

**Spring 2022, Math 579: Preliminary Problem Set 2**  
**Due: Thursday, February 2nd, 2023**  
**Pigeon-hole Principle and Inclusion-Exclusion**

**Preliminary problems.** These problems should be completed before discussion on Thursday.

(P1) Suppose, at a given airport, there are 1500 takeoffs per day. Use the pigeon hole principle to conclude that at least 2 planes takeoff within 1 minute of each other. Clearly specify the pigeons and holes/boxes in your argument.

(P2) Given the following information, use the Sieve formula to compute  $|A_1 \cup A_2 \cup A_3 \cup A_4|$ .

$$\begin{array}{llll} |A_1| = 15 & |A_1 \cap A_2| = 5 & |A_1 \cap A_2 \cap A_3| = 1 & |A_1 \cap A_2 \cap A_3 \cap A_4| = 1 \\ |A_2| = 10 & |A_1 \cap A_3| = 3 & |A_1 \cap A_2 \cap A_4| = 5 & \\ |A_3| = 6 & |A_1 \cap A_4| = 5 & |A_1 \cap A_3 \cap A_4| = 1 & \\ |A_4| = 5 & |A_2 \cap A_3| = 2 & |A_2 \cap A_3 \cap A_4| = 1 & \\ & |A_2 \cap A_4| = 5 & & \\ & |A_3 \cap A_4| = 1 & & \end{array}$$

$$|A_1 \cup A_2 \cup A_3 \cup A_4| =$$