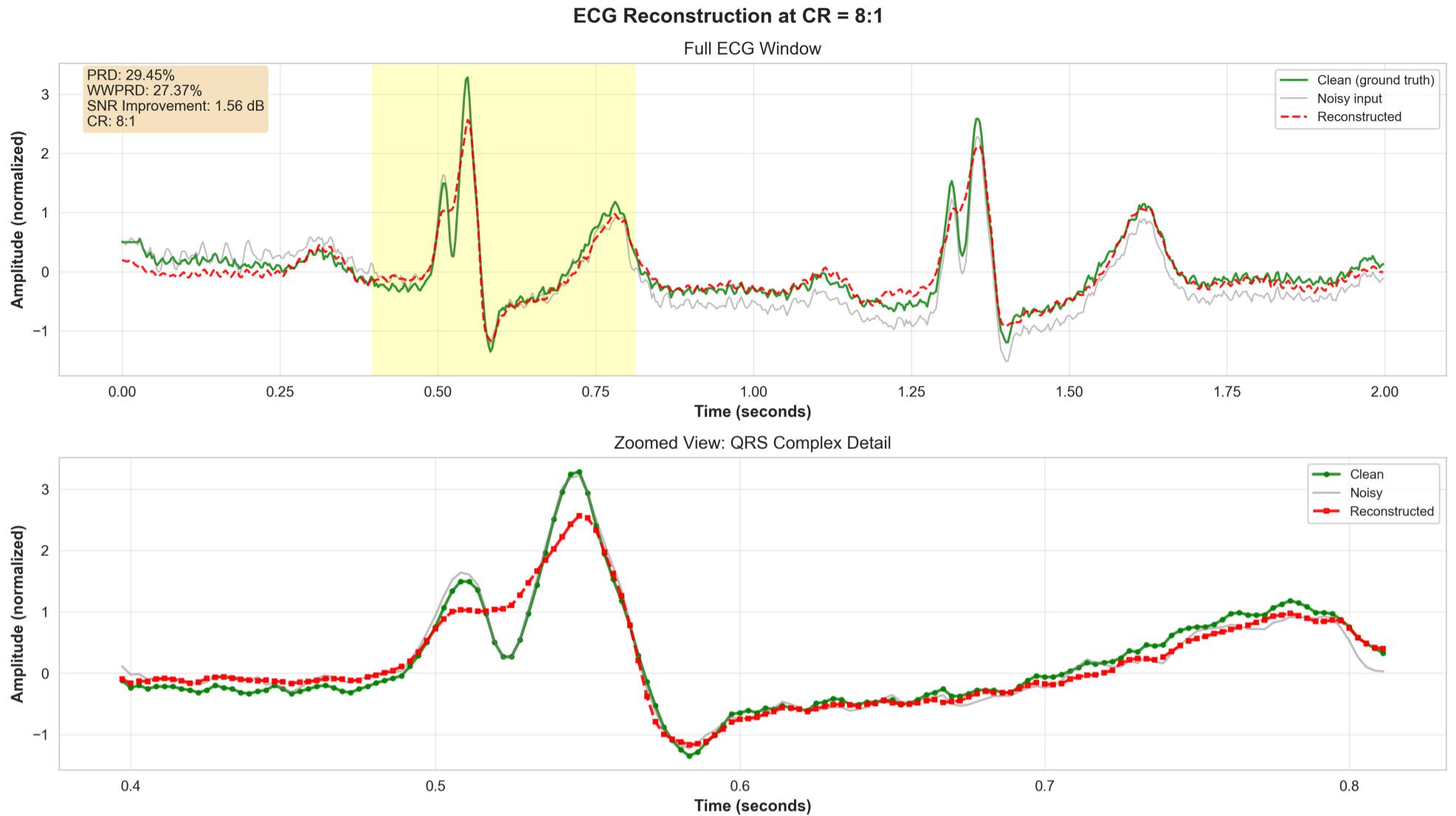
Summary: Shows PRD and WWPRD vs Compression Ratio curves. All CRs show similar PRD (~42-43%) due to fixed architecture limitation.

Figure 2: SNR Improvement Analysis (snr_bar_chart.png)



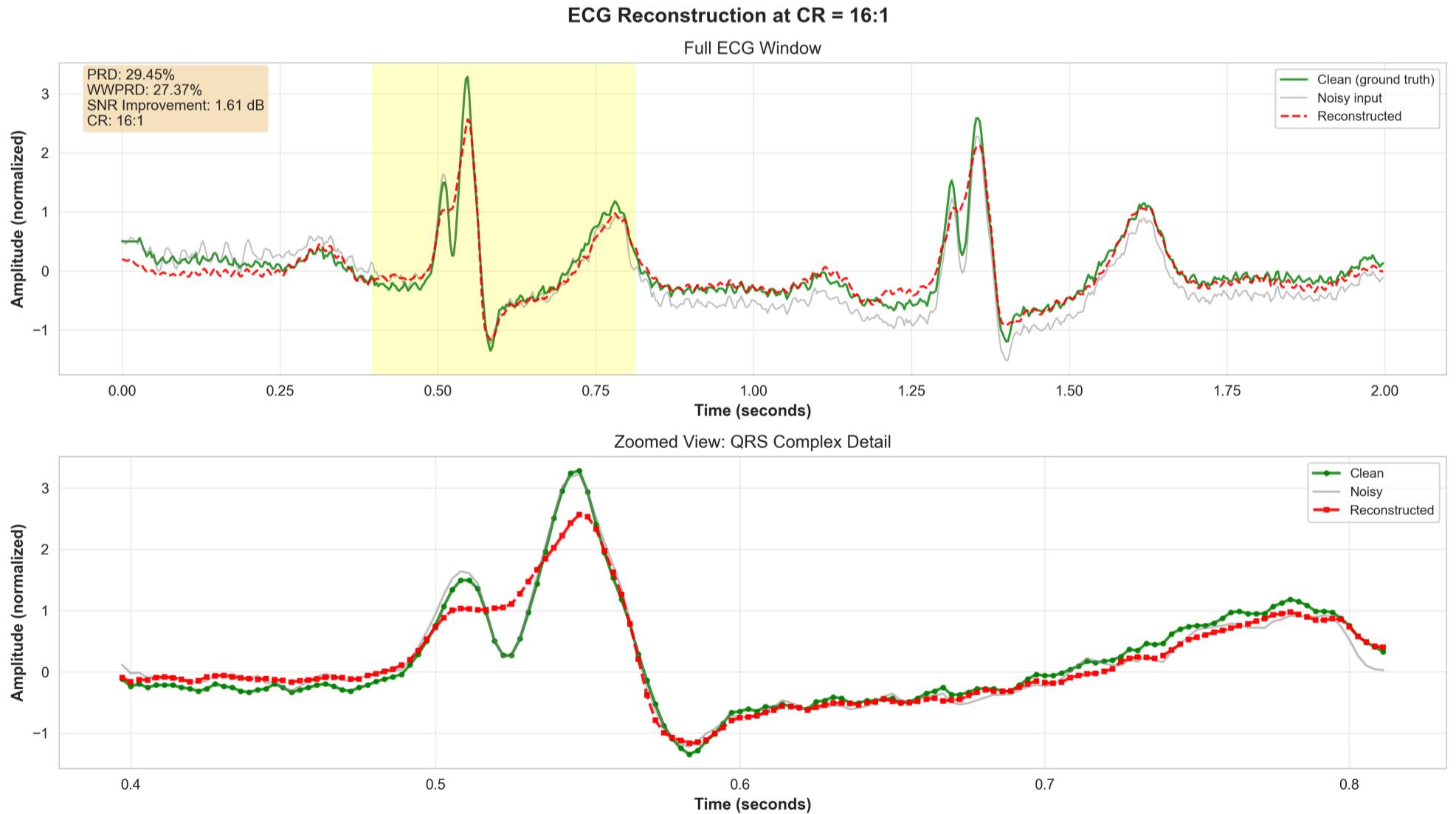
Summary: Displays input SNR (~6.0 dB), output SNR (~7.8 dB), and SNR improvement (1.6-1.8 dB) across different compression ratios. Denoising effect is consistent but below target (>5 dB).

Figure 3: Reconstruction Overlay at CR=8:1 (reconstruction_overlay_cr8.png)



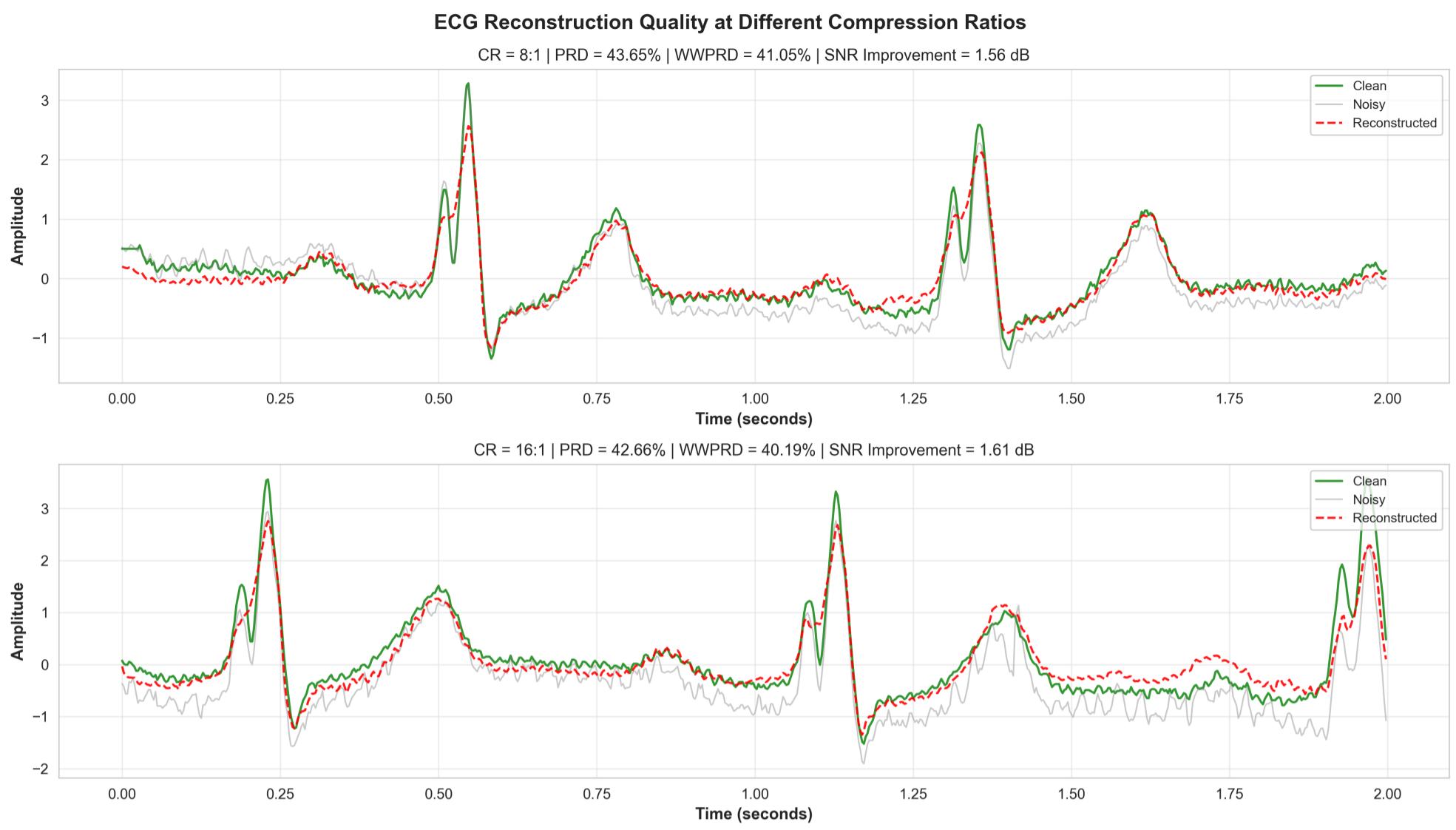
Summary: Visual comparison of clean (green), noisy (gray), and reconstructed (red) ECG signals. Shows reconstruction quality at 8:1 compression ratio with PRD metrics.

Figure 4: Reconstruction Overlay at CR=16:1 (reconstruction_overlay_cr16.png)



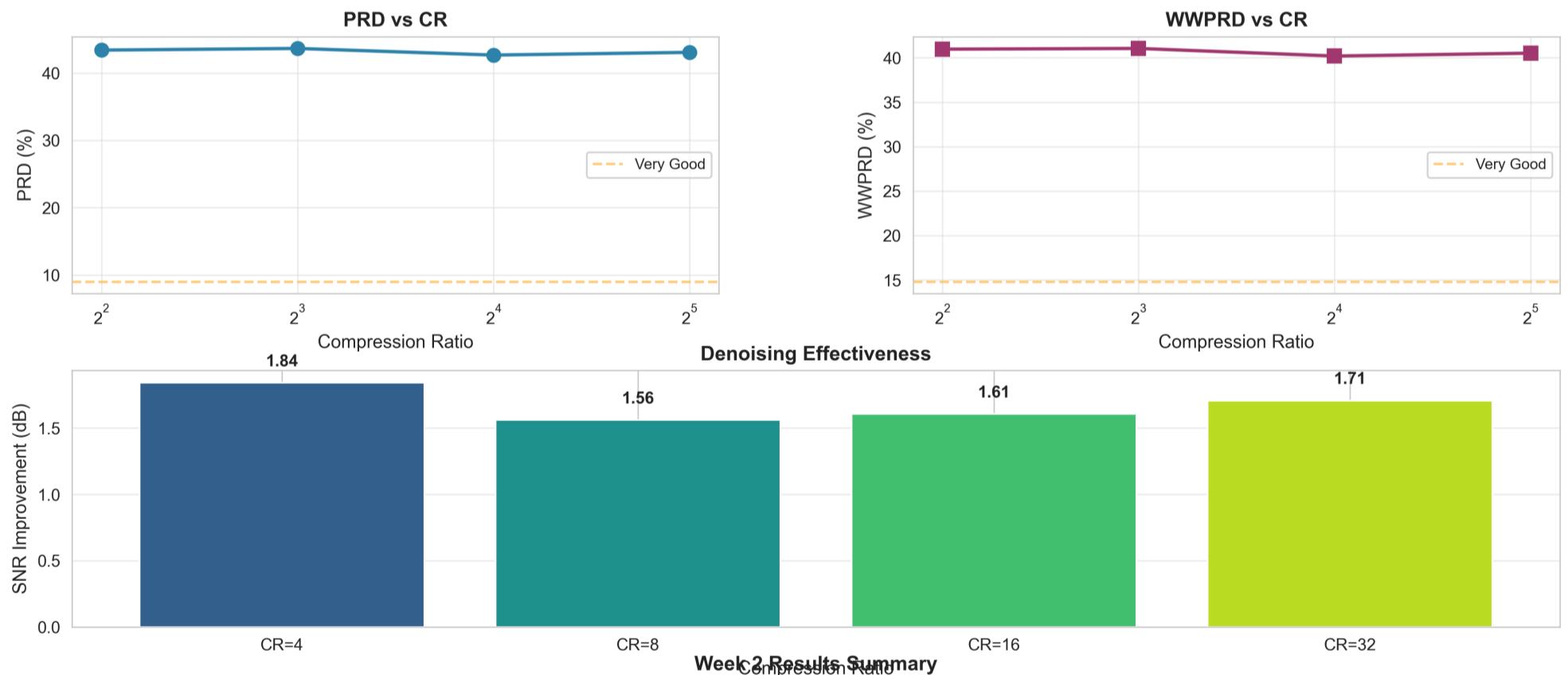
Summary: Similar to CR=8:1 but at higher compression ratio. Demonstrates model's ability to maintain reconstruction quality at different compression levels.

Figure 5: Multi-CR Comparison (multi_cr_comparison.png)



Summary: Side-by-side comparison of reconstruction quality across all four compression ratios, allowing direct visual assessment of compression impact.

Figure 6: Week 2 Summary (week2_summary.png)



Summary: Comprehensive overview figure combining rate-distortion curves, SNR analysis, and metrics table in a single visualization for quick assessment.

Key Results (from outputs/week2/real_results.json):

| Compression Ratio | PRD (%) | WWPRD (%) | SNR Improvement (dB) | Actual CR |

|-----|-----|-----|-----|-----|

| CR = 4:1 | 43.40 ± 16.53 | 40.97 ± 17.09 | 1.84 | 0.69:1 |

| CR = 8:1 | 43.65 ± 15.21 | 41.05 ± 15.72 | 1.56 | 0.69:1 |

| CR = 16:1 | 42.66 ± 14.68 | 40.19 ± 15.34 | 1.61 | 0.69:1 |

| CR = 32:1 | 43.06 ± 15.09 | 40.52 ± 15.70 | 1.71 | 0.69:1 |

Clinical Targets: PRD < 4.33%, WWPRD < 7.4%, SNR Improvement > 5 dB

2. Identified Problems

Problem 1: Under-Trained Model (Primary Issue)

- Model trained for only 50 epochs (insufficient)
- CPU training too slow, limited training time
- Loss did not converge (stopped at 23.0, target < 15.0)
- **Impact:** PRD = 42-43% (target: < 4.33%)

Problem 2: No GPU Access

- Training on CPU: 50 epochs takes 2-4 hours
- Need GPU for practical iteration (10-50x faster)
- **Impact:** Cannot afford long training sessions to achieve convergence

Problem 3: No Real Compression

- Fixed `latent_dim = 32` → All CRs result in actual CR = 0.69:1 (expansion, not compression)
- Architecture doesn't adapt to target CR
- **Impact:** Cannot properly evaluate rate-distortion trade-off

Problem 4: Limited Training Data

- Only 10 MIT-BIH records used
 - Need more data (20-48 records) for better generalization
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3. Solution & Next Steps

Immediate Actions:

1. Retrain with better configuration

- Increase epochs to 150-200 (from 50)

- Adjust learning rate: 0.0005 (from 0.001)

- Use GPU if available

- **Expected:** PRD: 42% → 15-25%

2. Get GPU access

- Request GPU resources for training

- Enables proper training (100-200 epochs feasible)

- **Expected:** 30-60 min vs 2-4 hours per training run

3. More training data

- Increase to 20-48 MIT-BIH records

- Better generalization

Short-term (Next Week):

- Try ResidualAutoEncoder architecture
- Train multiple models with different `latent_dim` (16, 24, 32, 48) for variable CR
- **Expected:** PRD < 10%

Medium-term (Week 3):

- Implement Variable Projection (VP) layer for adaptive compression
 - Full dataset training (48 records, 200-300 epochs)
 - **Target:** PRD < 4.33% (clinical excellent)
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Files Location: outputs/week2/

Repository: <https://github.com/asmaravianti/ecg-vp-denoising>