

Problem Statement

Appleby Camps, operated by Appleby College in Oakville, Ontario, offers over 50 distinct summer programs across arts, sports, science, and leadership. The program runs for **10 weeks**, with daily official hours from **9:00 a.m. to 3:30 p.m.**

Recognizing that families might have different time commitments, as well as the magical traffic on the 400-series highways, the camp provides:

- **Before Care:** 7:30 a.m. – 9:00 a.m.
- **After Care:** 4:00 p.m. – 6:00 p.m.

Parents can drop their children off and pick them up during any of these extended hours. Camp staff will be scheduled to supervise and keep the campers entertained.

Note: Before and After Care are not offered in Week 1 or Week 10.



Staffing information:

- Staff are **hired on a weekly basis**, which **do not have to be consecutive** (e.g., someone could work in Week 1, take Week 2 and Week 3 off, then return to work on Week 4).
- During weeks they are not scheduled to work, staff **cannot be assigned** to any Before or After Care shifts.

- Before the program starts, staff complete a form indicating:
 - The **weeks** they are available,
 - Their **preference** for Before or After Care,
 - Their **preferred working weekdays** (Monday through Friday).
- There are “dedicated” staff, who are hired specifically for the Before and After Care program. Other staff members are scheduled around them until the required ratio is reached.

As per **Ontario’s legal requirement**, a **minimum instructor-to-camper ratio of 1:8** must be met for every Before and After Care shift.

The number of campers enrolled in each shift is finalized before camp starts.

✨ **Optimization Goal:**

A **Technical Program Assistant**, majoring in Combinatorics and Optimization at the University of Waterloo, aims to **optimize staff assignments** to Before and After Care shifts across the summer. His optimizing goal is to *assign staff to Before and After Care shifts across the 8-week program* such that:

1. All coverage requirements are met:

- Each shift has enough staff to satisfy the 1:8 ratio based on weekly camper enrolments.

2. Staff availability and preferences are respected as much as possible:

- Staff are only assigned to shifts during weeks and days they are available.

- Preference violations (e.g., assigning someone to a shift they prefer not to work) are **minimized**.

3. **Shifts are distributed as fairly as possible:**

- The total number of shifts assigned to each staff member is **as balanced as possible**, minimizing disparities in workload across staff.
- This may be enforced by:
 - Minimizing the difference in total assigned shifts between any two staff members, or
 - Minimizing the maximum number of shifts any one staff works (i.e., promoting equitable load sharing).

4. **No single staff is scheduled for both shifts.**

- On a single day, a staff cannot be scheduled for both before and after care shifts.