$M=\begin{bmatrix}1&1\\1&0\end{bmatrix}$ we know that $M^n=\begin{bmatrix}F_{n+1}&F_n\\F_n&F_{n-1}\end{bmatrix}$

we want M^n, without doing n multiplications

trick: only need log(n) multiplications

$M\cdot M=M^2$; $M^2\cdot M^2=M^4$; $M^4\cdot M^4=M^8$, ...

what powers of M do we need?

Example: $n=77=64+8+4+1$

$2^6+2^3+2^2+2^0$

$\boxed{M}$ ✓ $M^{77}=M^{2^6}\cdot M^{2^3}\cdot M^{2^2}\cdot M^{2^0}$

$M\cdot M=\cancel{\boxed{M^2}}$ $\qquad M^8\cdot M^8=\cancel{\boxed{M^{16}}}$

$M^2\cdot M^2=\boxed{M^4}$ ✓ $\qquad M^{16}\cdot M^{16}=\cancel{\boxed{M^{32}}}$

$M^4\cdot M^4=\boxed{M^8}$ ✓ $\qquad M^{32}\cdot M^{32}=\boxed{M^{64}}$ ✓

6 multiplications

$M^{77}=M^{64}\cdot M^8\cdot M^4\cdot M$ 3 multiplications

total: 9 multiplications instead of 76.