Appendix

1 Transmitter City Ratios

Algorithm 1 Assign Transmitter City Ratios

```
Require: transmitter, teachers, students, bios
city_count ← {key: city ↦ value: count}
shared_s ← students who share a city with transmitter
shared_t ← teachers who share a city with transmitter
non_shared ← teachers and students who don't share a city with transmitter
transmitter_cities ← cities of transmitter from bios
foreach student $\in$ shared_s do
    student_cities ← cities of student from bios
    common_cities ← Intersection[transmitter_cities, student_cities]
    foreach city $\in$ common_cities do
        city_count[city] += edge count of transmitter  student
    end foreach
end foreach
foreach student $\in$ shared_t do
    teacher_cities ← cities of teacher from bios
    common_cities ← Intersection[transmitter_cities, teacher_cities]
    foreach city $\in$ common_cities do
        city_count[city] += edge count of transmitter  teacher
    end foreach
end foreach
foreach $\rho$ $\in$ non_shared do
    foreach city $\in$ transmitter_cities do
        city_count[city] += edge count of {transmitter, $\rho$} edge
    end foreach
end foreach
city_ratios ← divide each value in city_count by total count
```

2 Transmission Space Assignment

Algorithm 2 Place Transmission in Space

```
Require: teacher_cities, teacher_city_ratios, student_cities,
         num_transmissions
space ← {key: city ↦ value: count}
common_cities ← Intersection[teacher_cities, student_cities]
len_common_cities ← Length[common_cities]
switch len_common_cities do
    case == 1 :                              /* Share one city */
        space[common_city] += num_transmissions
    end case
    case > 1 :                     /* Share more than one city */
        foreach city ∈ common_cities do
            ratio ← teacher_city_ratios[city]
            space[city] += num_transmissions * ratio
        end foreach
    end case
    case == 0 :                             /* Share no cities */
        foreach city ∈ teacher_cities do
            ratio ← teacher_city_ratios[city]
            space[city] += num_transmissions * ratio
        end foreach
    end case
end switch
```

$$\begin{aligned}
\textbf{let: } & \text{teacher}_1\textbf{: } \text{cities}_{t_1} = \{c_1, c_2, c_3\} \\
& \qquad\qquad \text{ratios}_{t_1} = [c_1 \rightarrow r_1, c_2 \rightarrow r_2, c_3 \rightarrow r_3], \\
& \text{student}_1\textbf{: } \text{cities}_{s_1} = \{c_1, c_5, c_6\}, \\
& \text{student}_2\textbf{: } \text{cities}_{s_2} = \{c_1, c_2, c_6\}, \\
& \text{student}_3\textbf{: } \text{cities}_{s_3} = \{c_5, c_7\}, \\
\textbf{s.t. } & \textstyle\sum_{i=1}^{3} r_i = 1 \implies 0 <= (r_i)_{1<=i<=3} <= 1 \ \& \ c_i \in \text{city\_corpus}.
\end{aligned} \tag{1}$$

$$\begin{aligned}
\textbf{let: } & \text{teacher}_1\text{student}_1, \text{count} = V_{t_1 \rightarrow s_1}, \\
& \text{teacher}_1\text{student}_2, \text{count} = V_{t_1 \rightarrow s_2}, \\
& \text{teacher}_1\text{student}_3, \text{count} = V_{t_1 \rightarrow s_3}.
\end{aligned} \tag{2}$$

$$\begin{aligned}
\textbf{case 1: } & \texttt{one city shared} \\
& \text{cities}_{t_1} \cap \text{cities}_{s_1} = \{c_1\} = X, \\
& \text{since } |X| = 1\text{:} \\
& V_{t_1 \rightarrow s_1} \text{ placed in } c_1.
\end{aligned} \tag{3}$$

$$\begin{aligned}
\textbf{case 2: } & \texttt{more than one city shared} \\
& \text{cities}_{t_1} \cap \text{cities}_{s_2} = \{c_1, c_2\} = Y, \\
& \text{since } |Y| = 2 > 1\text{:} \\
& [V_{t_1 \rightarrow s_2} * \tfrac{r_1}{(r_1 + r_2)}] \text{ placed in } c_1, \\
& [V_{t_1 \rightarrow s_2} * \tfrac{r_2}{(r_1 + r_2)}] \text{ placed in } c_2.
\end{aligned} \tag{4}$$

$$\begin{aligned}
\textbf{case 3: } & \texttt{no cities shared} \\
& \text{cities}_{t_1} \cap \text{cities}_{s_3} = \{\} = Z, \\
& \text{since } |Z| = 0\text{:} \\
& V_{t_1 \rightarrow s_3} \text{ get placed in the teacher's cities, i.e.} \\
& [r_1 * V_{t_1 \rightarrow s_3}] \text{ in } c_1, [r_2 * V_{t_1 \rightarrow s_3}] \text{ in } c_2, \text{ and } [r_3 * V_{t_1 \rightarrow s_3}] \text{ in } c_3.
\end{aligned} \tag{5}$$

3 Transmission Time Assignment

Algorithm 3 Place Transmission in Time Span

```
Require: teacher_bio, student_bio
const_lifespan = 80
const_childhood = 20
death_date_teacher ← death date from teacher_bio
death_date_student ← death date from student_bio
if birth_date ∈ teacher_bio then
    birth_date_teacher ← birth date from teacher_bio
else
    birth_date_teacher ← death_date_teacher
                         − const_lifespan
end if
if birth_date ∈ student_bio then
    birth_date_teacher ← birth date from student_bio
else
    birth_date_student ← death_date_student
                         − const_lifespan
end if
upper_bound ← min(death_date_teacher, death_date_student)
lower_bound ← max(birth_date_teacher, birth_date_student)
if upper_bound − lower_bound > const_childhood then
    lower_bound += const_childhood
end if
time_span ← (lower_bound, upper_bound)
```