Exercise 8 – Solutions

1. Wasted memory: $w = \frac{s}{2} + \frac{m \cdot t}{s} \longrightarrow \infty$ for $s \to 0^+$ and $s \to \infty$

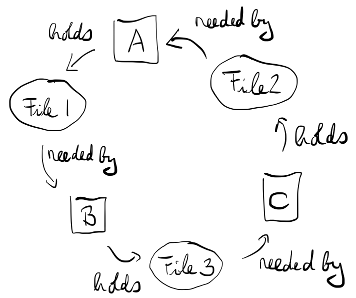
   Has minimum when $\frac{dw}{ds} = 0 \Rightarrow \frac{1}{2} - \frac{mt}{s^2} = 0 \Rightarrow \underbrace{s^2 = 2mt}_{(*)} \Rightarrow s = \sqrt{2mt}$

2. From $(*)$: $m_{opt} = \frac{s^2}{2t} = \frac{(2^{12})^2}{2 \cdot 4} B = 2^{21} B \approx 2MB$

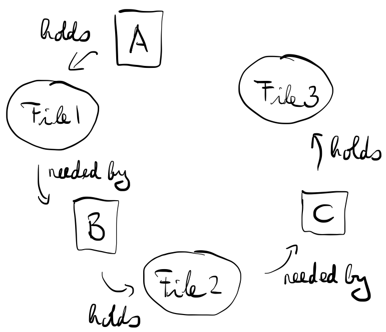
   The typical size of a process on a desktop system is much larger!

3. Here, $m_{opt} = \frac{(2^{12})^2}{2 \cdot 8} = 2^{20} B \approx 1MB$, so is even smaller.

   Thus, modern 64 bit architectures should increase page size.

4. 

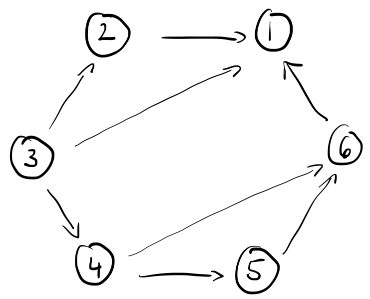
   Circular dependence
   $\Rightarrow$ deadlock

5. 

   No deadlock:
   - A can finish, release File 1
   - B then acquires File 1, releases File 1 & File 2 when done
   - Then C can acquire File 2 and finish.

6. - Deadlock is not possible: 4 philosophers have access to 5 chopsticks, so at least one can hold two and eat.
   - Starvation is possible, depending on timing, as it is possible that two philosophers alternatingly stand up and eat, the others holding only one chopstick each.

7. (a) Initial priority graph:



3 has only outgoing edges } 1 and 3 cannot be part of a cycle
1 " " incoming edges }

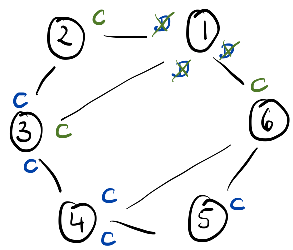
⇒ The only possible cycle is 4, 5, 6, but edges also do not line up.

⇒ graph is acyclic.

(b) ① 1 has all resources it needs, so 1 gets to "eat" first.

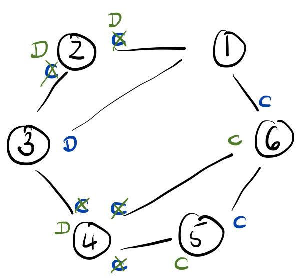
All others are requesting the missing resources, which will be handed by their neighbors as "clean" (c).

State after 1 has "eaten":



② Due to the pending requests from 2, 3, 6, philosopher 1 will also hand the resource over as clean

③ Now 3 can eat, will then hand over resources per pending requests to 2 and 4:



④ Now 2, 4 can "eat", will hand over resources to 5 and 6 when done

⑤ Now 5 can eat, then finally 6.