Supplementary Materials

A   CISI Standard Experiment Results

CISI, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=30)

Relative Error

Singular Value Index

Update(1)
Update(5)
Update(10)

CISI, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=30)

Scaled Residual Norm

Singular Value Index

Update(1)
Update(5)
Update(10)

CISI, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=40)

Relative Error

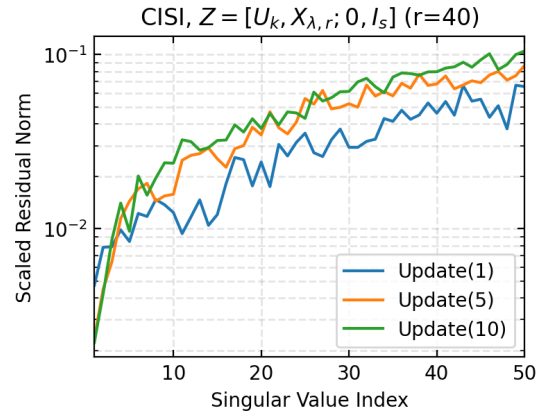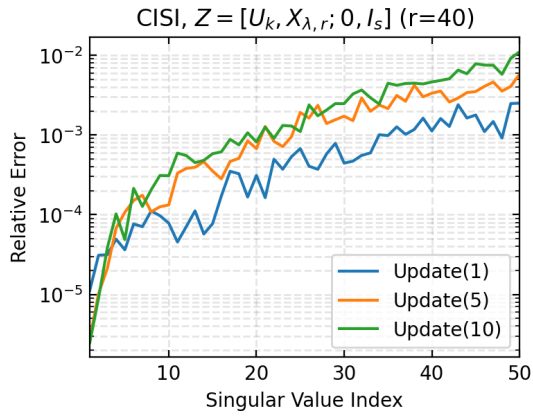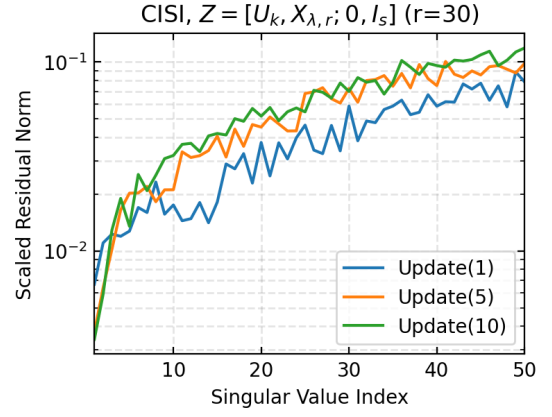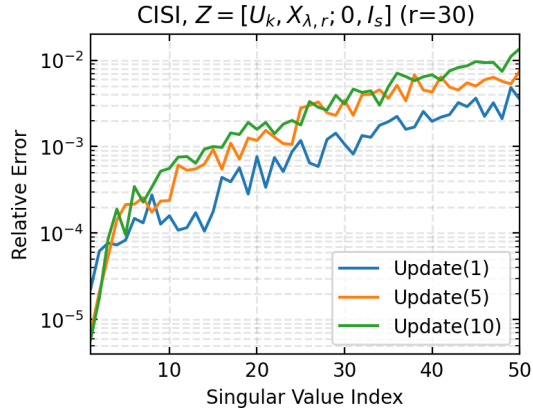Singular Value Index

Update(1)
Update(5)
Update(10)

CISI, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=40)

Scaled Residual Norm

Singular Value Index

Update(1)
Update(5)
Update(10)

CISI, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=50)

Relative Error

Singular Value Index

Update(1)
Update(5)
Update(10)

CISI, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=50)

Scaled Residual Norm

Singular Value Index

Update(1)
Update(5)
Update(10)

Figure 1: Relative errors and residual norms of leading $k = 50$ singular triplets for CISI at updates $\phi = 1, 5, 10$ using Algorithm 2.1, Algorithm 2.2 ($r = 10, 20, 30, 40, 50$), and `FrequentDirections`.

B   CRAN Standard Experiment Results

CRAN, $Z = [U_k, 0; 0, I_s]$

CRAN, $Z = [U_k, 0; 0, I_s]$

CRAN, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=10)

CRAN, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=10)

CRAN, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=20)

CRAN, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=20)

CRAN, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=30)

CRAN, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=40)

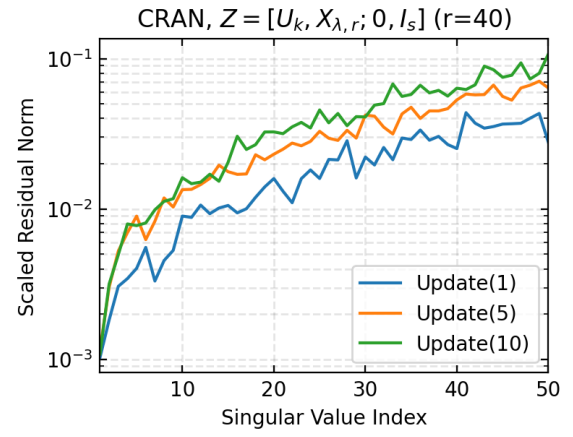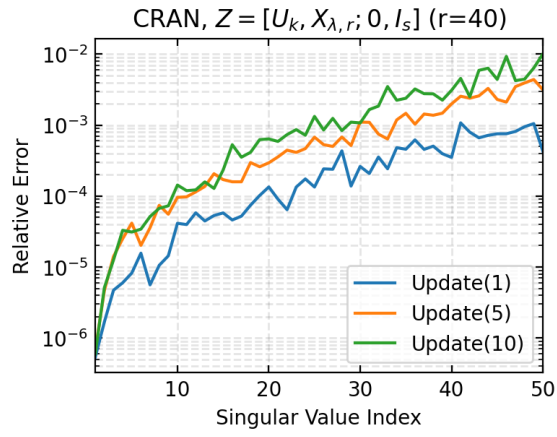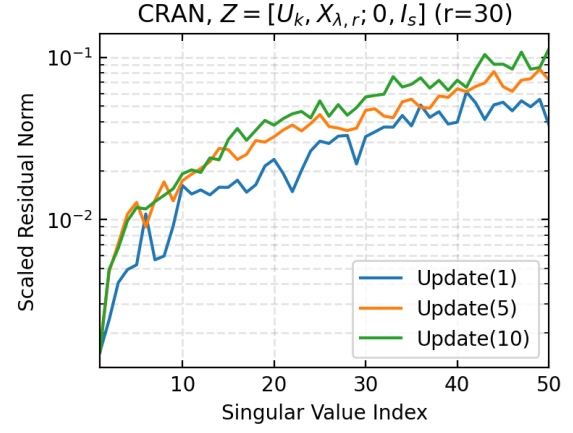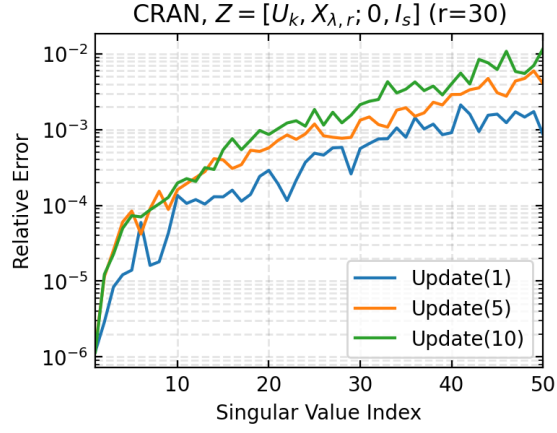CRAN, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=50)
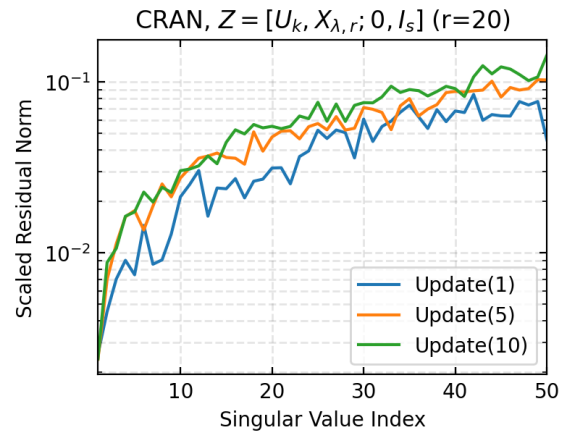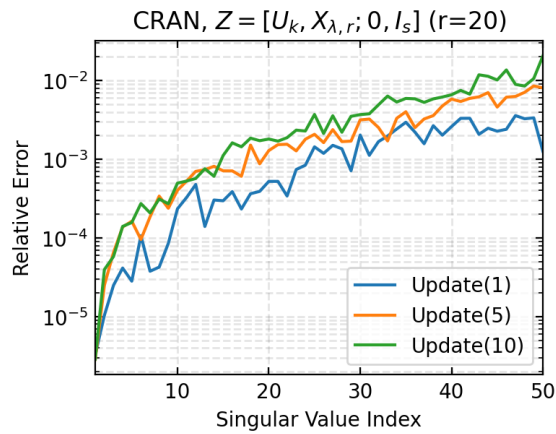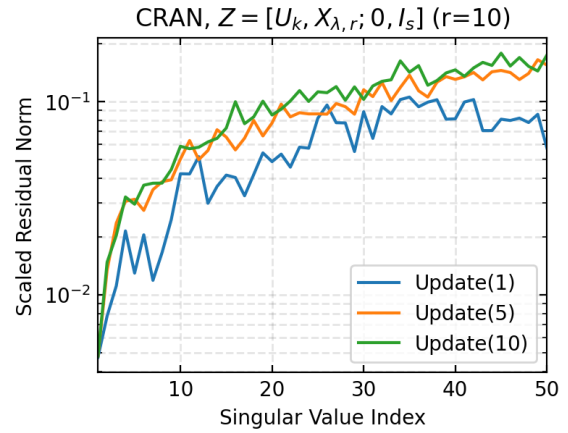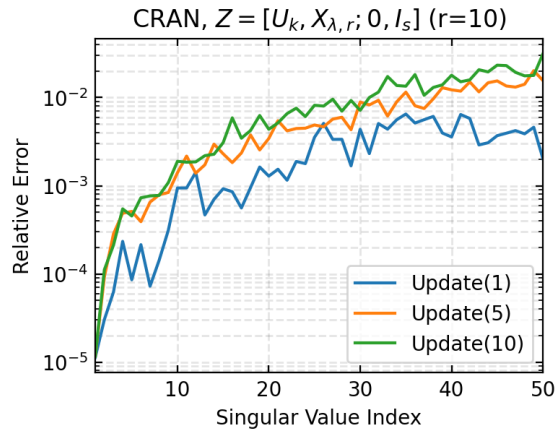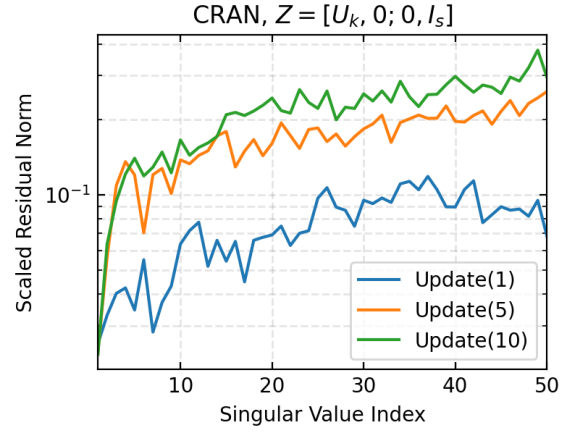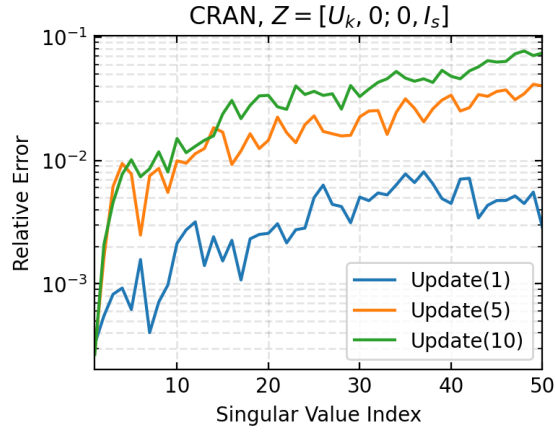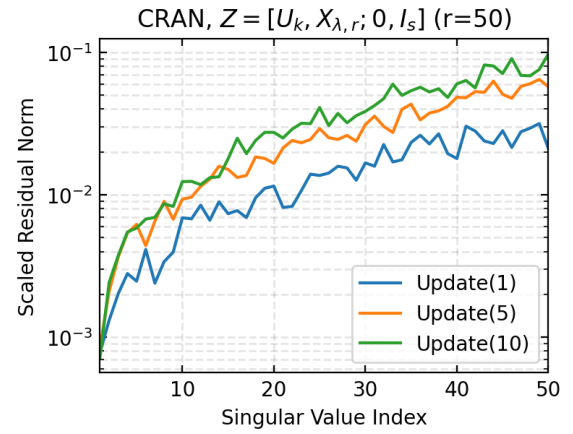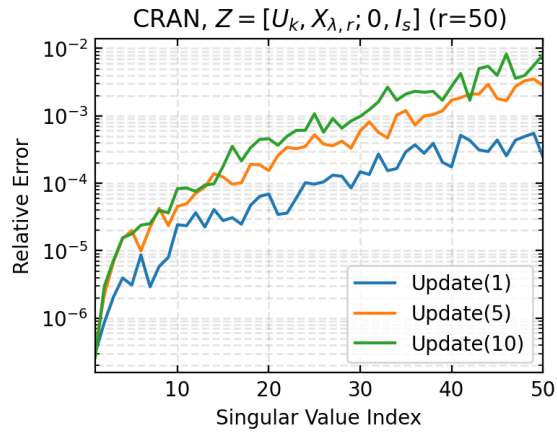
Figure 2: Relative errors and residual norms of leading $k = 50$ singular triplets for CRAN at updates $\phi = 1, 5, 10$ using using Algorithm 2.1, Algorithm 2.2 ($r = 10, 20, 30, 40, 50$), and `FrequentDirections`.
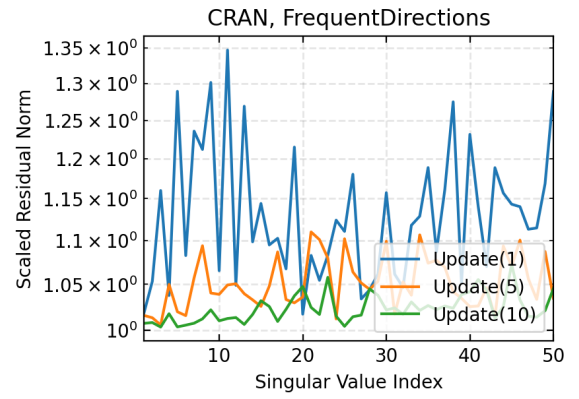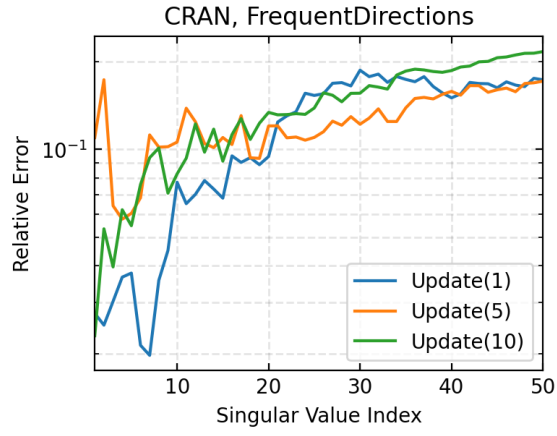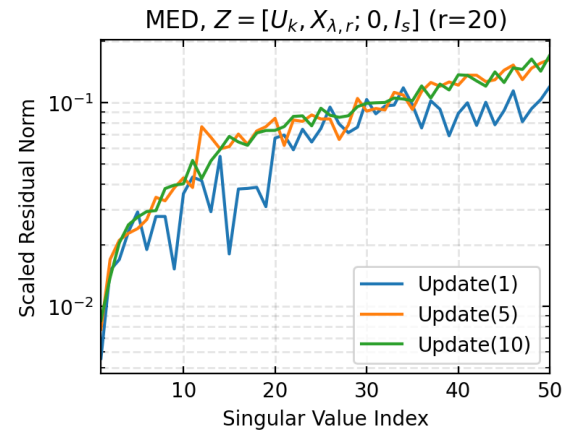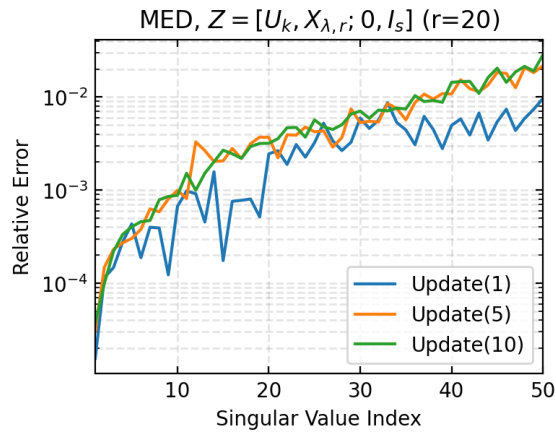
3 C MED Standard Experiment Results

MED, $Z = [U_k, 0; 0, I_s]$

MED, $Z = [U_k, 0; 0, I_s]$

MED, $Z = [U_k, X_{\lambda, r}; 0, I_s]$ (r=10)

MED, $Z = [U_k, X_{\lambda, r}; 0, I_s]$ (r=10)

MED, $Z = [U_k, X_{\lambda, r}; 0, I_s]$ (r=20)

MED, $Z = [U_k, X_{\lambda, r}; 0, I_s]$ (r=20)

MED, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=30)

MED, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=30)

MED, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=40)

MED, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=40)

MED, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=50)
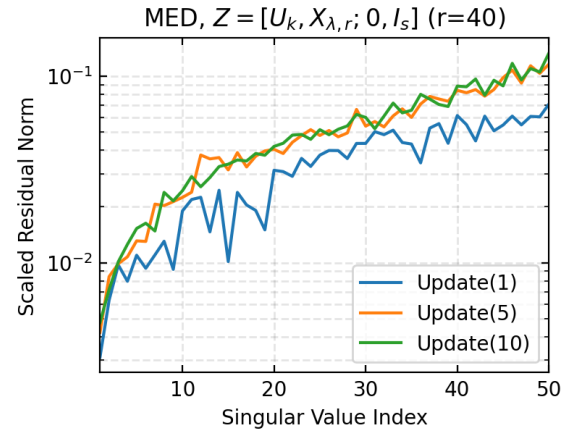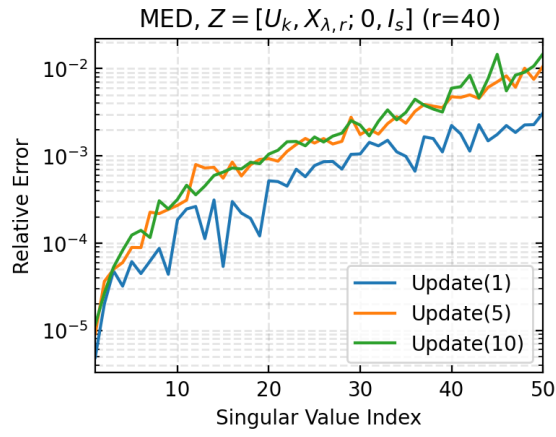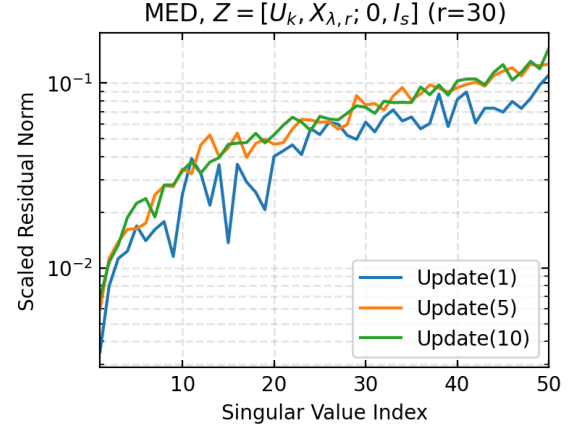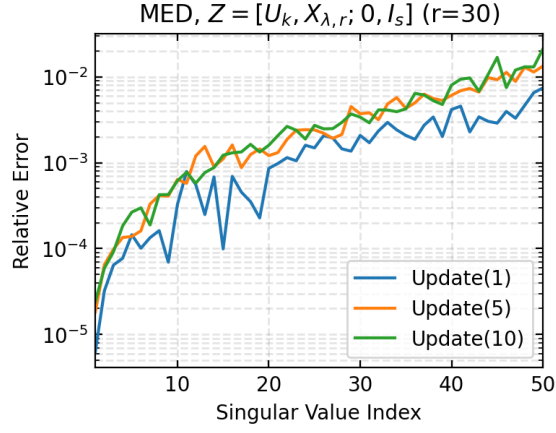
MED, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=50)
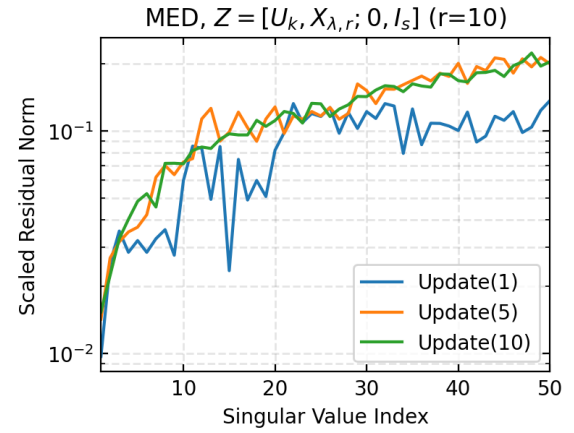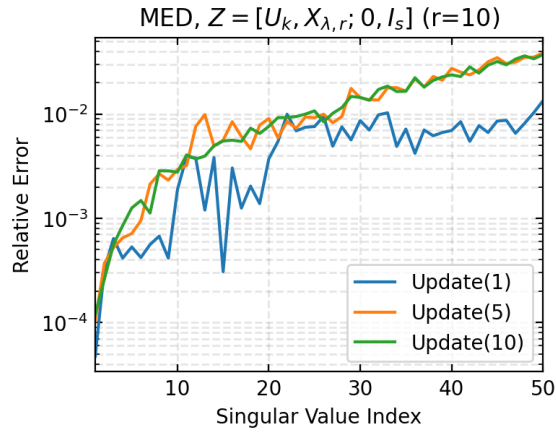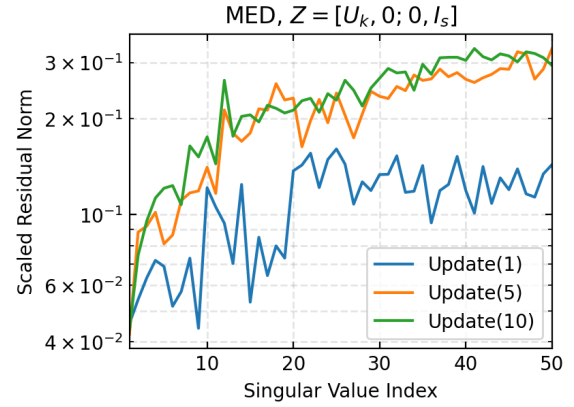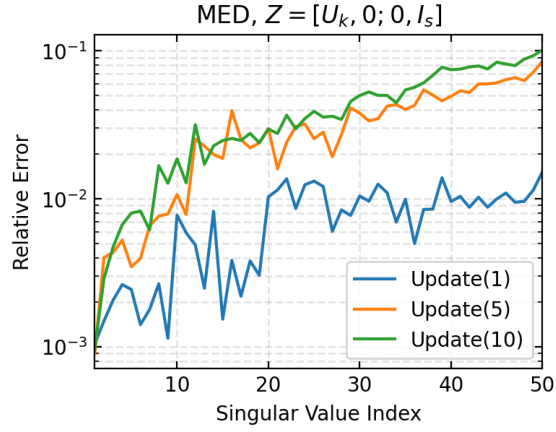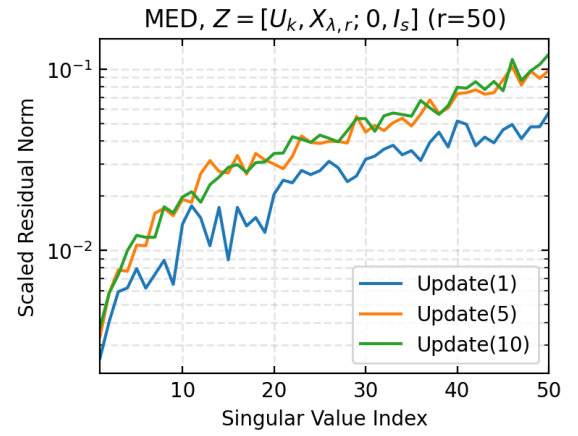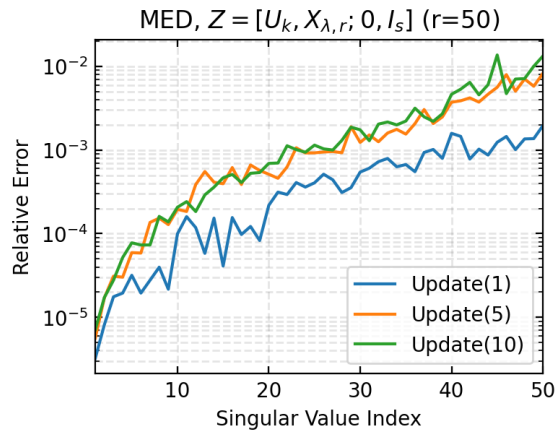
Figure 3: Relative errors and residual norms of leading $k = 50$ singular triplets for MED at updates $\phi = 1, 5, 10$ using Algorithm 2.1, Algorithm 2.2 ($r = 10, 20, 30, 40, 50$), and `FrequentDirections`.
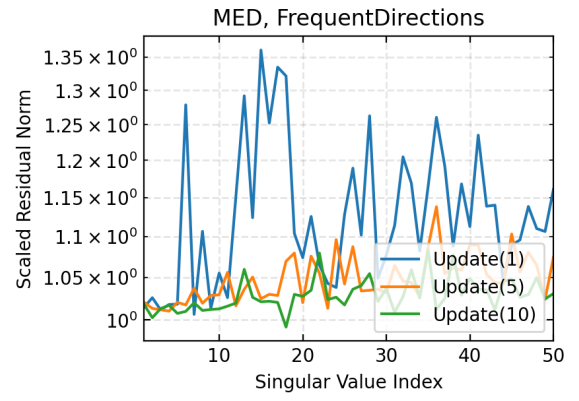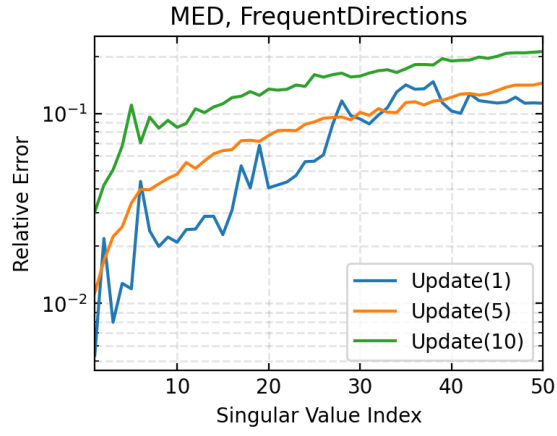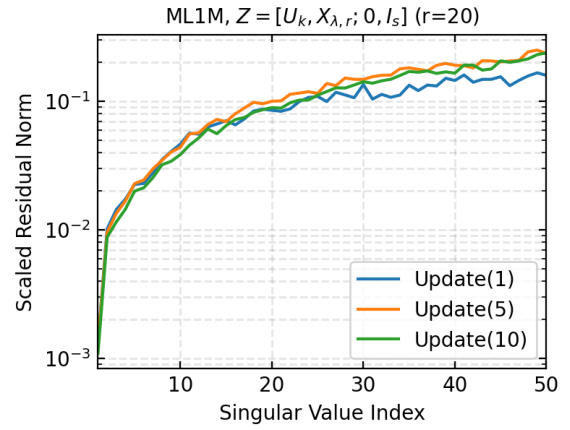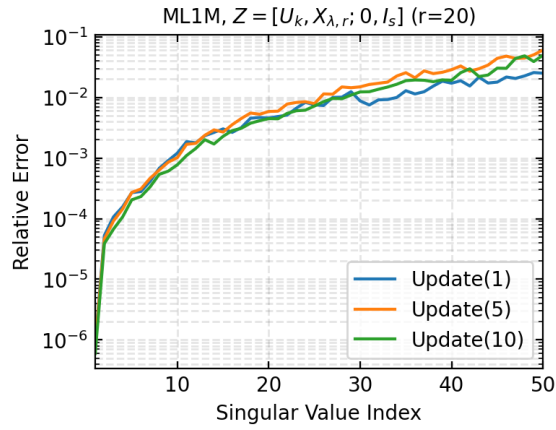
D ML1M Standard Experiment Results

ML1M, $Z = [U_k, 0; 0, I_s]$

ML1M, $Z = [U_k, 0; 0, I_s]$

ML1M, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=10)

ML1M, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=10)

ML1M, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=20)

ML1M, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=20)

10

ML1M, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=30)

ML1M, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=30)

ML1M, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=40)

ML1M, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=40)

ML1M, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=50)

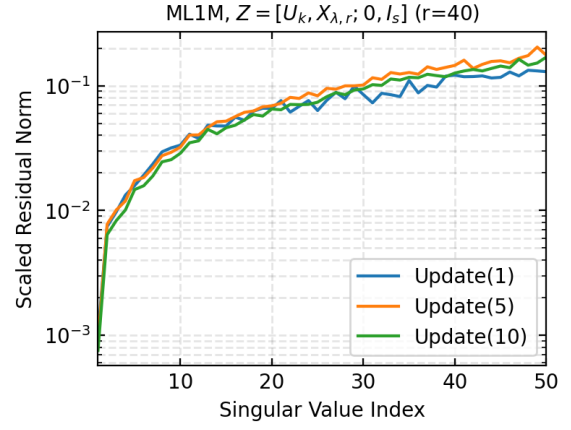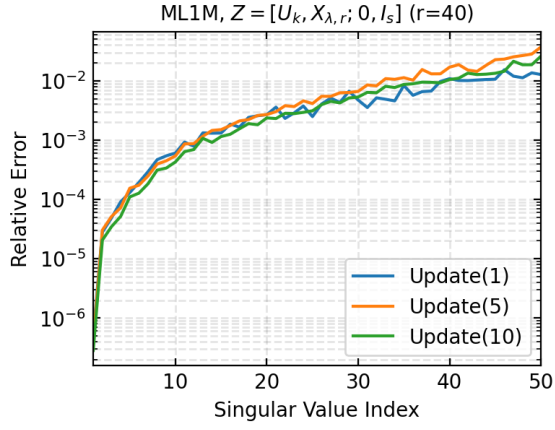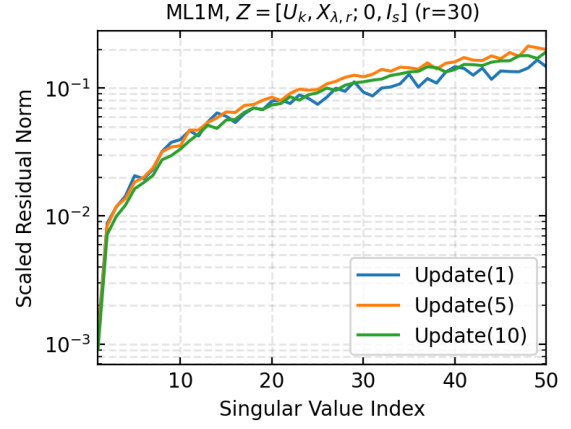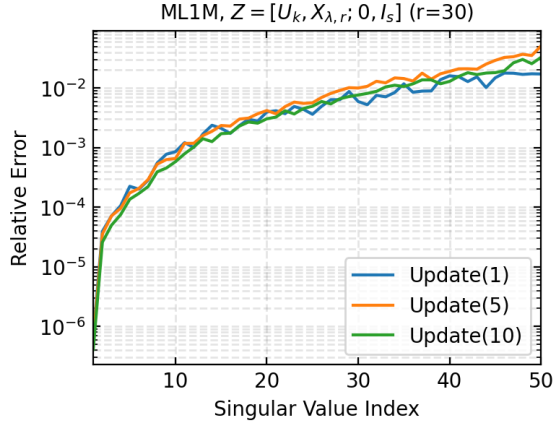ML1M, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=50)
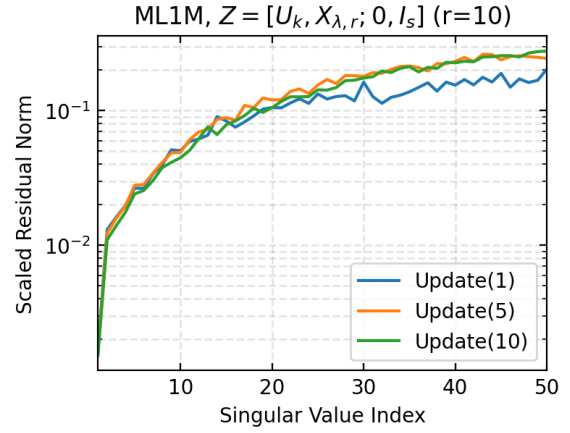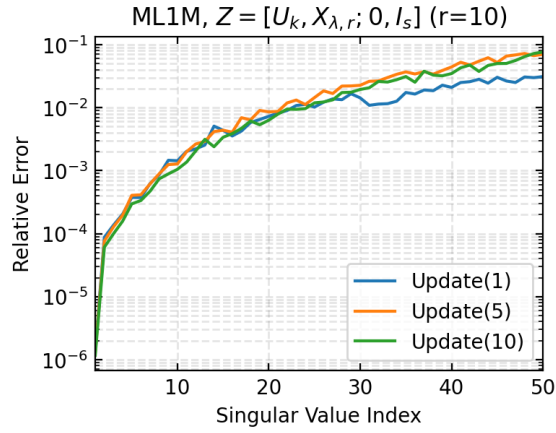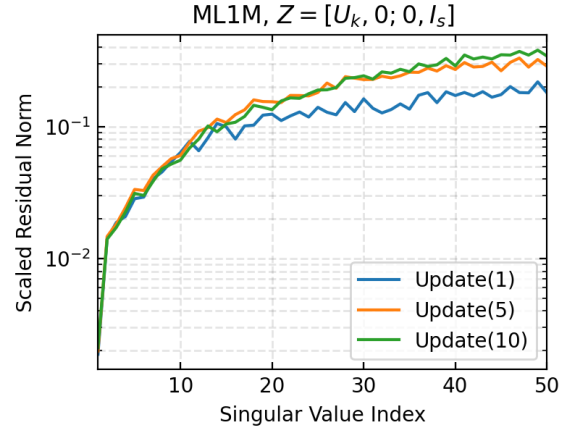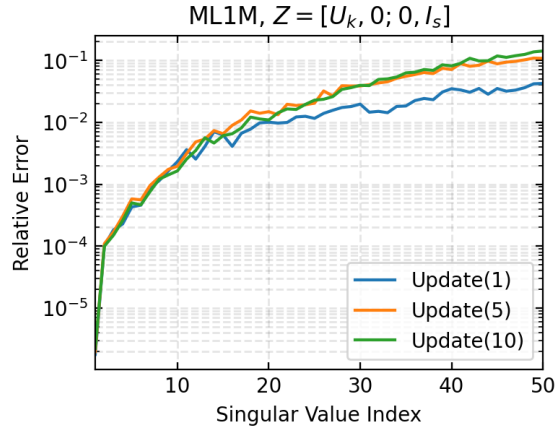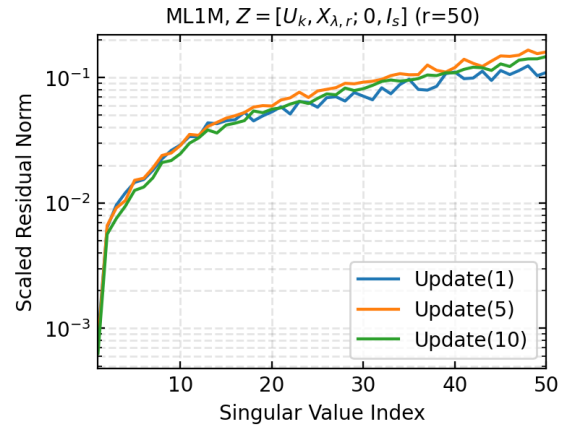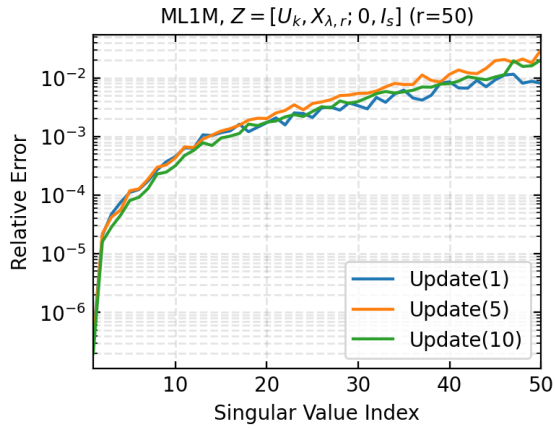
Figure 4: Relative errors and residual norms of leading $k = 50$ singular triplets for ML1M at updates $\phi = 1, 5, 10$ using Algorithm 2.1, Algorithm 2.2 ($r = 10, 20, 30, 40, 50$), and `FrequentDirections`.
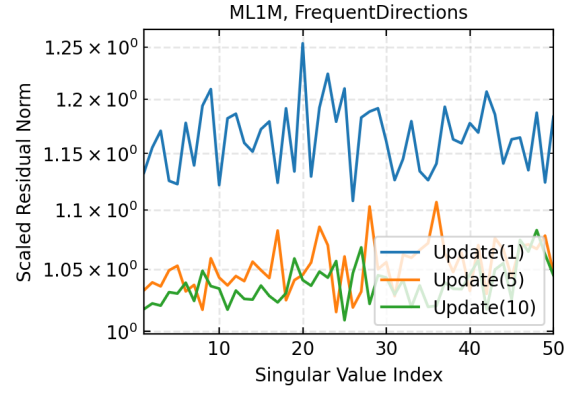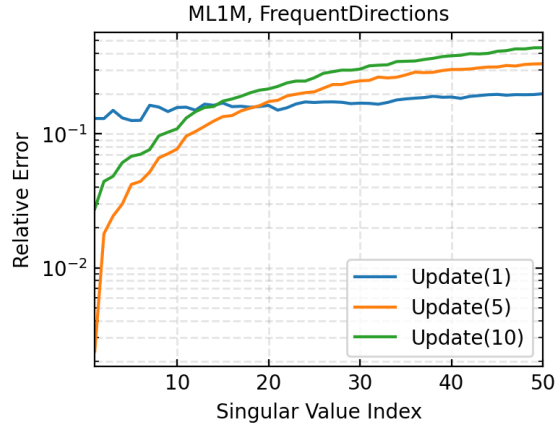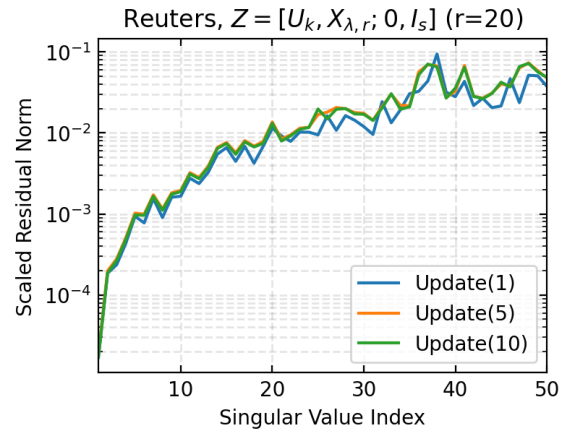
E   Reuters-21578 Standard Experiment Results

Reuters, $Z = [U_k, 0; 0, I_s]$

Reuters, $Z = [U_k, 0; 0, I_s]$

Reuters, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=10)

Reuters, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=10)

Reuters, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=20)

Reuters, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=20)

Reuters, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=30)

Reuters, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=30)

Reuters, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=40)

Reuters, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=40)
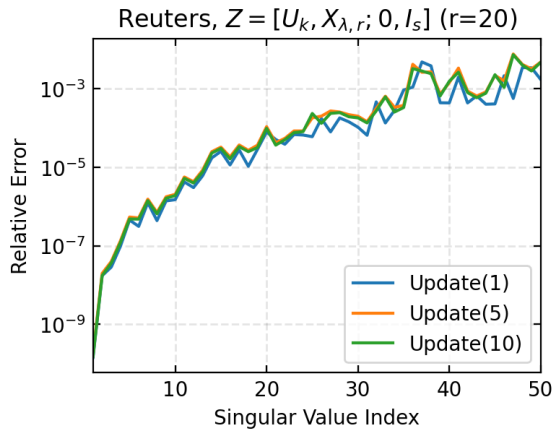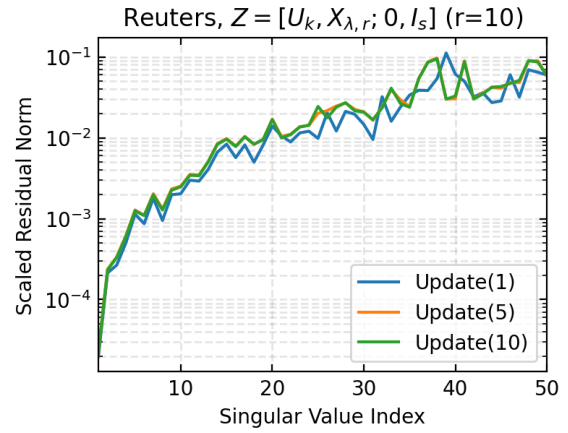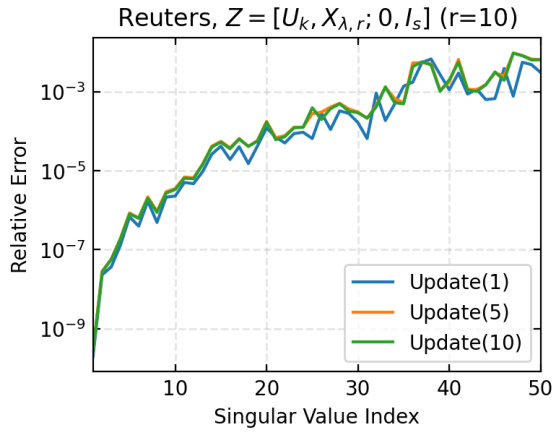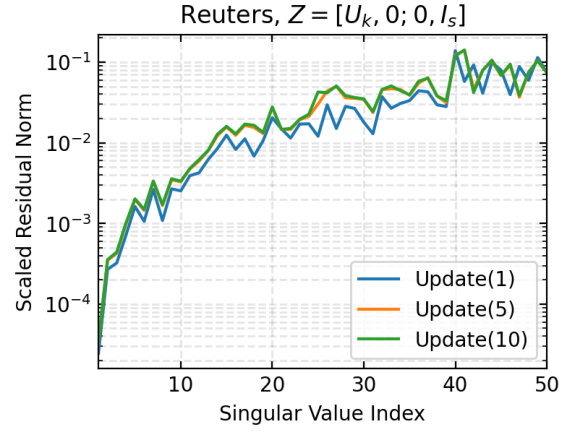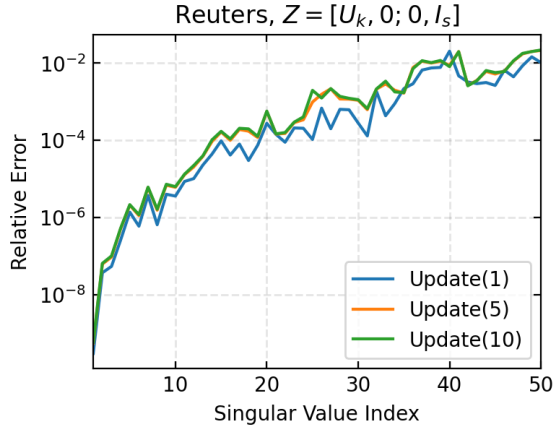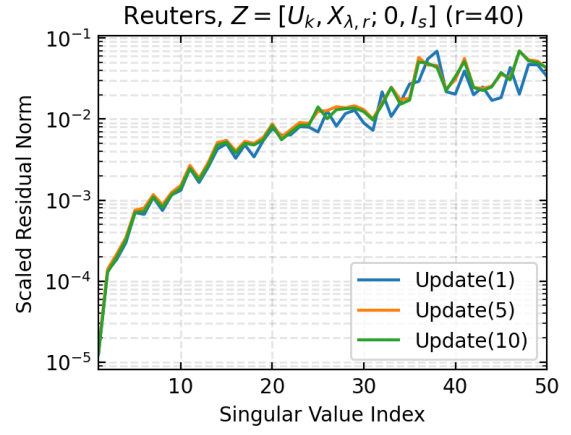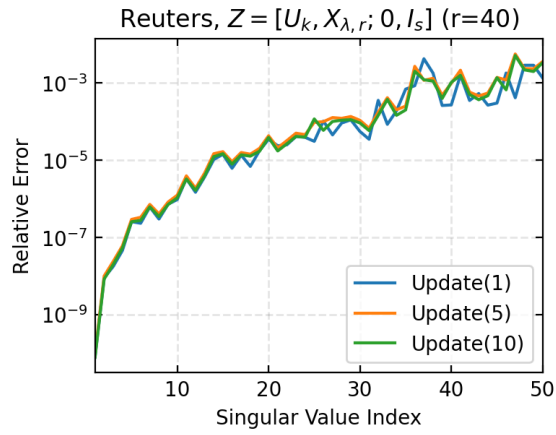
(a) Reuters residual norm (Algorithm 2.2)

Reuters, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=50)
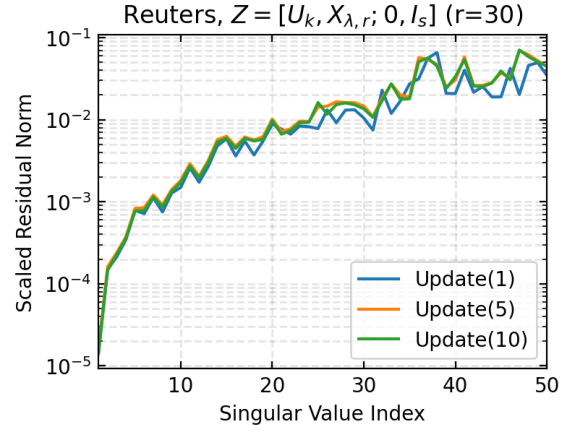
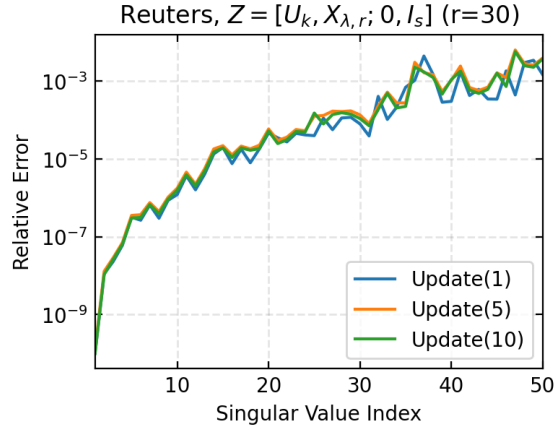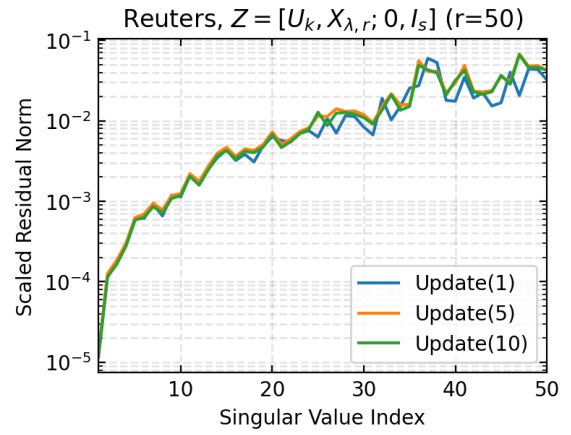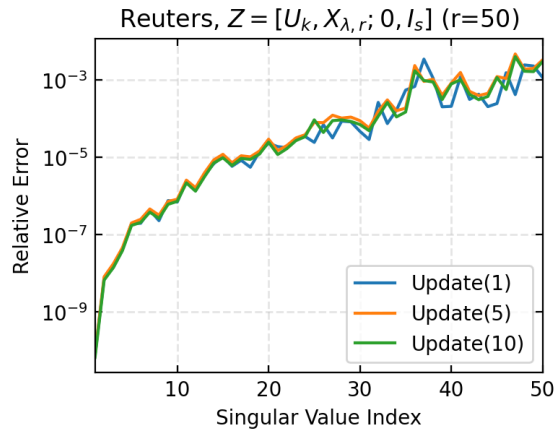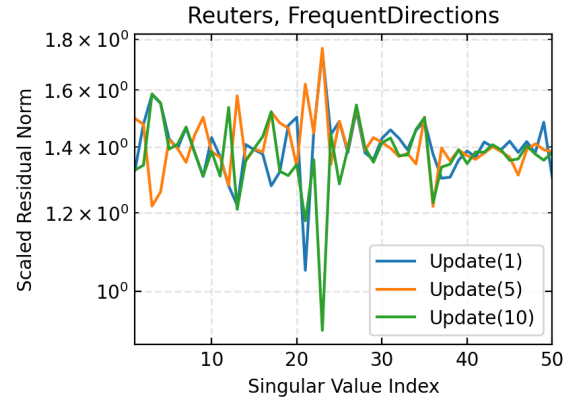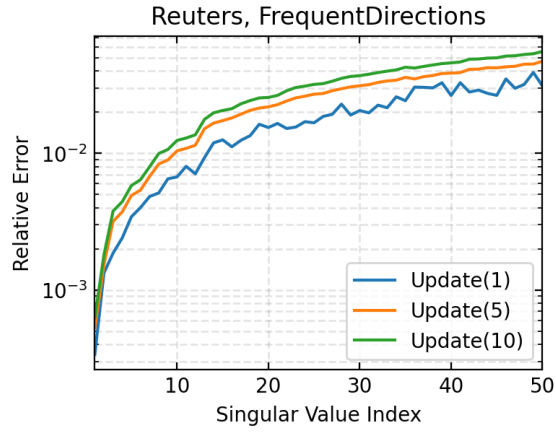Reuters, $Z = [U_k, X_{\lambda,r}; 0, I_s]$ (r=50)

Figure 5: Relative errors and residual norms of leading $k = 50$ singular triplets for Reuters-21578 at updates $\phi = 1, 5, 10$ using Algorithm 2.1, Algorithm 2.2 ($r = 10, 20, 30, 40, 50$), and `FrequentDirections`.
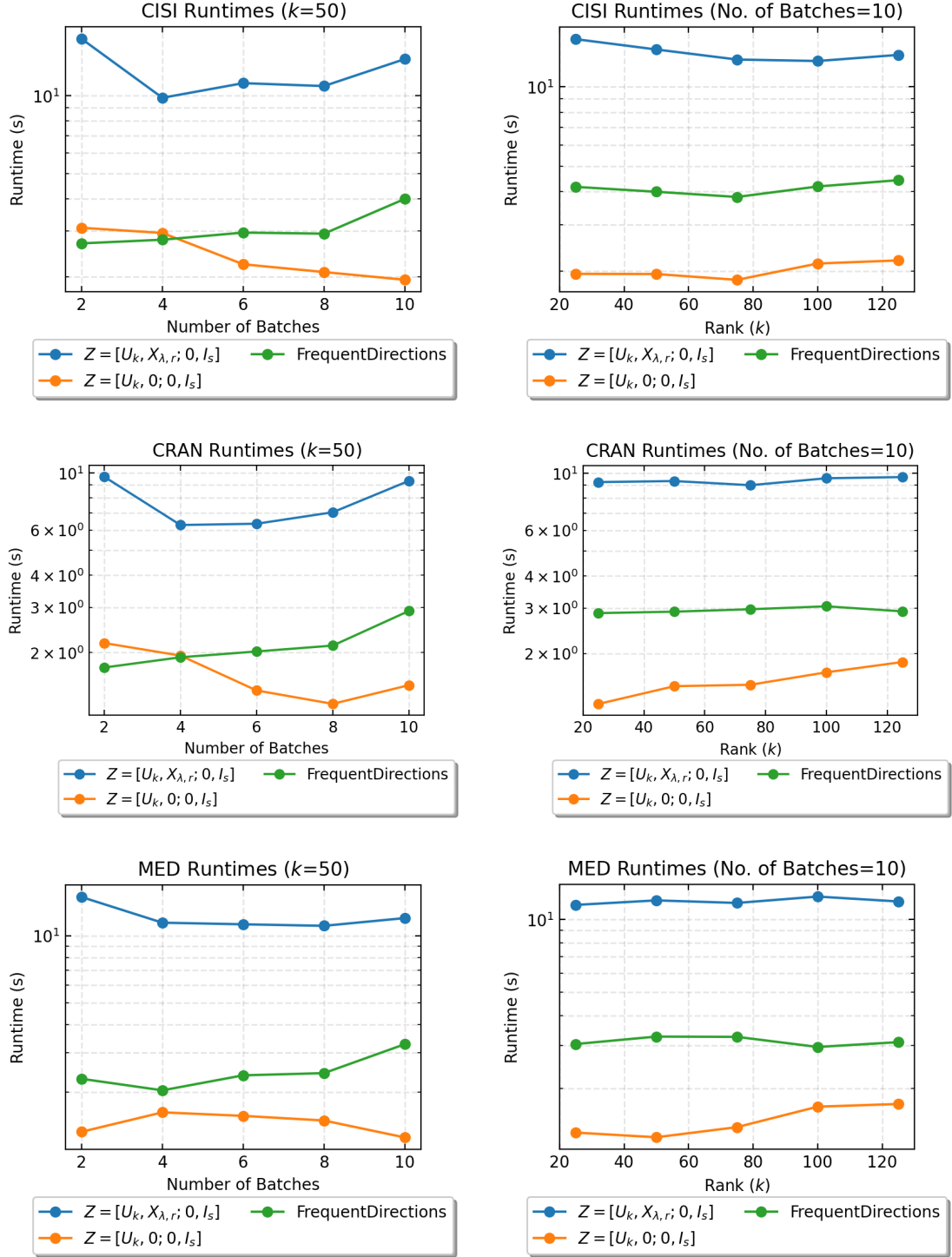
F   Runtimes from Standard Experiments

Figure 6: Runtimes on CISI, CRAN, and MED for all update methods.