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# Math221: Matrix Computations

# Selected Solutions to Homework #1, 2007

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- Problem 1.6:

$$\begin{aligned}\left\| E\left(I-\frac{ss^T}{s^Ts}\right)\right\|_F^2 &= \mathbf{tr}\left(\left(E\left(I-\frac{ss^T}{s^Ts}\right)\right)\left(E\left(I-\frac{ss^T}{s^Ts}\right)\right)^T\right)\\ &= \mathbf{tr}\left(\left(E\left(I-\frac{ss^T}{s^Ts}\right)\right)E^T\right)\\ &= \mathbf{tr}\left(EE^T\right)-\mathbf{tr}\left(\frac{Es(Es)^T}{s^Ts}\right)=\|E\|_F^2-\left(\frac{\|Es\|_2^2}{s^Ts}\right).\end{aligned}$$

- Problem 1.9: We will only consider the computations with tiny $x>0$. Let $\epsilon$ be the machine precision and let $x=(k+f)\epsilon$, where $k$ is an integer satisfying $10>k\geq 0$ and $f$ is the fraction with $1>f\geq 0$. In all cases, we need to compute $d=1+x$. We assume that $\mathbf{fl}(d)$ is obtained via rounding to the nearest. This implies that $\mathbf{fl}(d)=1+k\epsilon$ if $f<1/2$ and $\mathbf{fl}(d)=1+(k+1)\epsilon$ otherwise. This discontinuity in floating point computation of $1+x$ is the cause of the large errors in left plots. On the right plots, since $d=1+x$ has already been computed and is stored as $\mathbf{fl}(d)$, both $\log(\mathbf{fl}(d))$ and $\mathbf{fl}(d)-1$ can be computed highly accurately with respect to $\mathbf{fl}(d)$.

- **overflow/underflow protection in quadroot.m:** On the class website, there is a modified version of quadroot.m as well as a paper on solving for quadratic roots by George Forsythe.