Assignment - Bayesian Networks

Loading the Data

```
data_assignment_3 <- read.csv(file = "C:/Users/Suma Marri/Documents/GitHub/COVID/Cleaned-Data.csv",
                              colClasses = "character"
                    )
data_assignment_3
```

```
##      Fever Tiredness Dry.Cough Difficulty.in.Breathing Sore.Throat None_Sympton
## 1       1         1         1                       1           1            0
## 2       1         1         1                       1           1            0
## 3       1         1         1                       1           1            0
## 4       1         1         1                       1           1            0
## 5       1         1         1                       1           1            0
## 6       1         1         1                       1           1            0
## 7       1         1         1                       1           1            0
## 8       1         1         1                       1           1            0
## 9       1         1         1                       1           1            0
## 10      1         1         1                       1           1            0
## 11      1         1         1                       1           1            0
## 12      1         1         1                       1           1            0
## 13      1         1         1                       1           1            0
## 14      1         1         1                       1           1            0
## 15      1         1         1                       1           1            0
## 16      1         1         1                       1           1            0
## 17      1         1         1                       1           1            0
## 18      1         1         1                       1           1            0
## 19      1         1         1                       1           1            0
## 20      1         1         1                       1           1            0
## 21      1         1         1                       1           1            0
## 22      1         1         1                       1           1            0
## 23      1         1         1                       1           1            0
## 24      1         1         1                       1           1            0
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## 26      1         1         1                       1           1            0
## 27      1         1         1                       1           1            0
## 28      1         1         1                       1           1            0
## 29      1         1         1                       1           1            0
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## 31      1         1         1                       1           1            0
## 32      1         1         1                       1           1            0
## 33      1         1         1                       1           1            0
## 34      1         1         1                       1           1            0
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## 35        1         1         1                   1         1         0
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## 39        1         1         1                   1         1         0
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## 89    1    1    1              1    1    0
## 90    1    1    1              1    1    0
## 91    1    1    1              1    1    0
## 92    1    1    1              1    1    0
## 93    1    1    1              1    1    0
## 94    1    1    1              1    1    0
## 95    1    1    1              1    1    0
## 96    1    1    1              1    1    0
## 97    1    1    1              1    1    0
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## 105   1    1    1              1    1    0
## 106   1    1    1              1    1    0
## 107   1    1    1              1    1    0
## 108   1    1    1              1    1    0
## 109   1    1    1              1    1    0
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## 137   1    1    1              1    0    0
## 138   1    1    1              1    0    0
## 139   1    1    1              1    0    0
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## 304      1          1          1                        0          0          0
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## 359      1        1        1                     0          0          0
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## 413     1        1        0                      0        0        0
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## 467       1        1        0                        0        0        0
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## 519       1        1        0                        0        0        0
## 520       1        1        0                        0        0        0
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## 573     1       0       0                       0       0       0
## 574     1       0       0                       0       0       0
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## 627      1         0         0                          0         0         0
## 628      1         0         0                          0         0         0
```

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## 680     0          1          1                    1          1          0
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## 682     0          1          1                    1          1          0
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13

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## 734    0        1        1                1        1        0
## 735    0        1        1                1        1        0
## 736    0        1        1                1        1        0
```

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## 789     0          1          1                      1          1          0
## 790     0          1          1                      1          1          0
```

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```

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## 1222      0        0        1                    1        1        0
```

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```

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```

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## 1456     0          0          1                    0          0          0
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## 1462     0          0          1                    0          0          0
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## 1477     0          0          1                    0          0          0
## 1478     0          0          1                    0          0          0
## 1479     0          0          1                    0          0          0
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## 1486     0          0          1                    0          0          0
## 1487     0          0          1                    0          0          0
## 1488     0          0          1                    0          0          0
## 1489     0          0          1                    0          0          0
## 1490     0          0          1                    0          0          0
## 1491     0          0          1                    0          0          0
## 1492     0          0          1                    0          0          0
```

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## 1494       0         0         1                     0         0         0
## 1495       0         0         1                     0         0         0
## 1496       0         0         1                     0         0         0
## 1497       0         0         1                     0         0         0
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## 1522       0         0         1                     0         0         0
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## 1539       0         0         1                     0         0         0
## 1540       0         0         1                     0         0         0
## 1541       0         0         1                     0         0         0
## 1542       0         0         1                     0         0         0
## 1543       0         0         1                     0         0         0
## 1544       0         0         1                     0         0         0
## 1545       0         0         1                     0         0         0
## 1546       0         0         1                     0         0         0
```

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## 1547    0    0    1              0    0    0
## 1548    0    0    1              0    0    0
## 1549    0    0    1              0    0    0
## 1550    0    0    1              0    0    0
## 1551    0    0    1              0    0    0
## 1552    0    0    1              0    0    0
## 1553    0    0    1              0    0    0
## 1554    0    0    1              0    0    0
## 1555    0    0    1              0    0    0
## 1556    0    0    1              0    0    0
## 1557    0    0    1              0    0    0
## 1558    0    0    1              0    0    0
## 1559    0    0    1              0    0    0
## 1560    0    0    1              0    0    0
## 1561    0    0    1              0    0    0
## 1562    0    0    1              0    0    0
## 1563    0    0    1              0    0    0
## 1564    0    0    1              0    0    0
## 1565    0    0    1              0    0    0
## 1566    0    0    1              0    0    0
## 1567    0    0    1              0    0    0
## 1568    0    0    1              0    0    0
## 1569    0    0    1              0    0    0
## 1570    0    0    1              0    0    0
## 1571    0    0    1              0    0    0
## 1572    0    0    1              0    0    0
## 1573    0    0    1              0    0    0
## 1574    0    0    1              0    0    0
## 1575    0    0    1              0    0    0
## 1576    0    0    1              0    0    0
## 1577    0    0    1              0    0    0
## 1578    0    0    1              0    0    0
## 1579    0    0    1              0    0    0
## 1580    0    0    1              0    0    0
## 1581    0    0    1              0    0    0
## 1582    0    0    1              0    0    0
## 1583    0    0    1              0    0    0
## 1584    0    0    1              0    0    0
## 1585    0    0    0              1    1    0
## 1586    0    0    0              1    1    0
## 1587    0    0    0              1    1    0
## 1588    0    0    0              1    1    0
## 1589    0    0    0              1    1    0
## 1590    0    0    0              1    1    0
## 1591    0    0    0              1    1    0
## 1592    0    0    0              1    1    0
## 1593    0    0    0              1    1    0
## 1594    0    0    0              1    1    0
## 1595    0    0    0              1    1    0
## 1596    0    0    0              1    1    0
## 1597    0    0    0              1    1    0
## 1598    0    0    0              1    1    0
## 1599    0    0    0              1    1    0
## 1600    0    0    0              1    1    0
```

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## 1652      0          0          0                        1          1          0
## 1653      0          0          0                        1          1          0
## 1654      0          0          0                        1          1          0
```

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## 1662        0         0         0                    1         1         0
## 1663        0         0         0                    1         1         0
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## 1666        0         0         0                    1         1         0
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## 1689        0         0         0                    1         1         0
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## 1691        0         0         0                    1         1         0
## 1692        0         0         0                    1         1         0
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## 1707        0         0         0                    1         1         0
## 1708        0         0         0                    1         1         0
```

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## 1758        0           0           0                      1           0           0
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## 1760        0           0           0                      1           0           0
## 1761        0           0           0                      1           0           0
## 1762        0           0           0                      1           0           0
```

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## 1763        0           0           0                       1           0           0
## 1764        0           0           0                       1           0           0
## 1765        0           0           0                       1           0           0
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## 1768        0           0           0                       1           0           0
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## 1770        0           0           0                       1           0           0
## 1771        0           0           0                       1           0           0
## 1772        0           0           0                       1           0           0
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## 1789        0           0           0                       1           0           0
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## 1792        0           0           0                       1           0           0
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## 1798        0           0           0                       1           0           0
## 1799        0           0           0                       1           0           0
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## 1803        0           0           0                       1           0           0
## 1804        0           0           0                       1           0           0
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## 1807        0           0           0                       1           0           0
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## 1810        0           0           0                       1           0           0
## 1811        0           0           0                       1           0           0
## 1812        0           0           0                       1           0           0
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## 1815        0           0           0                       1           0           0
## 1816        0           0           0                       1           0           0
```

```
## 1817        0          0          0                    1          0          0
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## 1821        0          0          0                    1          0          0
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## 1826        0          0          0                    1          0          0
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## 1832        0          0          0                    1          0          0
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## 1868        0          0          0                    0          1          0
## 1869        0          0          0                    0          1          0
## 1870        0          0          0                    0          1          0
```

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## 1920        0         0         0                        0         1         0
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## 1923        0         0         0                        0         1         0
## 1924        0         0         0                        0         1         0
```

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## 1932     0          0          0                        0          1          0
## 1933     0          0          0                        0          1          0
## 1934     0          0          0                        0          1          0
## 1935     0          0          0                        0          1          0
## 1936     0          0          0                        0          1          0
## 1937     0          0          0                        0          1          0
## 1938     0          0          0                        0          1          0
## 1939     0          0          0                        0          1          0
## 1940     0          0          0                        0          1          0
## 1941     0          0          0                        0          1          0
## 1942     0          0          0                        0          1          0
## 1943     0          0          0                        0          1          0
## 1944     0          0          0                        0          1          0
## 1945     0          0          0                        0          1          0
## 1946     0          0          0                        0          1          0
## 1947     0          0          0                        0          1          0
## 1948     0          0          0                        0          1          0
## 1949     0          0          0                        0          1          0
## 1950     0          0          0                        0          1          0
## 1951     0          0          0                        0          1          0
## 1952     0          0          0                        0          1          0
## 1953     0          0          0                        0          1          0
## 1954     0          0          0                        0          1          0
## 1955     0          0          0                        0          1          0
## 1956     0          0          0                        0          1          0
## 1957     0          0          0                        0          1          0
## 1958     0          0          0                        0          1          0
## 1959     0          0          0                        0          1          0
## 1960     0          0          0                        0          1          0
## 1961     0          0          0                        0          1          0
## 1962     0          0          0                        0          1          0
## 1963     0          0          0                        0          1          0
## 1964     0          0          0                        0          1          0
## 1965     0          0          0                        0          1          0
## 1966     0          0          0                        0          1          0
## 1967     0          0          0                        0          1          0
## 1968     0          0          0                        0          1          0
## 1969     0          0          0                        0          1          0
## 1970     0          0          0                        0          1          0
## 1971     0          0          0                        0          1          0
## 1972     0          0          0                        0          1          0
## 1973     0          0          0                        0          1          0
## 1974     0          0          0                        0          1          0
## 1975     0          0          0                        0          1          0
## 1976     0          0          0                        0          1          0
## 1977     0          0          0                        0          1          0
## 1978     0          0          0                        0          1          0
```

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## 1979       0           0           0                       0           1           0
## 1980       0           0           0                       0           1           0
## 1981       0           0           0                       0           0           1
## 1982       0           0           0                       0           0           1
## 1983       0           0           0                       0           0           1
## 1984       0           0           0                       0           0           1
## 1985       0           0           0                       0           0           1
## 1986       0           0           0                       0           0           1
## 1987       0           0           0                       0           0           1
## 1988       0           0           0                       0           0           1
## 1989       0           0           0                       0           0           1
## 1990       0           0           0                       0           0           1
## 1991       0           0           0                       0           0           1
## 1992       0           0           0                       0           0           1
## 1993       0           0           0                       0           0           1
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## 1995       0           0           0                       0           0           1
## 1996       0           0           0                       0           0           1
## 1997       0           0           0                       0           0           1
## 1998       0           0           0                       0           0           1
## 1999       0           0           0                       0           0           1
## 2000       0           0           0                       0           0           1
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## 2002       0           0           0                       0           0           1
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## 2005       0           0           0                       0           0           1
## 2006       0           0           0                       0           0           1
## 2007       0           0           0                       0           0           1
## 2008       0           0           0                       0           0           1
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## 2010       0           0           0                       0           0           1
## 2011       0           0           0                       0           0           1
## 2012       0           0           0                       0           0           1
## 2013       0           0           0                       0           0           1
## 2014       0           0           0                       0           0           1
## 2015       0           0           0                       0           0           1
## 2016       0           0           0                       0           0           1
## 2017       0           0           0                       0           0           1
## 2018       0           0           0                       0           0           1
## 2019       0           0           0                       0           0           1
## 2020       0           0           0                       0           0           1
## 2021       0           0           0                       0           0           1
## 2022       0           0           0                       0           0           1
## 2023       0           0           0                       0           0           1
## 2024       0           0           0                       0           0           1
## 2025       0           0           0                       0           0           1
## 2026       0           0           0                       0           0           1
## 2027       0           0           0                       0           0           1
## 2028       0           0           0                       0           0           1
## 2029       0           0           0                       0           0           1
## 2030       0           0           0                       0           0           1
## 2031       0           0           0                       0           0           1
## 2032       0           0           0                       0           0           1
```

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## 2033       0           0           0                             0           0           1
## 2034       0           0           0                             0           0           1
## 2035       0           0           0                             0           0           1
## 2036       0           0           0                             0           0           1
## 2037       0           0           0                             0           0           1
## 2038       0           0           0                             0           0           1
## 2039       0           0           0                             0           0           1
## 2040       0           0           0                             0           0           1
## 2041       0           0           0                             0           0           1
## 2042       0           0           0                             0           0           1
## 2043       0           0           0                             0           0           1
## 2044       0           0           0                             0           0           1
## 2045       0           0           0                             0           0           1
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## 2048       0           0           0                             0           0           1
## 2049       0           0           0                             0           0           1
## 2050       0           0           0                             0           0           1
## 2051       0           0           0                             0           0           1
## 2052       0           0           0                             0           0           1
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## 2055       0           0           0                             0           0           1
## 2056       0           0           0                             0           0           1
## 2057       0           0           0                             0           0           1
## 2058       0           0           0                             0           0           1
## 2059       0           0           0                             0           0           1
## 2060       0           0           0                             0           0           1
## 2061       0           0           0                             0           0           1
## 2062       0           0           0                             0           0           1
## 2063       0           0           0                             0           0           1
## 2064       0           0           0                             0           0           1
## 2065       0           0           0                             0           0           1
## 2066       0           0           0                             0           0           1
## 2067       0           0           0                             0           0           1
## 2068       0           0           0                             0           0           1
## 2069       0           0           0                             0           0           1
## 2070       0           0           0                             0           0           1
## 2071       0           0           0                             0           0           1
## 2072       0           0           0                             0           0           1
## 2073       0           0           0                             0           0           1
## 2074       0           0           0                             0           0           1
## 2075       0           0           0                             0           0           1
## 2076       0           0           0                             0           0           1
## 2077       0           0           0                             0           0           1
## 2078       0           0           0                             0           0           1
## 2079       0           0           0                             0           0           1
## 2080       0           0           0                             0           0           1
## 2081       0           0           0                             0           0           1
## 2082       0           0           0                             0           0           1
## 2083       0           0           0                             0           0           1
## 2084       0           0           0                             0           0           1
## 2085       0           0           0                             0           0           1
## 2086       0           0           0                             0           0           1
```

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## 2090    0         0         0                   0         0         1
## 2091    0         0         0                   0         0         1
## 2092    0         0         0                   0         0         1
## 2093    0         0         0                   0         0         1
## 2094    0         0         0                   0         0         1
## 2095    0         0         0                   0         0         1
## 2096    0         0         0                   0         0         1
## 2097    0         0         0                   0         0         1
## 2098    0         0         0                   0         0         1
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## 2104    0         0         0                   0         0         1
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## 2107    0         0         0                   0         0         1
## 2108    0         0         0                   0         0         1
## 2109    0         0         0                   0         0         1
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## 2111    0         0         0                   0         0         1
## 2112    0         0         0                   0         0         1
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## 2140    1         1         1                   1         1         0
```

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## 2194    1         1         1                   1         1         0
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## 2248    1         1         1                   1         0         0
```

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## 2301    1          1          1                        1          0          0
## 2302    1          1          1                        1          0          0
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## 2314    1         1         1                   1         0         0
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## 2351    1         1         1                   1         0         0
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## 2355    1         1         1                   1         0         0
## 2356    1         1         1                   1         0         0
```

```
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## 2362    1        1        1                        1        0        0
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## 2382    1        1        1                        0        0        0
## 2383    1        1        1                        0        0        0
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## 2392    1        1        1                        0        0        0
## 2393    1        1        1                        0        0        0
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## 2403    1        1        1                        0        0        0
## 2404    1        1        1                        0        0        0
## 2405    1        1        1                        0        0        0
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## 2409    1        1        1                        0        0        0
## 2410    1        1        1                        0        0        0
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```
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## 2464      1      1      1                    0      0      0
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## 2517     1          1          0                          0          0          0
## 2518     1          1          0                          0          0          0
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## 2572      1           1           0                           0           0           0
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## 2734    1         0         0                    0         0         0
```

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```

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## 2841    0         1         1                     1         1         0
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## 2881          0          1          1                    1          1          0
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## 2883          0          1          1                    1          1          0
## 2884          0          1          1                    1          1          0
## 2885          0          1          1                    1          1          0
## 2886          0          1          1                    1          1          0
## 2887          0          1          1                    1          1          0
## 2888          0          1          1                    1          1          0
## 2889          0          1          1                    1          1          0
## 2890          0          1          1                    1          1          0
## 2891          0          1          1                    1          1          0
## 2892          0          1          1                    1          1          0
## 2893          0          1          1                    1          1          0
## 2894          0          1          1                    1          1          0
## 2895          0          1          1                    1          1          0
## 2896          0          1          1                    1          1          0
```

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## 2897      0           1           1                   1           1           0
## 2898      0           1           1                   1           1           0
## 2899      0           1           1                   1           1           0
## 2900      0           1           1                   1           1           0
## 2901      0           1           1                   1           1           0
## 2902      0           1           1                   1           1           0
## 2903      0           1           1                   1           1           0
## 2904      0           1           1                   1           1           0
## 2905      0           1           1                   1           0           0
## 2906      0           1           1                   1           0           0
## 2907      0           1           1                   1           0           0
## 2908      0           1           1                   1           0           0
## 2909      0           1           1                   1           0           0
## 2910      0           1           1                   1           0           0
## 2911      0           1           1                   1           0           0
## 2912      0           1           1                   1           0           0
## 2913      0           1           1                   1           0           0
## 2914      0           1           1                   1           0           0
## 2915      0           1           1                   1           0           0
## 2916      0           1           1                   1           0           0
## 2917      0           1           1                   1           0           0
## 2918      0           1           1                   1           0           0
## 2919      0           1           1                   1           0           0
## 2920      0           1           1                   1           0           0
## 2921      0           1           1                   1           0           0
## 2922      0           1           1                   1           0           0
## 2923      0           1           1                   1           0           0
## 2924      0           1           1                   1           0           0
## 2925      0           1           1                   1           0           0
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## 2927      0           1           1                   1           0           0
## 2928      0           1           1                   1           0           0
## 2929      0           1           1                   1           0           0
## 2930      0           1           1                   1           0           0
## 2931      0           1           1                   1           0           0
## 2932      0           1           1                   1           0           0
## 2933      0           1           1                   1           0           0
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## 2938      0           1           1                   1           0           0
## 2939      0           1           1                   1           0           0
## 2940      0           1           1                   1           0           0
## 2941      0           1           1                   1           0           0
## 2942      0           1           1                   1           0           0
## 2943      0           1           1                   1           0           0
## 2944      0           1           1                   1           0           0
## 2945      0           1           1                   1           0           0
## 2946      0           1           1                   1           0           0
## 2947      0           1           1                   1           0           0
## 2948      0           1           1                   1           0           0
## 2949      0           1           1                   1           0           0
## 2950      0           1           1                   1           0           0
```

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## 2951     0          1          1                    1          0          0
## 2952     0          1          1                    1          0          0
## 2953     0          1          1                    1          0          0
## 2954     0          1          1                    1          0          0
## 2955     0          1          1                    1          0          0
## 2956     0          1          1                    1          0          0
## 2957     0          1          1                    1          0          0
## 2958     0          1          1                    1          0          0
## 2959     0          1          1                    1          0          0
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## 2962     0          1          1                    1          0          0
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## 2964     0          1          1                    1          0          0
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## 2968     0          1          1                    1          0          0
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## 2971     0          1          1                    1          0          0
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## 2979     0          1          1                    1          0          0
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## 2982     0          1          1                    1          0          0
## 2983     0          1          1                    1          0          0
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## 2985     0          1          1                    1          0          0
## 2986     0          1          1                    1          0          0
## 2987     0          1          1                    1          0          0
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## 2998     0          1          1                    1          0          0
## 2999     0          1          1                    1          0          0
## 3000     0          1          1                    1          0          0
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## 3002     0          1          1                    1          0          0
## 3003     0          1          1                    1          0          0
## 3004     0          1          1                    1          0          0
```

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## 3005    0         1         1                   1         0         0
## 3006    0         1         1                   1         0         0
## 3007    0         1         1                   1         0         0
## 3008    0         1         1                   1         0         0
## 3009    0         1         1                   1         0         0
## 3010    0         1         1                   1         0         0
## 3011    0         1         1                   1         0         0
## 3012    0         1         1                   1         0         0
## 3013    0         1         1                   1         0         0
## 3014    0         1         1                   1         0         0
## 3015    0         1         1                   1         0         0
## 3016    0         1         1                   1         0         0
## 3017    0         1         1                   1         0         0
## 3018    0         1         1                   1         0         0
## 3019    0         1         1                   1         0         0
## 3020    0         1         1                   1         0         0
## 3021    0         1         1                   1         0         0
## 3022    0         1         1                   1         0         0
## 3023    0         1         1                   1         0         0
## 3024    0         1         1                   1         0         0
## 3025    0         1         1                   1         0         0
## 3026    0         1         1                   1         0         0
## 3027    0         1         1                   1         0         0
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## 3029    0         1         1                   1         0         0
## 3030    0         1         1                   1         0         0
## 3031    0         1         1                   1         0         0
## 3032    0         1         1                   1         0         0
## 3033    0         1         1                   1         0         0
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## 3035    0         1         1                   1         0         0
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## 3039    0         1         1                   0         0         0
## 3040    0         1         1                   0         0         0
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## 3045    0         1         1                   0         0         0
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## 3049    0         1         1                   0         0         0
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## 3051    0         1         1                   0         0         0
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## 3053    0         1         1                   0         0         0
## 3054    0         1         1                   0         0         0
## 3055    0         1         1                   0         0         0
## 3056    0         1         1                   0         0         0
## 3057    0         1         1                   0         0         0
## 3058    0         1         1                   0         0         0
```

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## 3063      0           1           1                       0           0           0
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## 3065      0           1           1                       0           0           0
## 3066      0           1           1                       0           0           0
## 3067      0           1           1                       0           0           0
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## 3072      0           1           1                       0           0           0
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## 3076      0           1           1                       0           0           0
## 3077      0           1           1                       0           0           0
## 3078      0           1           1                       0           0           0
## 3079      0           1           1                       0           0           0
## 3080      0           1           1                       0           0           0
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## 3083      0           1           1                       0           0           0
## 3084      0           1           1                       0           0           0
## 3085      0           1           1                       0           0           0
## 3086      0           1           1                       0           0           0
## 3087      0           1           1                       0           0           0
## 3088      0           1           1                       0           0           0
## 3089      0           1           1                       0           0           0
## 3090      0           1           1                       0           0           0
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## 3107      0           1           1                       0           0           0
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## 3111      0           1           1                       0           0           0
## 3112      0           1           1                       0           0           0
```

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## 3114     0          1          1                    0          0          0
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## 3116     0          1          1                    0          0          0
## 3117     0          1          1                    0          0          0
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## 3134     0          1          1                    0          0          0
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## 3137     0          1          1                    0          0          0
## 3138     0          1          1                    0          0          0
## 3139     0          1          1                    0          0          0
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## 3141     0          1          1                    0          0          0
## 3142     0          1          1                    0          0          0
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## 3148     0          1          1                    0          0          0
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## 3151     0          1          1                    0          0          0
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## 3165     0          1          1                    0          0          0
## 3166     0          1          1                    0          0          0
```

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## 3167      0          1          1                      0          0          0
## 3168      0          1          1                      0          0          0
## 3169      0          1          0                      0          0          0
## 3170      0          1          0                      0          0          0
## 3171      0          1          0                      0          0          0
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## 3176      0          1          0                      0          0          0
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## 3178      0          1          0                      0          0          0
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## 3181      0          1          0                      0          0          0
## 3182      0          1          0                      0          0          0
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## 3185      0          1          0                      0          0          0
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## 3187      0          1          0                      0          0          0
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## 3215      0          1          0                      0          0          0
## 3216      0          1          0                      0          0          0
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## 3218      0          1          0                      0          0          0
## 3219      0          1          0                      0          0          0
## 3220      0          1          0                      0          0          0
```

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## 3221     0     1     0                    0     0     0
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## 3224     0     1     0                    0     0     0
## 3225     0     1     0                    0     0     0
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## 3229     0     1     0                    0     0     0
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## 3232     0     1     0                    0     0     0
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## 3269     0     1     0                    0     0     0
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## 3272     0     1     0                    0     0     0
## 3273     0     1     0                    0     0     0
## 3274     0     1     0                    0     0     0
```

```
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## 3276    0    1    0              0    0    0
## 3277    0    1    0              0    0    0
## 3278    0    1    0              0    0    0
## 3279    0    1    0              0    0    0
## 3280    0    1    0              0    0    0
## 3281    0    1    0              0    0    0
## 3282    0    1    0              0    0    0
## 3283    0    1    0              0    0    0
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## 3286    0    1    0              0    0    0
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## 3300    0    1    0              0    0    0
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## 3306    0    0    1              1    1    0
## 3307    0    0    1              1    1    0
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## 3310    0    0    1              1    1    0
## 3311    0    0    1              1    1    0
## 3312    0    0    1              1    1    0
## 3313    0    0    1              1    1    0
## 3314    0    0    1              1    1    0
## 3315    0    0    1              1    1    0
## 3316    0    0    1              1    1    0
## 3317    0    0    1              1    1    0
## 3318    0    0    1              1    1    0
## 3319    0    0    1              1    1    0
## 3320    0    0    1              1    1    0
## 3321    0    0    1              1    1    0
## 3322    0    0    1              1    1    0
## 3323    0    0    1              1    1    0
## 3324    0    0    1              1    1    0
## 3325    0    0    1              1    1    0
## 3326    0    0    1              1    1    0
## 3327    0    0    1              1    1    0
## 3328    0    0    1              1    1    0
```

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## 3332    0        0        1                    1        1        0
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## 3340    0        0        1                    1        1        0
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## 3354    0        0        1                    1        1        0
## 3355    0        0        1                    1        1        0
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## 3357    0        0        1                    1        1        0
## 3358    0        0        1                    1        1        0
## 3359    0        0        1                    1        1        0
## 3360    0        0        1                    1        1        0
## 3361    0        0        1                    1        1        0
## 3362    0        0        1                    1        1        0
## 3363    0        0        1                    1        1        0
## 3364    0        0        1                    1        1        0
## 3365    0        0        1                    1        1        0
## 3366    0        0        1                    1        1        0
## 3367    0        0        1                    1        1        0
## 3368    0        0        1                    1        1        0
## 3369    0        0        1                    1        1        0
## 3370    0        0        1                    1        1        0
## 3371    0        0        1                    1        1        0
## 3372    0        0        1                    1        1        0
## 3373    0        0        1                    1        1        0
## 3374    0        0        1                    1        1        0
## 3375    0        0        1                    1        1        0
## 3376    0        0        1                    1        1        0
## 3377    0        0        1                    1        1        0
## 3378    0        0        1                    1        1        0
## 3379    0        0        1                    1        1        0
## 3380    0        0        1                    1        1        0
## 3381    0        0        1                    1        1        0
## 3382    0        0        1                    1        1        0
```

```
## 3383      0         0         1                    1         1         0
## 3384      0         0         1                    1         1         0
## 3385      0         0         1                    1         1         0
## 3386      0         0         1                    1         1         0
## 3387      0         0         1                    1         1         0
## 3388      0         0         1                    1         1         0
## 3389      0         0         1                    1         1         0
## 3390      0         0         1                    1         1         0
## 3391      0         0         1                    1         1         0
## 3392      0         0         1                    1         1         0
## 3393      0         0         1                    1         1         0
## 3394      0         0         1                    1         1         0
## 3395      0         0         1                    1         1         0
## 3396      0         0         1                    1         1         0
## 3397      0         0         1                    1         1         0
## 3398      0         0         1                    1         1         0
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## 3404      0         0         1                    1         1         0
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## 3406      0         0         1                    1         1         0
## 3407      0         0         1                    1         1         0
## 3408      0         0         1                    1         1         0
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## 3414      0         0         1                    1         1         0
## 3415      0         0         1                    1         1         0
## 3416      0         0         1                    1         1         0
## 3417      0         0         1                    1         1         0
## 3418      0         0         1                    1         1         0
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## 3423      0         0         1                    1         1         0
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## 3427      0         0         1                    1         1         0
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## 3430      0         0         1                    1         1         0
## 3431      0         0         1                    1         1         0
## 3432      0         0         1                    1         1         0
## 3433      0         0         1                    1         0         0
## 3434      0         0         1                    1         0         0
## 3435      0         0         1                    1         0         0
## 3436      0         0         1                    1         0         0
```

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## 3438	0	0	1	1	0	0
## 3439	0	0	1	1	0	0
## 3440	0	0	1	1	0	0
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## 3443	0	0	1	1	0	0
## 3444	0	0	1	1	0	0
## 3445	0	0	1	1	0	0
## 3446	0	0	1	1	0	0
## 3447	0	0	1	1	0	0
## 3448	0	0	1	1	0	0
## 3449	0	0	1	1	0	0
## 3450	0	0	1	1	0	0
## 3451	0	0	1	1	0	0
## 3452	0	0	1	1	0	0
## 3453	0	0	1	1	0	0
## 3454	0	0	1	1	0	0
## 3455	0	0	1	1	0	0
## 3456	0	0	1	1	0	0
## 3457	0	0	1	1	0	0
## 3458	0	0	1	1	0	0
## 3459	0	0	1	1	0	0
## 3460	0	0	1	1	0	0
## 3461	0	0	1	1	0	0
## 3462	0	0	1	1	0	0
## 3463	0	0	1	1	0	0
## 3464	0	0	1	1	0	0
## 3465	0	0	1	1	0	0
## 3466	0	0	1	1	0	0
## 3467	0	0	1	1	0	0
## 3468	0	0	1	1	0	0
## 3469	0	0	1	1	0	0
## 3470	0	0	1	1	0	0
## 3471	0	0	1	1	0	0
## 3472	0	0	1	1	0	0
## 3473	0	0	1	1	0	0
## 3474	0	0	1	1	0	0
## 3475	0	0	1	1	0	0
## 3476	0	0	1	1	0	0
## 3477	0	0	1	1	0	0
## 3478	0	0	1	1	0	0
## 3479	0	0	1	1	0	0
## 3480	0	0	1	1	0	0
## 3481	0	0	1	1	0	0
## 3482	0	0	1	1	0	0
## 3483	0	0	1	1	0	0
## 3484	0	0	1	1	0	0
## 3485	0	0	1	1	0	0
## 3486	0	0	1	1	0	0
## 3487	0	0	1	1	0	0
## 3488	0	0	1	1	0	0
## 3489	0	0	1	1	0	0
## 3490	0	0	1	1	0	0

```
## 3491    0    0    1              1    0    0
## 3492    0    0    1              1    0    0
## 3493    0    0    1              1    0    0
## 3494    0    0    1              1    0    0
## 3495    0    0    1              1    0    0
## 3496    0    0    1              1    0    0
## 3497    0    0    1              1    0    0
## 3498    0    0    1              1    0    0
## 3499    0    0    1              1    0    0
## 3500    0    0    1              1    0    0
## 3501    0    0    1              1    0    0
## 3502    0    0    1              1    0    0
## 3503    0    0    1              1    0    0
## 3504    0    0    1              1    0    0
## 3505    0    0    1              1    0    0
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## 3507    0    0    1              1    0    0
## 3508    0    0    1              1    0    0
## 3509    0    0    1              1    0    0
## 3510    0    0    1              1    0    0
## 3511    0    0    1              1    0    0
## 3512    0    0    1              1    0    0
## 3513    0    0    1              1    0    0
## 3514    0    0    1              1    0    0
## 3515    0    0    1              1    0    0
## 3516    0    0    1              1    0    0
## 3517    0    0    1              1    0    0
## 3518    0    0    1              1    0    0
## 3519    0    0    1              1    0    0
## 3520    0    0    1              1    0    0
## 3521    0    0    1              1    0    0
## 3522    0    0    1              1    0    0
## 3523    0    0    1              1    0    0
## 3524    0    0    1              1    0    0
## 3525    0    0    1              1    0    0
## 3526    0    0    1              1    0    0
## 3527    0    0    1              1    0    0
## 3528    0    0    1              1    0    0
## 3529    0    0    1              1    0    0
## 3530    0    0    1              1    0    0
## 3531    0    0    1              1    0    0
## 3532    0    0    1              1    0    0
## 3533    0    0    1              1    0    0
## 3534    0    0    1              1    0    0
## 3535    0    0    1              1    0    0
## 3536    0    0    1              1    0    0
## 3537    0    0    1              1    0    0
## 3538    0    0    1              1    0    0
## 3539    0    0    1              1    0    0
## 3540    0    0    1              1    0    0
## 3541    0    0    1              1    0    0
## 3542    0    0    1              1    0    0
## 3543    0    0    1              1    0    0
## 3544    0    0    1              1    0    0
```

```
## 3545   0        0        1                    1        0        0
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## 3550   0        0        1                    1        0        0
## 3551   0        0        1                    1        0        0
## 3552   0        0        1                    1        0        0
## 3553   0        0        1                    1        0        0
## 3554   0        0        1                    1        0        0
## 3555   0        0        1                    1        0        0
## 3556   0        0        1                    1        0        0
## 3557   0        0        1                    1        0        0
## 3558   0        0        1                    1        0        0
## 3559   0        0        1                    1        0        0
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## 3562   0        0        1                    1        0        0
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## 3565   0        0        1                    0        0        0
## 3566   0        0        1                    0        0        0
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## 3572   0        0        1                    0        0        0
## 3573   0        0        1                    0        0        0
## 3574   0        0        1                    0        0        0
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## 3576   0        0        1                    0        0        0
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## 3580   0        0        1                    0        0        0
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## 3583   0        0        1                    0        0        0
## 3584   0        0        1                    0        0        0
## 3585   0        0        1                    0        0        0
## 3586   0        0        1                    0        0        0
## 3587   0        0        1                    0        0        0
## 3588   0        0        1                    0        0        0
## 3589   0        0        1                    0        0        0
## 3590   0        0        1                    0        0        0
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## 3592   0        0        1                    0        0        0
## 3593   0        0        1                    0        0        0
## 3594   0        0        1                    0        0        0
## 3595   0        0        1                    0        0        0
## 3596   0        0        1                    0        0        0
## 3597   0        0        1                    0        0        0
## 3598   0        0        1                    0        0        0
```

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## 3599      0        0        1                    0        0        0
## 3600      0        0        1                    0        0        0
## 3601      0        0        1                    0        0        0
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## 3603      0        0        1                    0        0        0
## 3604      0        0        1                    0        0        0
## 3605      0        0        1                    0        0        0
## 3606      0        0        1                    0        0        0
## 3607      0        0        1                    0        0        0
## 3608      0        0        1                    0        0        0
## 3609      0        0        1                    0        0        0
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## 3613      0        0        1                    0        0        0
## 3614      0        0        1                    0        0        0
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## 3616      0        0        1                    0        0        0
## 3617      0        0        1                    0        0        0
## 3618      0        0        1                    0        0        0
## 3619      0        0        1                    0        0        0
## 3620      0        0        1                    0        0        0
## 3621      0        0        1                    0        0        0
## 3622      0        0        1                    0        0        0
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## 3624      0        0        1                    0        0        0
## 3625      0        0        1                    0        0        0
## 3626      0        0        1                    0        0        0
## 3627      0        0        1                    0        0        0
## 3628      0        0        1                    0        0        0
## 3629      0        0        1                    0        0        0
## 3630      0        0        1                    0        0        0
## 3631      0        0        1                    0        0        0
## 3632      0        0        1                    0        0        0
## 3633      0        0        1                    0        0        0
## 3634      0        0        1                    0        0        0
## 3635      0        0        1                    0        0        0
## 3636      0        0        1                    0        0        0
## 3637      0        0        1                    0        0        0
## 3638      0        0        1                    0        0        0
## 3639      0        0        1                    0        0        0
## 3640      0        0        1                    0        0        0
## 3641      0        0        1                    0        0        0
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## 3643      0        0        1                    0        0        0
## 3644      0        0        1                    0        0        0
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## 3646      0        0        1                    0        0        0
## 3647      0        0        1                    0        0        0
## 3648      0        0        1                    0        0        0
## 3649      0        0        1                    0        0        0
## 3650      0        0        1                    0        0        0
## 3651      0        0        1                    0        0        0
## 3652      0        0        1                    0        0        0
```

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## 3653     0           0           1                    0           0           0
## 3654     0           0           1                    0           0           0
## 3655     0           0           1                    0           0           0
## 3656     0           0           1                    0           0           0
## 3657     0           0           1                    0           0           0
## 3658     0           0           1                    0           0           0
## 3659     0           0           1                    0           0           0
## 3660     0           0           1                    0           0           0
## 3661     0           0           1                    0           0           0
## 3662     0           0           1                    0           0           0
## 3663     0           0           1                    0           0           0
## 3664     0           0           1                    0           0           0
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## 3667     0           0           1                    0           0           0
## 3668     0           0           1                    0           0           0
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## 3670     0           0           1                    0           0           0
## 3671     0           0           1                    0           0           0
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## 3674     0           0           1                    0           0           0
## 3675     0           0           1                    0           0           0
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## 3678     0           0           1                    0           0           0
## 3679     0           0           1                    0           0           0
## 3680     0           0           1                    0           0           0
## 3681     0           0           1                    0           0           0
## 3682     0           0           1                    0           0           0
## 3683     0           0           1                    0           0           0
## 3684     0           0           1                    0           0           0
## 3685     0           0           1                    0           0           0
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## 3687     0           0           1                    0           0           0
## 3688     0           0           1                    0           0           0
## 3689     0           0           1                    0           0           0
## 3690     0           0           1                    0           0           0
## 3691     0           0           1                    0           0           0
## 3692     0           0           1                    0           0           0
## 3693     0           0           1                    0           0           0
## 3694     0           0           1                    0           0           0
## 3695     0           0           1                    0           0           0
## 3696     0           0           1                    0           0           0
## 3697     0           0           0                    1           1           0
## 3698     0           0           0                    1           1           0
## 3699     0           0           0                    1           1           0
## 3700     0           0           0                    1           1           0
## 3701     0           0           0                    1           1           0
## 3702     0           0           0                    1           1           0
## 3703     0           0           0                    1           1           0
##      Pains Nasal.Congestion Runny.Nose Diarrhea None_Experiencing Age_0.9
## 1        1                1          1        1                 0       1
## 2        1                1          1        1                 0       1
```

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```
## 3      1              1              1              1                      0         1
## 4      1              1              1              1                      0         1
## 5      1              1              1              1                      0         1
## 6      1              1              1              1                      0         1
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## 8      1              1              1              1                      0         1
## 9      1              1              1              1                      0         1
## 10     1              1              1              1                      0         1
## 11     1              1              1              1                      0         1
## 12     1              1              1              1                      0         1
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## 14     1              1              1              0                      0         1
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## 21     1              1              1              0                      0         1
## 22     1              1              1              0                      0         1
## 23     1              1              1              0                      0         1
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## 38     1              0              0              0                      0         1
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## 40     1              0              0              0                      0         1
## 41     1              0              0              0                      0         1
## 42     1              0              0              0                      0         1
## 43     1              0              0              0                      0         1
## 44     1              0              0              0                      0         1
## 45     1              0              0              0                      0         1
## 46     1              0              0              0                      0         1
## 47     1              0              0              0                      0         1
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## 49     0              1              1              1                      0         1
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## 52     0              1              1              1                      0         1
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## 54     0              1              1              1                      0         1
## 55     0              1              1              1                      0         1
## 56     0              1              1              1                      0         1
```

```
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## 62      0                1          1          0                0          1
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## 67      0                1          1          0                0          1
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## 75      0                1          0          0                0          1
## 76      0                1          0          0                0          1
## 77      0                1          0          0                0          1
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## 80      0                1          0          0                0          1
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## 85      0                0          1          1                0          1
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## 87      0                0          1          1                0          1
## 88      0                0          1          1                0          1
## 89      0                0          1          1                0          1
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## 91      0                0          1          1                0          1
## 92      0                0          1          1                0          1
## 93      0                0          1          1                0          1
## 94      0                0          1          1                0          1
## 95      0                0          1          1                0          1
## 96      0                0          1          1                0          1
## 97      0                0          1          0                0          1
## 98      0                0          1          0                0          1
## 99      0                0          1          0                0          1
## 100     0                0          1          0                0          1
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## 103     0                0          1          0                0          1
## 104     0                0          1          0                0          1
## 105     0                0          1          0                0          1
## 106     0                0          1          0                0          1
## 107     0                0          1          0                0          1
## 108     0                0          1          0                0          1
## 109     0                0          0          1                0          1
## 110     0                0          0          1                0          1
```

```
## 111    0              0            0            1              0            1
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## 113    0              0            0            1              0            1
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## 135    1              1            1            1              0            1
## 136    1              1            1            1              0            1
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## 218    0              0            1          1                    0          1
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## 643	0	0	0	1	0	1
## 644	0	0	0	1	0	1
## 645	0	0	0	1	0	1
## 646	0	0	0	1	0	1
## 647	0	0	0	1	0	1
## 648	0	0	0	1	0	1
## 649	0	0	0	0	1	1
## 650	0	0	0	0	1	1

```
## 651    0              0         0         0              1    1
## 652    0              0         0         0              1    1
## 653    0              0         0         0              1    1
## 654    0              0         0         0              1    1
## 655    0              0         0         0              1    1
## 656    0              0         0         0              1    1
## 657    0              0         0         0              1    1
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## 659    0              0         0         0              1    1
## 660    0              0         0         0              1    1
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## 662    1              1         1         1              0    1
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## 672    1              1         1         1              0    1
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## 674    1              1         1         0              0    1
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## 679    1              1         1         0              0    1
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## 682    1              1         1         0              0    1
## 683    1              1         1         0              0    1
## 684    1              1         1         0              0    1
## 685    1              1         0         0              0    1
## 686    1              1         0         0              0    1
## 687    1              1         0         0              0    1
## 688    1              1         0         0              0    1
## 689    1              1         0         0              0    1
## 690    1              1         0         0              0    1
## 691    1              1         0         0              0    1
## 692    1              1         0         0              0    1
## 693    1              1         0         0              0    1
## 694    1              1         0         0              0    1
## 695    1              1         0         0              0    1
## 696    1              1         0         0              0    1
## 697    1              0         0         0              0    1
## 698    1              0         0         0              0    1
## 699    1              0         0         0              0    1
## 700    1              0         0         0              0    1
## 701    1              0         0         0              0    1
## 702    1              0         0         0              0    1
## 703    1              0         0         0              0    1
## 704    1              0         0         0              0    1
```

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```
## 705    1           0       0       0           0       1
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## 707    1           0       0       0           0       1
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## 712    0           1       1       1           0       1
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## 714    0           1       1       1           0       1
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## 717    0           1       1       1           0       1
## 718    0           1       1       1           0       1
## 719    0           1       1       1           0       1
## 720    0           1       1       1           0       1
## 721    0           1       1       0           0       1
## 722    0           1       1       0           0       1
## 723    0           1       1       0           0       1
## 724    0           1       1       0           0       1
## 725    0           1       1       0           0       1
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## 727    0           1       1       0           0       1
## 728    0           1       1       0           0       1
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## 730    0           1       1       0           0       1
## 731    0           1       1       0           0       1
## 732    0           1       1       0           0       1
## 733    0           1       0       0           0       1
## 734    0           1       0       0           0       1
## 735    0           1       0       0           0       1
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## 738    0           1       0       0           0       1
## 739    0           1       0       0           0       1
## 740    0           1       0       0           0       1
## 741    0           1       0       0           0       1
## 742    0           1       0       0           0       1
## 743    0           1       0       0           0       1
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## 745    0           0       1       1           0       1
## 746    0           0       1       1           0       1
## 747    0           0       1       1           0       1
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## 753    0           0       1       1           0       1
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## 757    0           0       1       0           0       1
## 758    0           0       1       0           0       1
```

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## 765      0              0            1          0                0         1
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## 772      0              0            0          1                0         1
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## 777      0              0            0          1                0         1
## 778      0              0            0          1                0         1
## 779      0              0            0          1                0         1
## 780      0              0            0          1                0         1
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## 782      0              0            0          0                1         1
## 783      0              0            0          0                1         1
## 784      0              0            0          0                1         1
## 785      0              0            0          0                1         1
## 786      0              0            0          0                1         1
## 787      0              0            0          0                1         1
## 788      0              0            0          0                1         1
## 789      0              0            0          0                1         1
## 790      0              0            0          0                1         1
## 791      0              0            0          0                1         1
## 792      0              0            0          0                1         1
## 793      1              1            1          1                0         1
## 794      1              1            1          1                0         1
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## 811      1              1            1          0                0         1
## 812      1              1            1          0                0         1
```

```
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## 820    1              1              0              0                   0              1
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## 823    1              1              0              0                   0              1
## 824    1              1              0              0                   0              1
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## 826    1              1              0              0                   0              1
## 827    1              1              0              0                   0              1
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## 831    1              0              0              0                   0              1
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## 847    0              1              1              1                   0              1
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## 853    0              1              1              0                   0              1
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## 861    0              1              1              0                   0              1
## 862    0              1              1              0                   0              1
## 863    0              1              1              0                   0              1
## 864    0              1              1              0                   0              1
## 865    0              1              0              0                   0              1
## 866    0              1              0              0                   0              1
```

```
## 867    0                1            0          0                  0        1
## 868    0                1            0          0                  0        1
## 869    0                1            0          0                  0        1
## 870    0                1            0          0                  0        1
## 871    0                1            0          0                  0        1
## 872    0                1            0          0                  0        1
## 873    0                1            0          0                  0        1
## 874    0                1            0          0                  0        1
## 875    0                1            0          0                  0        1
## 876    0                1            0          0                  0        1
## 877    0                0            1          1                  0        1
## 878    0                0            1          1                  0        1
## 879    0                0            1          1                  0        1
## 880    0                0            1          1                  0        1
## 881    0                0            1          1                  0        1
## 882    0                0            1          1                  0        1
## 883    0                0            1          1                  0        1
## 884    0                0            1          1                  0        1
## 885    0                0            1          1                  0        1
## 886    0                0            1          1                  0        1
## 887    0                0            1          1                  0        1
## 888    0                0            1          1                  0        1
## 889    0                0            1          0                  0        1
## 890    0                0            1          0                  0        1
## 891    0                0            1          0                  0        1
## 892    0                0            1          0                  0        1
## 893    0                0            1          0                  0        1
## 894    0                0            1          0                  0        1
## 895    0                0            1          0                  0        1
## 896    0                0            1          0                  0        1
## 897    0                0            1          0                  0        1
## 898    0                0            1          0                  0        1
## 899    0                0            1          0                  0        1
## 900    0                0            1          0                  0        1
## 901    0                0            0          1                  0        1
## 902    0                0            0          1                  0        1
## 903    0                0            0          1                  0        1
## 904    0                0            0          1                  0        1
## 905    0                0            0          1                  0        1
## 906    0                0            0          1                  0        1
## 907    0                0            0          1                  0        1
## 908    0                0            0          1                  0        1
## 909    0                0            0          1                  0        1
## 910    0                0            0          1                  0        1
## 911    0                0            0          1                  0        1
## 912    0                0            0          1                  0        1
## 913    0                0            0          0                  1        1
## 914    0                0            0          0                  1        1
## 915    0                0            0          0                  1        1
## 916    0                0            0          0                  1        1
## 917    0                0            0          0                  1        1
## 918    0                0            0          0                  1        1
## 919    0                0            0          0                  1        1
## 920    0                0            0          0                  1        1
```

```
## 921    0          0       0       0            1       1
## 922    0          0       0       0            1       1
## 923    0          0       0       0            1       1
## 924    0          0       0       0            1       1
## 925    1          1       1       1            0       1
## 926    1          1       1       1            0       1
## 927    1          1       1       1            0       1
## 928    1          1       1       1            0       1
## 929    1          1       1       1            0       1
## 930    1          1       1       1            0       1
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## 932    1          1       1       1            0       1
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## 947    1          1       1       0            0       1
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## 953    1          1       0       0            0       1
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## 955    1          1       0       0            0       1
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## 957    1          1       0       0            0       1
## 958    1          1       0       0            0       1
## 959    1          1       0       0            0       1
## 960    1          1       0       0            0       1
## 961    1          0       0       0            0       1
## 962    1          0       0       0            0       1
## 963    1          0       0       0            0       1
## 964    1          0       0       0            0       1
## 965    1          0       0       0            0       1
## 966    1          0       0       0            0       1
## 967    1          0       0       0            0       1
## 968    1          0       0       0            0       1
## 969    1          0       0       0            0       1
## 970    1          0       0       0            0       1
## 971    1          0       0       0            0       1
## 972    1          0       0       0            0       1
## 973    0          1       1       1            0       1
## 974    0          1       1       1            0       1
```

```
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## 977    0            1      1      1            0      1
## 978    0            1      1      1            0      1
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## 981    0            1      1      1            0      1
## 982    0            1      1      1            0      1
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## 985    0            1      1      0            0      1
## 986    0            1      1      0            0      1
## 987    0            1      1      0            0      1
## 988    0            1      1      0            0      1
## 989    0            1      1      0            0      1
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## 991    0            1      1      0            0      1
## 992    0            1      1      0            0      1
## 993    0            1      1      0            0      1
## 994    0            1      1      0            0      1
## 995    0            1      1      0            0      1
## 996    0            1      1      0            0      1
## 997    0            1      0      0            0      1
## 998    0            1      0      0            0      1
## 999    0            1      0      0            0      1
## 1000   0            1      0      0            0      1
## 1001   0            1      0      0            0      1
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## 1003   0            1      0      0            0      1
## 1004   0            1      0      0            0      1
## 1005   0            1      0      0            0      1
## 1006   0            1      0      0            0      1
## 1007   0            1      0      0            0      1
## 1008   0            1      0      0            0      1
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## 1010   0            0      1      1            0      1
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## 1012   0            0      1      1            0      1
## 1013   0            0      1      1            0      1
## 1014   0            0      1      1            0      1
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## 1017   0            0      1      1            0      1
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## 1020   0            0      1      1            0      1
## 1021   0            0      1      0            0      1
## 1022   0            0      1      0            0      1
## 1023   0            0      1      0            0      1
## 1024   0            0      1      0            0      1
## 1025   0            0      1      0            0      1
## 1026   0            0      1      0            0      1
## 1027   0            0      1      0            0      1
## 1028   0            0      1      0            0      1
```

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## 1029	0	0	1	0	0	1
## 1030	0	0	1	0	0	1
## 1031	0	0	1	0	0	1
## 1032	0	0	1	0	0	1
## 1033	0	0	0	1	0	1
## 1034	0	0	0	1	0	1
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## 1055	0	0	0	0	1	1
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## 1059	1	1	1	1	0	1
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## 1061	1	1	1	1	0	1
## 1062	1	1	1	1	0	1
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## 1065	1	1	1	1	0	1
## 1066	1	1	1	1	0	1
## 1067	1	1	1	1	0	1
## 1068	1	1	1	1	0	1
## 1069	1	1	1	0	0	1
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## 1071	1	1	1	0	0	1
## 1072	1	1	1	0	0	1
## 1073	1	1	1	0	0	1
## 1074	1	1	1	0	0	1
## 1075	1	1	1	0	0	1
## 1076	1	1	1	0	0	1
## 1077	1	1	1	0	0	1
## 1078	1	1	1	0	0	1
## 1079	1	1	1	0	0	1
## 1080	1	1	1	0	0	1
## 1081	1	1	0	0	0	1
## 1082	1	1	0	0	0	1

```
## 1083    1              1         0       0              0      1
## 1084    1              1         0       0              0      1
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## 1086    1              1         0       0              0      1
## 1087    1              1         0       0              0      1
## 1088    1              1         0       0              0      1
## 1089    1              1         0       0              0      1
## 1090    1              1         0       0              0      1
## 1091    1              1         0       0              0      1
## 1092    1              1         0       0              0      1
## 1093    1              0         0       0              0      1
## 1094    1              0         0       0              0      1
## 1095    1              0         0       0              0      1
## 1096    1              0         0       0              0      1
## 1097    1              0         0       0              0      1
## 1098    1              0         0       0              0      1
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## 1100    1              0         0       0              0      1
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## 1102    1              0         0       0              0      1
## 1103    1              0         0       0              0      1
## 1104    1              0         0       0              0      1
## 1105    0              1         1       1              0      1
## 1106    0              1         1       1              0      1
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## 1108    0              1         1       1              0      1
## 1109    0              1         1       1              0      1
## 1110    0              1         1       1              0      1
## 1111    0              1         1       1              0      1
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## 1115    0              1         1       1              0      1
## 1116    0              1         1       1              0      1
## 1117    0              1         1       0              0      1
## 1118    0              1         1       0              0      1
## 1119    0              1         1       0              0      1
## 1120    0              1         1       0              0      1
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## 1123    0              1         1       0              0      1
## 1124    0              1         1       0              0      1
## 1125    0              1         1       0              0      1
## 1126    0              1         1       0              0      1
## 1127    0              1         1       0              0      1
## 1128    0              1         1       0              0      1
## 1129    0              1         0       0              0      1
## 1130    0              1         0       0              0      1
## 1131    0              1         0       0              0      1
## 1132    0              1         0       0              0      1
## 1133    0              1         0       0              0      1
## 1134    0              1         0       0              0      1
## 1135    0              1         0       0              0      1
## 1136    0              1         0       0              0      1
```

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## 1137    0              1           0          0                0     1
## 1138    0              1           0          0                0     1
## 1139    0              1           0          0                0     1
## 1140    0              1           0          0                0     1
## 1141    0              0           1          1                0     1
## 1142    0              0           1          1                0     1
## 1143    0              0           1          1                0     1
## 1144    0              0           1          1                0     1
## 1145    0              0           1          1                0     1
## 1146    0              0           1          1                0     1
## 1147    0              0           1          1                0     1
## 1148    0              0           1          1                0     1
## 1149    0              0           1          1                0     1
## 1150    0              0           1          1                0     1
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## 1152    0              0           1          1                0     1
## 1153    0              0           1          0                0     1
## 1154    0              0           1          0                0     1
## 1155    0              0           1          0                0     1
## 1156    0              0           1          0                0     1
## 1157    0              0           1          0                0     1
## 1158    0              0           1          0                0     1
## 1159    0              0           1          0                0     1
## 1160    0              0           1          0                0     1
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## 1162    0              0           1          0                0     1
## 1163    0              0           1          0                0     1
## 1164    0              0           1          0                0     1
## 1165    0              0           0          1                0     1
## 1166    0              0           0          1                0     1
## 1167    0              0           0          1                0     1
## 1168    0              0           0          1                0     1
## 1169    0              0           0          1                0     1
## 1170    0              0           0          1                0     1
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## 1173    0              0           0          1                0     1
## 1174    0              0           0          1                0     1
## 1175    0              0           0          1                0     1
## 1176    0              0           0          1                0     1
## 1177    0              0           0          0                1     1
## 1178    0              0           0          0                1     1
## 1179    0              0           0          0                1     1
## 1180    0              0           0          0                1     1
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## 1182    0              0           0          0                1     1
## 1183    0              0           0          0                1     1
## 1184    0              0           0          0                1     1
## 1185    0              0           0          0                1     1
## 1186    0              0           0          0                1     1
## 1187    0              0           0          0                1     1
## 1188    0              0           0          0                1     1
## 1189    1              1           1          1                0     1
## 1190    1              1           1          1                0     1
```

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## 1193    1              1            1           1                0        1
## 1194    1              1            1           1                0        1
## 1195    1              1            1           1                0        1
## 1196    1              1            1           1                0        1
## 1197    1              1            1           1                0        1
## 1198    1              1            1           1                0        1
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## 1200    1              1            1           1                0        1
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## 1202    1              1            1           0                0        1
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## 1204    1              1            1           0                0        1
## 1205    1              1            1           0                0        1
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## 1207    1              1            1           0                0        1
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## 1214    1              1            0           0                0        1
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## 1216    1              1            0           0                0        1
## 1217    1              1            0           0                0        1
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## 1219    1              1            0           0                0        1
## 1220    1              1            0           0                0        1
## 1221    1              1            0           0                0        1
## 1222    1              1            0           0                0        1
## 1223    1              1            0           0                0        1
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## 1227    1              0            0           0                0        1
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## 1229    1              0            0           0                0        1
## 1230    1              0            0           0                0        1
## 1231    1              0            0           0                0        1
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## 1233    1              0            0           0                0        1
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## 1238    0              1            1           1                0        1
## 1239    0              1            1           1                0        1
## 1240    0              1            1           1                0        1
## 1241    0              1            1           1                0        1
## 1242    0              1            1           1                0        1
## 1243    0              1            1           1                0        1
## 1244    0              1            1           1                0        1
```

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## 1247    0              1         1         1              0         1
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## 1253    0              1         1         0              0         1
## 1254    0              1         1         0              0         1
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## 1262    0              1         0         0              0         1
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## 1265    0              1         0         0              0         1
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## 1269    0              1         0         0              0         1
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## 1271    0              1         0         0              0         1
## 1272    0              1         0         0              0         1
## 1273    0              0         1         1              0         1
## 1274    0              0         1         1              0         1
## 1275    0              0         1         1              0         1
## 1276    0              0         1         1              0         1
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## 1291    0              0         1         0              0         1
## 1292    0              0         1         0              0         1
## 1293    0              0         1         0              0         1
## 1294    0              0         1         0              0         1
## 1295    0              0         1         0              0         1
## 1296    0              0         1         0              0         1
## 1297    0              0         0         1              0         1
## 1298    0              0         0         1              0         1
```

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## 1299   0            0            0            1            0            1
## 1300   0            0            0            1            0            1
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## 1303   0            0            0            1            0            1
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## 1306   0            0            0            1            0            1
## 1307   0            0            0            1            0            1
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## 1316   0            0            0            0            1            1
## 1317   0            0            0            0            1            1
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## 1327   1            1            1            1            0            1
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## 1334   1            1            1            0            0            1
## 1335   1            1            1            0            0            1
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## 1337   1            1            1            0            0            1
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## 1339   1            1            1            0            0            1
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## 1346   1            1            0            0            0            1
## 1347   1            1            0            0            0            1
## 1348   1            1            0            0            0            1
## 1349   1            1            0            0            0            1
## 1350   1            1            0            0            0            1
## 1351   1            1            0            0            0            1
## 1352   1            1            0            0            0            1
```

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## 1354   1              1              0         0                    0         1
## 1355   1              1              0         0                    0         1
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## 1357   1              0              0         0                    0         1
## 1358   1              0              0         0                    0         1
## 1359   1              0              0         0                    0         1
## 1360   1              0              0         0                    0         1
## 1361   1              0              0         0                    0         1
## 1362   1              0              0         0                    0         1
## 1363   1              0              0         0                    0         1
## 1364   1              0              0         0                    0         1
## 1365   1              0              0         0                    0         1
## 1366   1              0              0         0                    0         1
## 1367   1              0              0         0                    0         1
## 1368   1              0              0         0                    0         1
## 1369   0              1              1         1                    0         1
## 1370   0              1              1         1                    0         1
## 1371   0              1              1         1                    0         1
## 1372   0              1              1         1                    0         1
## 1373   0              1              1         1                    0         1
## 1374   0              1              1         1                    0         1
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## 1376   0              1              1         1                    0         1
## 1377   0              1              1         1                    0         1
## 1378   0              1              1         1                    0         1
## 1379   0              1              1         1                    0         1
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## 1382   0              1              1         0                    0         1
## 1383   0              1              1         0                    0         1
## 1384   0              1              1         0                    0         1
## 1385   0              1              1         0                    0         1
## 1386   0              1              1         0                    0         1
## 1387   0              1              1         0                    0         1
## 1388   0              1              1         0                    0         1
## 1389   0              1              1         0                    0         1
## 1390   0              1              1         0                    0         1
## 1391   0              1              1         0                    0         1
## 1392   0              1              1         0                    0         1
## 1393   0              1              0         0                    0         1
## 1394   0              1              0         0                    0         1
## 1395   0              1              0         0                    0         1
## 1396   0              1              0         0                    0         1
## 1397   0              1              0         0                    0         1
## 1398   0              1              0         0                    0         1
## 1399   0              1              0         0                    0         1
## 1400   0              1              0         0                    0         1
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## 1402   0              1              0         0                    0         1
## 1403   0              1              0         0                    0         1
## 1404   0              1              0         0                    0         1
## 1405   0              0              1         1                    0         1
## 1406   0              0              1         1                    0         1
```

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## 1407        0                0                1            1                0            1
## 1408        0                0                1            1                0            1
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## 1410        0                0                1            1                0            1
## 1411        0                0                1            1                0            1
## 1412        0                0                1            1                0            1
## 1413        0                0                1            1                0            1
## 1414        0                0                1            1                0            1
## 1415        0                0                1            1                0            1
## 1416        0                0                1            1                0            1
## 1417        0                0                1            0                0            1
## 1418        0                0                1            0                0            1
## 1419        0                0                1            0                0            1
## 1420        0                0                1            0                0            1
## 1421        0                0                1            0                0            1
## 1422        0                0                1            0                0            1
## 1423        0                0                1            0                0            1
## 1424        0                0                1            0                0            1
## 1425        0                0                1            0                0            1
## 1426        0                0                1            0                0            1
## 1427        0                0                1            0                0            1
## 1428        0                0                1            0                0            1
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## 1432        0                0                0            1                0            1
## 1433        0                0                0            1                0            1
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## 1445        0                0                0            0                1            1
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## 1447        0                0                0            0                1            1
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## 1455        1                1                1            1                0            1
## 1456        1                1                1            1                0            1
## 1457        1                1                1            1                0            1
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## 1460        1                1                1            1                0            1
```

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## 1467   1           1      1      0             0      1
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## 1489   1           0      0      0             0      1
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## 1492   1           0      0      0             0      1
## 1493   1           0      0      0             0      1
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## 1498   1           0      0      0             0      1
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## 1509   0           1      1      1             0      1
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## 1513   0           1      1      0             0      1
## 1514   0           1      1      0             0      1
```

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## 1562    0              0         0         1                   0         1
## 1563    0              0         0         1                   0         1
## 1564    0              0         0         1                   0         1
## 1565    0              0         0         1                   0         1
## 1566    0              0         0         1                   0         1
## 1567    0              0         0         1                   0         1
## 1568    0              0         0         1                   0         1
```

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## 1569      0              0         0         1              0         1
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## 1577      0              0         0         0              1         1
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## 1583      0              0         0         0              1         1
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## 1617      1              1         0         0              0         1
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## 1619      1              1         0         0              0         1
## 1620      1              1         0         0              0         1
## 1621      1              0         0         0              0         1
## 1622      1              0         0         0              0         1
```

99

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## 1624	1	0	0	0	0	1
## 1625	1	0	0	0	0	1
## 1626	1	0	0	0	0	1
## 1627	1	0	0	0	0	1
## 1628	1	0	0	0	0	1
## 1629	1	0	0	0	0	1
## 1630	1	0	0	0	0	1
## 1631	1	0	0	0	0	1
## 1632	1	0	0	0	0	1
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## 1642	0	1	1	1	0	1
## 1643	0	1	1	1	0	1
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## 1652	0	1	1	0	0	1
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## 1659	0	1	0	0	0	1
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## 1663	0	1	0	0	0	1
## 1664	0	1	0	0	0	1
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## 1675	0	0	1	1	0	1
## 1676	0	0	1	1	0	1

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## 1730      1              1              1       0              0       1
```

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## 1783    0              1              1              0                    0              1
## 1784    0              1              1              0                    0              1
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## 1833    0                0            0            1                0        1
## 1834    0                0            0            1                0        1
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## 1836    0                0            0            1                0        1
## 1837    0                0            0            0                1        1
## 1838    0                0            0            0                1        1
```

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## 1842    0              0         0         0                   1    1
## 1843    0              0         0         0                   1    1
## 1844    0              0         0         0                   1    1
## 1845    0              0         0         0                   1    1
## 1846    0              0         0         0                   1    1
## 1847    0              0         0         0                   1    1
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## 1886    1              0         0         0                   0    1
## 1887    1              0         0         0                   0    1
## 1888    1              0         0         0                   0    1
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## 1890    1              0         0         0                   0    1
## 1891    1              0         0         0                   0    1
## 1892    1              0         0         0                   0    1
```

```
## 1893  1              0        0        0              0        1
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## 1896  1              0        0        0              0        1
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## 1901  0              1        1        1              0        1
## 1902  0              1        1        1              0        1
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## 1904  0              1        1        1              0        1
## 1905  0              1        1        1              0        1
## 1906  0              1        1        1              0        1
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## 1910  0              1        1        0              0        1
## 1911  0              1        1        0              0        1
## 1912  0              1        1        0              0        1
## 1913  0              1        1        0              0        1
## 1914  0              1        1        0              0        1
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## 1916  0              1        1        0              0        1
## 1917  0              1        1        0              0        1
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## 1921  0              1        0        0              0        1
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## 1923  0              1        0        0              0        1
## 1924  0              1        0        0              0        1
## 1925  0              1        0        0              0        1
## 1926  0              1        0        0              0        1
## 1927  0              1        0        0              0        1
## 1928  0              1        0        0              0        1
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## 1930  0              1        0        0              0        1
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## 1934  0              0        1        1              0        1
## 1935  0              0        1        1              0        1
## 1936  0              0        1        1              0        1
## 1937  0              0        1        1              0        1
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## 1940  0              0        1        1              0        1
## 1941  0              0        1        1              0        1
## 1942  0              0        1        1              0        1
## 1943  0              0        1        1              0        1
## 1944  0              0        1        1              0        1
## 1945  0              0        1        0              0        1
## 1946  0              0        1        0              0        1
```

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## 1948	0	0	1	0	0	1
## 1949	0	0	1	0	0	1
## 1950	0	0	1	0	0	1
## 1951	0	0	1	0	0	1
## 1952	0	0	1	0	0	1
## 1953	0	0	1	0	0	1
## 1954	0	0	1	0	0	1
## 1955	0	0	1	0	0	1
## 1956	0	0	1	0	0	1
## 1957	0	0	0	1	0	1
## 1958	0	0	0	1	0	1
## 1959	0	0	0	1	0	1
## 1960	0	0	0	1	0	1
## 1961	0	0	0	1	0	1
## 1962	0	0	0	1	0	1
## 1963	0	0	0	1	0	1
## 1964	0	0	0	1	0	1
## 1965	0	0	0	1	0	1
## 1966	0	0	0	1	0	1
## 1967	0	0	0	1	0	1
## 1968	0	0	0	1	0	1
## 1969	0	0	0	0	1	1
## 1970	0	0	0	0	1	1
## 1971	0	0	0	0	1	1
## 1972	0	0	0	0	1	1
## 1973	0	0	0	0	1	1
## 1974	0	0	0	0	1	1
## 1975	0	0	0	0	1	1
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## 1977	0	0	0	0	1	1
## 1978	0	0	0	0	1	1
## 1979	0	0	0	0	1	1
## 1980	0	0	0	0	1	1
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## 1982	1	1	1	1	0	1
## 1983	1	1	1	1	0	1
## 1984	1	1	1	1	0	1
## 1985	1	1	1	1	0	1
## 1986	1	1	1	1	0	1
## 1987	1	1	1	1	0	1
## 1988	1	1	1	1	0	1
## 1989	1	1	1	1	0	1
## 1990	1	1	1	1	0	1
## 1991	1	1	1	1	0	1
## 1992	1	1	1	1	0	1
## 1993	1	1	1	0	0	1
## 1994	1	1	1	0	0	1
## 1995	1	1	1	0	0	1
## 1996	1	1	1	0	0	1
## 1997	1	1	1	0	0	1
## 1998	1	1	1	0	0	1
## 1999	1	1	1	0	0	1
## 2000	1	1	1	0	0	1

```
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## 2033   0              1             1            1                     0           1
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## 2036   0              1             1            1                     0           1
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## 2054   0              1             0            0                     0           1
```

```
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## 2085    0              0          1         0                 0         1
## 2086    0              0          1         0                 0         1
## 2087    0              0          1         0                 0         1
## 2088    0              0          1         0                 0         1
## 2089    0              0          0         1                 0         1
## 2090    0              0          0         1                 0         1
## 2091    0              0          0         1                 0         1
## 2092    0              0          0         1                 0         1
## 2093    0              0          0         1                 0         1
## 2094    0              0          0         1                 0         1
## 2095    0              0          0         1                 0         1
## 2096    0              0          0         1                 0         1
## 2097    0              0          0         1                 0         1
## 2098    0              0          0         1                 0         1
## 2099    0              0          0         1                 0         1
## 2100    0              0          0         1                 0         1
## 2101    0              0          0         0                 1         1
## 2102    0              0          0         0                 1         1
## 2103    0              0          0         0                 1         1
## 2104    0              0          0         0                 1         1
## 2105    0              0          0         0                 1         1
## 2106    0              0          0         0                 1         1
## 2107    0              0          0         0                 1         1
## 2108    0              0          0         0                 1         1
```

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## 2153    1              0        0        0              0        1
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## 2155    1              0        0        0              0        1
## 2156    1              0        0        0              0        1
## 2157    1              0        0        0              0        1
## 2158    1              0        0        0              0        1
## 2159    1              0        0        0              0        1
## 2160    1              0        0        0              0        1
## 2161    0              1        1        1              0        1
## 2162    0              1        1        1              0        1
```

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## 2171    0                 1          1          1                    0          1
## 2172    0                 1          1          1                    0          1
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## 2178    0                 1          1          0                    0          1
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## 2212    0                 0          1          0                    0          1
## 2213    0                 0          1          0                    0          1
## 2214    0                 0          1          0                    0          1
## 2215    0                 0          1          0                    0          1
## 2216    0                 0          1          0                    0          1
```

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## 2225     0          0          0          1                0          1
## 2226     0          0          0          1                0          1
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## 2230     0          0          0          1                0          1
## 2231     0          0          0          1                0          1
## 2232     0          0          0          1                0          1
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## 2269     1          1          0          0                0          1
## 2270     1          1          0          0                0          1
```

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## 2282   1              0          0          0                    0          1
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## 2311   0              1          1          0                    0          1
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## 2318   0              1          0          0                    0          1
## 2319   0              1          0          0                    0          1
## 2320   0              1          0          0                    0          1
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## 2323   0              1          0          0                    0          1
## 2324   0              1          0          0                    0          1
```

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## 2357     0              0          0          1              0      1
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## 2359     0              0          0          1              0      1
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## 2362     0              0          0          1              0      1
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## 2378     1              1          1          1              0      1
```

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## 2418   1              0              0              0                     0              1
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## 2431   0              1              1              1                     0              1
## 2432   0              1              1              1                     0              1
```

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## 2486       0              0          0         1              0        1
```

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## 2540     1               1          0          0               0          1
```

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## 2701    0              1              1              0                   0              1
## 2702    0              1              1              0                   0              1
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## 2809   1            0            0            0            0            1
## 2810   1            0            0            0            0            1
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## 2819   1              0         0         0                   0         1
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## 2873    0            0            1    0            0    1
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## 2883    0            0            0    1            0    1
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## 2894    0            0            0    0            1    1
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## 2898    0            0            0    0            1    1
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## 2901    0            0            0    0            1    1
## 2902    0            0            0    0            1    1
## 2903    0            0            0    0            1    1
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## 2913    1            1            1    1            0    1
## 2914    1            1            1    1            0    1
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## 2918    1            1            1    0            0    1
```

123

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```

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## 3514     0              1              0         0              0         1
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## 3519     0              0              1         1              0         1
## 3520     0              0              1         1              0         1
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## 3522     0              0              1         1              0         1
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## 3554     0              0              0         0              1         1
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## 3556     0              0              0         0              1         1
## 3557     0              0              0         0              1         1
## 3558     0              0              0         0              1         1
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## 3560     0              0              0         0              1         1
## 3561     0              0              0         0              1         1
## 3562     0              0              0         0              1         1
## 3563     0              0              0         0              1         1
## 3564     0              0              0         0              1         1
## 3565     1              1              1         1              0         1
## 3566     1              1              1         1              0         1
```

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## 3576    1              1            1            1                  0          1
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## 3618    0              1            1            1                  0          1
## 3619    0              1            1            1                  0          1
## 3620    0              1            1            1                  0          1
```

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## 3622    0                1            1            1                      0          1
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## 3632    0                1            1            0                      0          1
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## 3653    0                0            1            1                      0          1
## 3654    0                0            1            1                      0          1
## 3655    0                0            1            1                      0          1
## 3656    0                0            1            1                      0          1
## 3657    0                0            1            1                      0          1
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## 3662    0                0            1            0                      0          1
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## 3665    0                0            1            0                      0          1
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## 3670    0                0            1            0                      0          1
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## 3672    0                0            1            0                      0          1
## 3673    0                0            0            1                      0          1
## 3674    0                0            0            1                      0          1
```

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## 3681     0           0           0           1               0           1
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## 3692     0           0           0           0               1           1
## 3693     0           0           0           0               1           1
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## 3696     0           0           0           0               1           1
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## 3701     1           1           1           1               0           1
## 3702     1           1           1           1               0           1
## 3703     1           1           1           1               0           1
##      Age_10.19 Age_20.24 Age_25.59 Age_60. Gender_Female Gender_Male
## 1            0         0         0       0             0           1
## 2            0         0         0       0             0           1
## 3            0         0         0       0             0           1
## 4            0         0         0       0             0           1
## 5            0         0         0       0             0           1
## 6            0         0         0       0             0           1
## 7            0         0         0       0             0           1
## 8            0         0         0       0             0           1
## 9            0         0         0       0             0           1
## 10           0         0         0       0             0           1
## 11           0         0         0       0             0           1
## 12           0         0         0       0             0           1
## 13           0         0         0       0             0           1
## 14           0         0         0       0             0           1
## 15           0         0         0       0             0           1
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## 17           0         0         0       0             0           1
## 18           0         0         0       0             0           1
## 19           0         0         0       0             0           1
## 20           0         0         0       0             0           1
## 21           0         0         0       0             0           1
## 22           0         0         0       0             0           1
## 23           0         0         0       0             0           1
## 24           0         0         0       0             0           1
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## 53          0          0          0          0          0          1
## 54          0          0          0          0          0          1
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## 60          0          0          0          0          0          1
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## 62          0          0          0          0          0          1
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## 64          0          0          0          0          0          1
## 65          0          0          0          0          0          1
## 66          0          0          0          0          0          1
## 67          0          0          0          0          0          1
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## 69          0          0          0          0          0          1
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## 71          0          0          0          0          0          1
## 72          0          0          0          0          0          1
## 73          0          0          0          0          0          1
## 74          0          0          0          0          0          1
## 75          0          0          0          0          0          1
## 76          0          0          0          0          0          1
## 77          0          0          0          0          0          1
## 78          0          0          0          0          0          1
```

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## 79              0          0          0          0              0          1
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## 81              0          0          0          0              0          1
## 82              0          0          0          0              0          1
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## 85              0          0          0          0              0          1
## 86              0          0          0          0              0          1
## 87              0          0          0          0              0          1
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## 90              0          0          0          0              0          1
## 91              0          0          0          0              0          1
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## 95              0          0          0          0              0          1
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## 402          0          0          0          0          0          1
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## 672          0          0          0          0          0          1
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## 1319        0        0        0        0        0        1
## 1320        0        0        0        0        0        1
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## 1373         0         0         0         0         0         1
## 1374         0         0         0         0         0         1
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## 1428       0         0         0         0         0         1
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## 1481          0          0          0          0          0          1
## 1482          0          0          0          0          0          1
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## 1536        0        0        0        0        0        1
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## 1750          0          0          0          0          0          1
## 1751          0          0          0          0          0          1
## 1752          0          0          0          0          0          1
```

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## 1753          0          0          0          0          0          1
## 1754          0          0          0          0          0          1
## 1755          0          0          0          0          0          1
## 1756          0          0          0          0          0          1
## 1757          0          0          0          0          0          1
## 1758          0          0          0          0          0          1
## 1759          0          0          0          0          0          1
## 1760          0          0          0          0          0          1
## 1761          0          0          0          0          0          1
## 1762          0          0          0          0          0          1
## 1763          0          0          0          0          0          1
## 1764          0          0          0          0          0          1
## 1765          0          0          0          0          0          1
## 1766          0          0          0          0          0          1
## 1767          0          0          0          0          0          1
## 1768          0          0          0          0          0          1
## 1769          0          0          0          0          0          1
## 1770          0          0          0          0          0          1
## 1771          0          0          0          0          0          1
## 1772          0          0          0          0          0          1
## 1773          0          0          0          0          0          1
## 1774          0          0          0          0          0          1
## 1775          0          0          0          0          0          1
## 1776          0          0          0          0          0          1
## 1777          0          0          0          0          0          1
## 1778          0          0          0          0          0          1
## 1779          0          0          0          0          0          1
## 1780          0          0          0          0          0          1
## 1781          0          0          0          0          0          1
## 1782          0          0          0          0          0          1
## 1783          0          0          0          0          0          1
## 1784          0          0          0          0          0          1
## 1785          0          0          0          0          0          1
## 1786          0          0          0          0          0          1
## 1787          0          0          0          0          0          1
## 1788          0          0          0          0          0          1
## 1789          0          0          0          0          0          1
## 1790          0          0          0          0          0          1
## 1791          0          0          0          0          0          1
## 1792          0          0          0          0          0          1
## 1793          0          0          0          0          0          1
## 1794          0          0          0          0          0          1
## 1795          0          0          0          0          0          1
## 1796          0          0          0          0          0          1
## 1797          0          0          0          0          0          1
## 1798          0          0          0          0          0          1
## 1799          0          0          0          0          0          1
## 1800          0          0          0          0          0          1
## 1801          0          0          0          0          0          1
## 1802          0          0          0          0          0          1
## 1803          0          0          0          0          0          1
## 1804          0          0          0          0          0          1
## 1805          0          0          0          0          0          1
## 1806          0          0          0          0          0          1
```

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## 1807           0           0           0           0           0           1
## 1808           0           0           0           0           0           1
## 1809           0           0           0           0           0           1
## 1810           0           0           0           0           0           1
## 1811           0           0           0           0           0           1
## 1812           0           0           0           0           0           1
## 1813           0           0           0           0           0           1
## 1814           0           0           0           0           0           1
## 1815           0           0           0           0           0           1
## 1816           0           0           0           0           0           1
## 1817           0           0           0           0           0           1
## 1818           0           0           0           0           0           1
## 1819           0           0           0           0           0           1
## 1820           0           0           0           0           0           1
## 1821           0           0           0           0           0           1
## 1822           0           0           0           0           0           1
## 1823           0           0           0           0           0           1
## 1824           0           0           0           0           0           1
## 1825           0           0           0           0           0           1
## 1826           0           0           0           0           0           1
## 1827           0           0           0           0           0           1
## 1828           0           0           0           0           0           1
## 1829           0           0           0           0           0           1
## 1830           0           0           0           0           0           1
## 1831           0           0           0           0           0           1
## 1832           0           0           0           0           0           1
## 1833           0           0           0           0           0           1
## 1834           0           0           0           0           0           1
## 1835           0           0           0           0           0           1
## 1836           0           0           0           0           0           1
## 1837           0           0           0           0           0           1
## 1838           0           0           0           0           0           1
## 1839           0           0           0           0           0           1
## 1840           0           0           0           0           0           1
## 1841           0           0           0           0           0           1
## 1842           0           0           0           0           0           1
## 1843           0           0           0           0           0           1
## 1844           0           0           0           0           0           1
## 1845           0           0           0           0           0           1
## 1846           0           0           0           0           0           1
## 1847           0           0           0           0           0           1
## 1848           0           0           0           0           0           1
## 1849           0           0           0           0           0           1
## 1850           0           0           0           0           0           1
## 1851           0           0           0           0           0           1
## 1852           0           0           0           0           0           1
## 1853           0           0           0           0           0           1
## 1854           0           0           0           0           0           1
## 1855           0           0           0           0           0           1
## 1856           0           0           0           0           0           1
## 1857           0           0           0           0           0           1
## 1858           0           0           0           0           0           1
## 1859           0           0           0           0           0           1
## 1860           0           0           0           0           0           1
```

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## 1861            0            0            0            0            0            1
## 1862            0            0            0            0            0            1
## 1863            0            0            0            0            0            1
## 1864            0            0            0            0            0            1
## 1865            0            0            0            0            0            1
## 1866            0            0            0            0            0            1
## 1867            0            0            0            0            0            1
## 1868            0            0            0            0            0            1
## 1869            0            0            0            0            0            1
## 1870            0            0            0            0            0            1
## 1871            0            0            0            0            0            1
## 1872            0            0            0            0            0            1
## 1873            0            0            0            0            0            1
## 1874            0            0            0            0            0            1
## 1875            0            0            0            0            0            1
## 1876            0            0            0            0            0            1
## 1877            0            0            0            0            0            1
## 1878            0            0            0            0            0            1
## 1879            0            0            0            0            0            1
## 1880            0            0            0            0            0            1
## 1881            0            0            0            0            0            1
## 1882            0            0            0            0            0            1
## 1883            0            0            0            0            0            1
## 1884            0            0            0            0            0            1
## 1885            0            0            0            0            0            1
## 1886            0            0            0            0            0            1
## 1887            0            0            0            0            0            1
## 1888            0            0            0            0            0            1
## 1889            0            0            0            0            0            1
## 1890            0            0            0            0            0            1
## 1891            0            0            0            0            0            1
## 1892            0            0            0            0            0            1
## 1893            0            0            0            0            0            1
## 1894            0            0            0            0            0            1
## 1895            0            0            0            0            0            1
## 1896            0            0            0            0            0            1
## 1897            0            0            0            0            0            1
## 1898            0            0            0            0            0            1
## 1899            0            0            0            0            0            1
## 1900            0            0            0            0            0            1
## 1901            0            0            0            0            0            1
## 1902            0            0            0            0            0            1
## 1903            0            0            0            0            0            1
## 1904            0            0            0            0            0            1
## 1905            0            0            0            0            0            1
## 1906            0            0            0            0            0            1
## 1907            0            0            0            0            0            1
## 1908            0            0            0            0            0            1
## 1909            0            0            0            0            0            1
## 1910            0            0            0            0            0            1
## 1911            0            0            0            0            0            1
## 1912            0            0            0            0            0            1
## 1913            0            0            0            0            0            1
## 1914            0            0            0            0            0            1
```

```
## 1915        0        0        0        0        0        1
## 1916        0        0        0        0        0        1
## 1917        0        0        0        0        0        1
## 1918        0        0        0        0        0        1
## 1919        0        0        0        0        0        1
## 1920        0        0        0        0        0        1
## 1921        0        0        0        0        0        1
## 1922        0        0        0        0        0        1
## 1923        0        0        0        0        0        1
## 1924        0        0        0        0        0        1
## 1925        0        0        0        0        0        1
## 1926        0        0        0        0        0        1
## 1927        0        0        0        0        0        1
## 1928        0        0        0        0        0        1
## 1929        0        0        0        0        0        1
## 1930        0        0        0        0        0        1
## 1931        0        0        0        0        0        1
## 1932        0        0        0        0        0        1
## 1933        0        0        0        0        0        1
## 1934        0        0        0        0        0        1
## 1935        0        0        0        0        0        1
## 1936        0        0        0        0        0        1
## 1937        0        0        0        0        0        1
## 1938        0        0        0        0        0        1
## 1939        0        0        0        0        0        1
## 1940        0        0        0        0        0        1
## 1941        0        0        0        0        0        1
## 1942        0        0        0        0        0        1
## 1943        0        0        0        0        0        1
## 1944        0        0        0        0        0        1
## 1945        0        0        0        0        0        1
## 1946        0        0        0        0        0        1
## 1947        0        0        0        0        0        1
## 1948        0        0        0        0        0        1
## 1949        0        0        0        0        0        1
## 1950        0        0        0        0        0        1
## 1951        0        0        0        0        0        1
## 1952        0        0        0        0        0        1
## 1953        0        0        0        0        0        1
## 1954        0        0        0        0        0        1
## 1955        0        0        0        0        0        1
## 1956        0        0        0        0        0        1
## 1957        0        0        0        0        0        1
## 1958        0        0        0        0        0        1
## 1959        0        0        0        0        0        1
## 1960        0        0        0        0        0        1
## 1961        0        0        0        0        0        1
## 1962        0        0        0        0        0        1
## 1963        0        0        0        0        0        1
## 1964        0        0        0        0        0        1
## 1965        0        0        0        0        0        1
## 1966        0        0        0        0        0        1
## 1967        0        0        0        0        0        1
## 1968        0        0        0        0        0        1
```

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## 1969        0        0        0        0        0        1
## 1970        0        0        0        0        0        1
## 1971        0        0        0        0        0        1
## 1972        0        0        0        0        0        1
## 1973        0        0        0        0        0        1
## 1974        0        0        0        0        0        1
## 1975        0        0        0        0        0        1
## 1976        0        0        0        0        0        1
## 1977        0        0        0        0        0        1
## 1978        0        0        0        0        0        1
## 1979        0        0        0        0        0        1
## 1980        0        0        0        0        0        1
## 1981        0        0        0        0        0        1
## 1982        0        0        0        0        0        1
## 1983        0        0        0        0        0        1
## 1984        0        0        0        0        0        1
## 1985        0        0        0        0        0        1
## 1986        0        0        0        0        0        1
## 1987        0        0        0        0        0        1
## 1988        0        0        0        0        0        1
## 1989        0        0        0        0        0        1
## 1990        0        0        0        0        0        1
## 1991        0        0        0        0        0        1
## 1992        0        0        0        0        0        1
## 1993        0        0        0        0        0        1
## 1994        0        0        0        0        0        1
## 1995        0        0        0        0        0        1
## 1996        0        0        0        0        0        1
## 1997        0        0        0        0        0        1
## 1998        0        0        0        0        0        1
## 1999        0        0        0        0        0        1
## 2000        0        0        0        0        0        1
## 2001        0        0        0        0        0        1
## 2002        0        0        0        0        0        1
## 2003        0        0        0        0        0        1
## 2004        0        0        0        0        0        1
## 2005        0        0        0        0        0        1
## 2006        0        0        0        0        0        1
## 2007        0        0        0        0        0        1
## 2008        0        0        0        0        0        1
## 2009        0        0        0        0        0        1
## 2010        0        0        0        0        0        1
## 2011        0        0        0        0        0        1
## 2012        0        0        0        0        0        1
## 2013        0        0        0        0        0        1
## 2014        0        0        0        0        0        1
## 2015        0        0        0        0        0        1
## 2016        0        0        0        0        0        1
## 2017        0        0        0        0        0        1
## 2018        0        0        0        0        0        1
## 2019        0        0        0        0        0        1
## 2020        0        0        0        0        0        1
## 2021        0        0        0        0        0        1
## 2022        0        0        0        0        0        1
```

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## 2023          0          0          0          0          0          1
## 2024          0          0          0          0          0          1
## 2025          0          0          0          0          0          1
## 2026          0          0          0          0          0          1
## 2027          0          0          0          0          0          1
## 2028          0          0          0          0          0          1
## 2029          0          0          0          0          0          1
## 2030          0          0          0          0          0          1
## 2031          0          0          0          0          0          1
## 2032          0          0          0          0          0          1
## 2033          0          0          0          0          0          1
## 2034          0          0          0          0          0          1
## 2035          0          0          0          0          0          1
## 2036          0          0          0          0          0          1
## 2037          0          0          0          0          0          1
## 2038          0          0          0          0          0          1
## 2039          0          0          0          0          0          1
## 2040          0          0          0          0          0          1
## 2041          0          0          0          0          0          1
## 2042          0          0          0          0          0          1
## 2043          0          0          0          0          0          1
## 2044          0          0          0          0          0          1
## 2045          0          0          0          0          0          1
## 2046          0          0          0          0          0          1
## 2047          0          0          0          0          0          1
## 2048          0          0          0          0          0          1
## 2049          0          0          0          0          0          1
## 2050          0          0          0          0          0          1
## 2051          0          0          0          0          0          1
## 2052          0          0          0          0          0          1
## 2053          0          0          0          0          0          1
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## 2056          0          0          0          0          0          1
## 2057          0          0          0          0          0          1
## 2058          0          0          0          0          0          1
## 2059          0          0          0          0          0          1
## 2060          0          0          0          0          0          1
## 2061          0          0          0          0          0          1
## 2062          0          0          0          0          0          1
## 2063          0          0          0          0          0          1
## 2064          0          0          0          0          0          1
## 2065          0          0          0          0          0          1
## 2066          0          0          0          0          0          1
## 2067          0          0          0          0          0          1
## 2068          0          0          0          0          0          1
## 2069          0          0          0          0          0          1
## 2070          0          0          0          0          0          1
## 2071          0          0          0          0          0          1
## 2072          0          0          0          0          0          1
## 2073          0          0          0          0          0          1
## 2074          0          0          0          0          0          1
## 2075          0          0          0          0          0          1
## 2076          0          0          0          0          0          1
```

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## 2077            0            0            0            0            0            1
## 2078            0            0            0            0            0            1
## 2079            0            0            0            0            0            1
## 2080            0            0            0            0            0            1
## 2081            0            0            0            0            0            1
## 2082            0            0            0            0            0            1
## 2083            0            0            0            0            0            1
## 2084            0            0            0            0            0            1
## 2085            0            0            0            0            0            1
## 2086            0            0            0            0            0            1
## 2087            0            0            0            0            0            1
## 2088            0            0            0            0            0            1
## 2089            0            0            0            0            0            1
## 2090            0            0            0            0            0            1
## 2091            0            0            0            0            0            1
## 2092            0            0            0            0            0            1
## 2093            0            0            0            0            0            1
## 2094            0            0            0            0            0            1
## 2095            0            0            0            0            0            1
## 2096            0            0            0            0            0            1
## 2097            0            0            0            0            0            1
## 2098            0            0            0            0            0            1
## 2099            0            0            0            0            0            1
## 2100            0            0            0            0            0            1
## 2101            0            0            0            0            0            1
## 2102            0            0            0            0            0            1
## 2103            0            0            0            0            0            1
## 2104            0            0            0            0            0            1
## 2105            0            0            0            0            0            1
## 2106            0            0            0            0            0            1
## 2107            0            0            0            0            0            1
## 2108            0            0            0            0            0            1
## 2109            0            0            0            0            0            1
## 2110            0            0            0            0            0            1
## 2111            0            0            0            0            0            1
## 2112            0            0            0            0            0            1
## 2113            0            0            0            0            1            0
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## 2115            0            0            0            0            1            0
## 2116            0            0            0            0            1            0
## 2117            0            0            0            0            1            0
## 2118            0            0            0            0            1            0
## 2119            0            0            0            0            1            0
## 2120            0            0            0            0            1            0
## 2121            0            0            0            0            1            0
## 2122            0            0            0            0            1            0
## 2123            0            0            0            0            1            0
## 2124            0            0            0            0            1            0
## 2125            0            0            0            0            1            0
## 2126            0            0            0            0            1            0
## 2127            0            0            0            0            1            0
## 2128            0            0            0            0            1            0
## 2129            0            0            0            0            1            0
## 2130            0            0            0            0            1            0
```

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## 2131        0        0        0        0        1        0
## 2132        0        0        0        0        1        0
## 2133        0        0        0        0        1        0
## 2134        0        0        0        0        1        0
## 2135        0        0        0        0        1        0
## 2136        0        0        0        0        1        0
## 2137        0        0        0        0        1        0
## 2138        0        0        0        0        1        0
## 2139        0        0        0        0        1        0
## 2140        0        0        0        0        1        0
## 2141        0        0        0        0        1        0
## 2142        0        0        0        0        1        0
## 2143        0        0        0        0        1        0
## 2144        0        0        0        0        1        0
## 2145        0        0        0        0        1        0
## 2146        0        0        0        0        1        0
## 2147        0        0        0        0        1        0
## 2148        0        0        0        0        1        0
## 2149        0        0        0        0        1        0
## 2150        0        0        0        0        1        0
## 2151        0        0        0        0        1        0
## 2152        0        0        0        0        1        0
## 2153        0        0        0        0        1        0
## 2154        0        0        0        0        1        0
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## 2156        0        0        0        0        1        0
## 2157        0        0        0        0        1        0
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## 2159        0        0        0        0        1        0
## 2160        0        0        0        0        1        0
## 2161        0        0        0        0        1        0
## 2162        0        0        0        0        1        0
## 2163        0        0        0        0        1        0
## 2164        0        0        0        0        1        0
## 2165        0        0        0        0        1        0
## 2166        0        0        0        0        1        0
## 2167        0        0        0        0        1        0
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## 2169        0        0        0        0        1        0
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## 2172        0        0        0        0        1        0
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## 2176        0        0        0        0        1        0
## 2177        0        0        0        0        1        0
## 2178        0        0        0        0        1        0
## 2179        0        0        0        0        1        0
## 2180        0        0        0        0        1        0
## 2181        0        0        0        0        1        0
## 2182        0        0        0        0        1        0
## 2183        0        0        0        0        1        0
## 2184        0        0        0        0        1        0
```

```
## 2185        0        0        0        0        1        0
## 2186        0        0        0        0        1        0
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## 2188        0        0        0        0        1        0
## 2189        0        0        0        0        1        0
## 2190        0        0        0        0        1        0
## 2191        0        0        0        0        1        0
## 2192        0        0        0        0        1        0
## 2193        0        0        0        0        1        0
## 2194        0        0        0        0        1        0
## 2195        0        0        0        0        1        0
## 2196        0        0        0        0        1        0
## 2197        0        0        0        0        1        0
## 2198        0        0        0        0        1        0
## 2199        0        0        0        0        1        0
## 2200        0        0        0        0        1        0
## 2201        0        0        0        0        1        0
## 2202        0        0        0        0        1        0
## 2203        0        0        0        0        1        0
## 2204        0        0        0        0        1        0
## 2205        0        0        0        0        1        0
## 2206        0        0        0        0        1        0
## 2207        0        0        0        0        1        0
## 2208        0        0        0        0        1        0
## 2209        0        0        0        0        1        0
## 2210        0        0        0        0        1        0
## 2211        0        0        0        0        1        0
## 2212        0        0        0        0        1        0
## 2213        0        0        0        0        1        0
## 2214        0        0        0        0        1        0
## 2215        0        0        0        0        1        0
## 2216        0        0        0        0        1        0
## 2217        0        0        0        0        1        0
## 2218        0        0        0        0        1        0
## 2219        0        0        0        0        1        0
## 2220        0        0        0        0        1        0
## 2221        0        0        0        0        1        0
## 2222        0        0        0        0        1        0
## 2223        0        0        0        0        1        0
## 2224        0        0        0        0        1        0
## 2225        0        0        0        0        1        0
## 2226        0        0        0        0        1        0
## 2227        0        0        0        0        1        0
## 2228        0        0        0        0        1        0
## 2229        0        0        0        0        1        0
## 2230        0        0        0        0        1        0
## 2231        0        0        0        0        1        0
## 2232        0        0        0        0        1        0
## 2233        0        0        0        0        1        0
## 2234        0        0        0        0        1        0
## 2235        0        0        0        0        1        0
## 2236        0        0        0        0        1        0
## 2237        0        0        0        0        1        0
## 2238        0        0        0        0        1        0
```

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## 2239          0          0          0          0          1          0
## 2240          0          0          0          0          1          0
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## 2242          0          0          0          0          1          0
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## 2244          0          0          0          0          1          0
## 2245          0          0          0          0          1          0
## 2246          0          0          0          0          1          0
## 2247          0          0          0          0          1          0
## 2248          0          0          0          0          1          0
## 2249          0          0          0          0          1          0
## 2250          0          0          0          0          1          0
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## 2252          0          0          0          0          1          0
## 2253          0          0          0          0          1          0
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## 2258          0          0          0          0          1          0
## 2259          0          0          0          0          1          0
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## 2278          0          0          0          0          1          0
## 2279          0          0          0          0          1          0
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## 2282          0          0          0          0          1          0
## 2283          0          0          0          0          1          0
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## 2286          0          0          0          0          1          0
## 2287          0          0          0          0          1          0
## 2288          0          0          0          0          1          0
## 2289          0          0          0          0          1          0
## 2290          0          0          0          0          1          0
## 2291          0          0          0          0          1          0
## 2292          0          0          0          0          1          0
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## 2301          0          0          0          0          1          0
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## 2340          0          0          0          0          1          0
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## 2344          0          0          0          0          1          0
## 2345          0          0          0          0          1          0
## 2346          0          0          0          0          1          0
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## 2351            0           0           0           0           1           0
## 2352            0           0           0           0           1           0
## 2353            0           0           0           0           1           0
## 2354            0           0           0           0           1           0
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## 2362            0           0           0           0           1           0
## 2363            0           0           0           0           1           0
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## 2367            0           0           0           0           1           0
## 2368            0           0           0           0           1           0
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## 2370            0           0           0           0           1           0
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## 2372            0           0           0           0           1           0
## 2373            0           0           0           0           1           0
## 2374            0           0           0           0           1           0
## 2375            0           0           0           0           1           0
## 2376            0           0           0           0           1           0
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## 2378            0           0           0           0           1           0
## 2379            0           0           0           0           1           0
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## 2381            0           0           0           0           1           0
## 2382            0           0           0           0           1           0
## 2383            0           0           0           0           1           0
## 2384            0           0           0           0           1           0
## 2385            0           0           0           0           1           0
## 2386            0           0           0           0           1           0
## 2387            0           0           0           0           1           0
## 2388            0           0           0           0           1           0
## 2389            0           0           0           0           1           0
## 2390            0           0           0           0           1           0
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## 2392            0           0           0           0           1           0
## 2393            0           0           0           0           1           0
## 2394            0           0           0           0           1           0
## 2395            0           0           0           0           1           0
## 2396            0           0           0           0           1           0
## 2397            0           0           0           0           1           0
## 2398            0           0           0           0           1           0
## 2399            0           0           0           0           1           0
## 2400            0           0           0           0           1           0
```

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## 2408          0          0          0          0          1          0
## 2409          0          0          0          0          1          0
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## 2412          0          0          0          0          1          0
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## 2414          0          0          0          0          1          0
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## 2416          0          0          0          0          1          0
## 2417          0          0          0          0          1          0
## 2418          0          0          0          0          1          0
## 2419          0          0          0          0          1          0
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## 2422          0          0          0          0          1          0
## 2423          0          0          0          0          1          0
## 2424          0          0          0          0          1          0
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## 2427          0          0          0          0          1          0
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## 2429          0          0          0          0          1          0
## 2430          0          0          0          0          1          0
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## 2432          0          0          0          0          1          0
## 2433          0          0          0          0          1          0
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## 2436          0          0          0          0          1          0
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## 2438          0          0          0          0          1          0
## 2439          0          0          0          0          1          0
## 2440          0          0          0          0          1          0
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## 2442          0          0          0          0          1          0
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## 2452          0          0          0          0          1          0
## 2453          0          0          0          0          1          0
## 2454          0          0          0          0          1          0
```

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## 2458        0          0          0          0          1          0
## 2459        0          0          0          0          1          0
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## 2462        0          0          0          0          1          0
## 2463        0          0          0          0          1          0
## 2464        0          0          0          0          1          0
## 2465        0          0          0          0          1          0
## 2466        0          0          0          0          1          0
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## 2468        0          0          0          0          1          0
## 2469        0          0          0          0          1          0
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## 2472        0          0          0          0          1          0
## 2473        0          0          0          0          1          0
## 2474        0          0          0          0          1          0
## 2475        0          0          0          0          1          0
## 2476        0          0          0          0          1          0
## 2477        0          0          0          0          1          0
## 2478        0          0          0          0          1          0
## 2479        0          0          0          0          1          0
## 2480        0          0          0          0          1          0
## 2481        0          0          0          0          1          0
## 2482        0          0          0          0          1          0
## 2483        0          0          0          0          1          0
## 2484        0          0          0          0          1          0
## 2485        0          0          0          0          1          0
## 2486        0          0          0          0          1          0
## 2487        0          0          0          0          1          0
## 2488        0          0          0          0          1          0
## 2489        0          0          0          0          1          0
## 2490        0          0          0          0          1          0
## 2491        0          0          0          0          1          0
## 2492        0          0          0          0          1          0
## 2493        0          0          0          0          1          0
## 2494        0          0          0          0          1          0
## 2495        0          0          0          0          1          0
## 2496        0          0          0          0          1          0
## 2497        0          0          0          0          1          0
## 2498        0          0          0          0          1          0
## 2499        0          0          0          0          1          0
## 2500        0          0          0          0          1          0
## 2501        0          0          0          0          1          0
## 2502        0          0          0          0          1          0
## 2503        0          0          0          0          1          0
## 2504        0          0          0          0          1          0
## 2505        0          0          0          0          1          0
## 2506        0          0          0          0          1          0
## 2507        0          0          0          0          1          0
## 2508        0          0          0          0          1          0
```

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## 2511        0        0        0        0        1        0
## 2512        0        0        0        0        1        0
## 2513        0        0        0        0        1        0
## 2514        0        0        0        0        1        0
## 2515        0        0        0        0        1        0
## 2516        0        0        0        0        1        0
## 2517        0        0        0        0        1        0
## 2518        0        0        0        0        1        0
## 2519        0        0        0        0        1        0
## 2520        0        0        0        0        1        0
## 2521        0        0        0        0        1        0
## 2522        0        0        0        0        1        0
## 2523        0        0        0        0        1        0
## 2524        0        0        0        0        1        0
## 2525        0        0        0        0        1        0
## 2526        0        0        0        0        1        0
## 2527        0        0        0        0        1        0
## 2528        0        0        0        0        1        0
## 2529        0        0        0        0        1        0
## 2530        0        0        0        0        1        0
## 2531        0        0        0        0        1        0
## 2532        0        0        0        0        1        0
## 2533        0        0        0        0        1        0
## 2534        0        0        0        0        1        0
## 2535        0        0        0        0        1        0
## 2536        0        0        0        0        1        0
## 2537        0        0        0        0        1        0
## 2538        0        0        0        0        1        0
## 2539        0        0        0        0        1        0
## 2540        0        0        0        0        1        0
## 2541        0        0        0        0        1        0
## 2542        0        0        0        0        1        0
## 2543        0        0        0        0        1        0
## 2544        0        0        0        0        1        0
## 2545        0        0        0        0        1        0
## 2546        0        0        0        0        1        0
## 2547        0        0        0        0        1        0
## 2548        0        0        0        0        1        0
## 2549        0        0        0        0        1        0
## 2550        0        0        0        0        1        0
## 2551        0        0        0        0        1        0
## 2552        0        0        0        0        1        0
## 2553        0        0        0        0        1        0
## 2554        0        0        0        0        1        0
## 2555        0        0        0        0        1        0
## 2556        0        0        0        0        1        0
## 2557        0        0        0        0        1        0
## 2558        0        0        0        0        1        0
## 2559        0        0        0        0        1        0
## 2560        0        0        0        0        1        0
## 2561        0        0        0        0        1        0
## 2562        0        0        0        0        1        0
```

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## 2563          0          0          0          0          1          0
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## 2589          0          0          0          0          1          0
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## 2591          0          0          0          0          1          0
## 2592          0          0          0          0          1          0
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## 2600          0          0          0          0          1          0
## 2601          0          0          0          0          1          0
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## 2611          0          0          0          0          1          0
## 2612          0          0          0          0          1          0
## 2613          0          0          0          0          1          0
## 2614          0          0          0          0          1          0
## 2615          0          0          0          0          1          0
## 2616          0          0          0          0          1          0
```

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## 2663          0          0          0          0          1          0
## 2664          0          0          0          0          1          0
## 2665          0          0          0          0          1          0
## 2666          0          0          0          0          1          0
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## 2668          0          0          0          0          1          0
## 2669          0          0          0          0          1          0
## 2670          0          0          0          0          1          0
```

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## 2682          0          0          0          0          1          0
## 2683          0          0          0          0          1          0
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## 2695          0          0          0          0          1          0
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## 2708          0          0          0          0          1          0
## 2709          0          0          0          0          1          0
## 2710          0          0          0          0          1          0
## 2711          0          0          0          0          1          0
## 2712          0          0          0          0          1          0
## 2713          0          0          0          0          1          0
## 2714          0          0          0          0          1          0
## 2715          0          0          0          0          1          0
## 2716          0          0          0          0          1          0
## 2717          0          0          0          0          1          0
## 2718          0          0          0          0          1          0
## 2719          0          0          0          0          1          0
## 2720          0          0          0          0          1          0
## 2721          0          0          0          0          1          0
## 2722          0          0          0          0          1          0
## 2723          0          0          0          0          1          0
## 2724          0          0          0          0          1          0
```

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## 2725        0        0        0        0        1        0
## 2726        0        0        0        0        1        0
## 2727        0        0        0        0        1        0
## 2728        0        0        0        0        1        0
## 2729        0        0        0        0        1        0
## 2730        0        0        0        0        1        0
## 2731        0        0        0        0        1        0
## 2732        0        0        0        0        1        0
## 2733        0        0        0        0        1        0
## 2734        0        0        0        0        1        0
## 2735        0        0        0        0        1        0
## 2736        0        0        0        0        1        0
## 2737        0        0        0        0        1        0
## 2738        0        0        0        0        1        0
## 2739        0        0        0        0        1        0
## 2740        0        0        0        0        1        0
## 2741        0        0        0        0        1        0
## 2742        0        0        0        0        1        0
## 2743        0        0        0        0        1        0
## 2744        0        0        0        0        1        0
## 2745        0        0        0        0        1        0
## 2746        0        0        0        0        1        0
## 2747        0        0        0        0        1        0
## 2748        0        0        0        0        1        0
## 2749        0        0        0        0        1        0
## 2750        0        0        0        0        1        0
## 2751        0        0        0        0        1        0
## 2752        0        0        0        0        1        0
## 2753        0        0        0        0        1        0
## 2754        0        0        0        0        1        0
## 2755        0        0        0        0        1        0
## 2756        0        0        0        0        1        0
## 2757        0        0        0        0        1        0
## 2758        0        0        0        0        1        0
## 2759        0        0        0        0        1        0
## 2760        0        0        0        0        1        0
## 2761        0        0        0        0        1        0
## 2762        0        0        0        0        1        0
## 2763        0        0        0        0        1        0
## 2764        0        0        0        0        1        0
## 2765        0        0        0        0        1        0
## 2766        0        0        0        0        1        0
## 2767        0        0        0        0        1        0
## 2768        0        0        0        0        1        0
## 2769        0        0        0        0        1        0
## 2770        0        0        0        0        1        0
## 2771        0        0        0        0        1        0
## 2772        0        0        0        0        1        0
## 2773        0        0        0        0        1        0
## 2774        0        0        0        0        1        0
## 2775        0        0        0        0        1        0
## 2776        0        0        0        0        1        0
## 2777        0        0        0        0        1        0
## 2778        0        0        0        0        1        0
```

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## 2779          0          0          0          0          1          0
## 2780          0          0          0          0          1          0
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## 2782          0          0          0          0          1          0
## 2783          0          0          0          0          1          0
## 2784          0          0          0          0          1          0
## 2785          0          0          0          0          1          0
## 2786          0          0          0          0          1          0
## 2787          0          0          0          0          1          0
## 2788          0          0          0          0          1          0
## 2789          0          0          0          0          1          0
## 2790          0          0          0          0          1          0
## 2791          0          0          0          0          1          0
## 2792          0          0          0          0          1          0
## 2793          0          0          0          0          1          0
## 2794          0          0          0          0          1          0
## 2795          0          0          0          0          1          0
## 2796          0          0          0          0          1          0
## 2797          0          0          0          0          1          0
## 2798          0          0          0          0          1          0
## 2799          0          0          0          0          1          0
## 2800          0          0          0          0          1          0
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## 2802          0          0          0          0          1          0
## 2803          0          0          0          0          1          0
## 2804          0          0          0          0          1          0
## 2805          0          0          0          0          1          0
## 2806          0          0          0          0          1          0
## 2807          0          0          0          0          1          0
## 2808          0          0          0          0          1          0
## 2809          0          0          0          0          1          0
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## 2812          0          0          0          0          1          0
## 2813          0          0          0          0          1          0
## 2814          0          0          0          0          1          0
## 2815          0          0          0          0          1          0
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## 2817          0          0          0          0          1          0
## 2818          0          0          0          0          1          0
## 2819          0          0          0          0          1          0
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## 2821          0          0          0          0          1          0
## 2822          0          0          0          0          1          0
## 2823          0          0          0          0          1          0
## 2824          0          0          0          0          1          0
## 2825          0          0          0          0          1          0
## 2826          0          0          0          0          1          0
## 2827          0          0          0          0          1          0
## 2828          0          0          0          0          1          0
## 2829          0          0          0          0          1          0
## 2830          0          0          0          0          1          0
## 2831          0          0          0          0          1          0
## 2832          0          0          0          0          1          0
```

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## 2839          0          0          0          0          1          0
## 2840          0          0          0          0          1          0
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## 2842          0          0          0          0          1          0
## 2843          0          0          0          0          1          0
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## 2846          0          0          0          0          1          0
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## 2849          0          0          0          0          1          0
## 2850          0          0          0          0          1          0
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## 2852          0          0          0          0          1          0
## 2853          0          0          0          0          1          0
## 2854          0          0          0          0          1          0
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## 2856          0          0          0          0          1          0
## 2857          0          0          0          0          1          0
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## 2859          0          0          0          0          1          0
## 2860          0          0          0          0          1          0
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## 2867          0          0          0          0          1          0
## 2868          0          0          0          0          1          0
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## 2874          0          0          0          0          1          0
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## 2881          0          0          0          0          1          0
## 2882          0          0          0          0          1          0
## 2883          0          0          0          0          1          0
## 2884          0          0          0          0          1          0
## 2885          0          0          0          0          1          0
## 2886          0          0          0          0          1          0
```

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## 2887           0           0           0           0           1           0
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## 2892           0           0           0           0           1           0
## 2893           0           0           0           0           1           0
## 2894           0           0           0           0           1           0
## 2895           0           0           0           0           1           0
## 2896           0           0           0           0           1           0
## 2897           0           0           0           0           1           0
## 2898           0           0           0           0           1           0
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## 2900           0           0           0           0           1           0
## 2901           0           0           0           0           1           0
## 2902           0           0           0           0           1           0
## 2903           0           0           0           0           1           0
## 2904           0           0           0           0           1           0
## 2905           0           0           0           0           1           0
## 2906           0           0           0           0           1           0
## 2907           0           0           0           0           1           0
## 2908           0           0           0           0           1           0
## 2909           0           0           0           0           1           0
## 2910           0           0           0           0           1           0
## 2911           0           0           0           0           1           0
## 2912           0           0           0           0           1           0
## 2913           0           0           0           0           1           0
## 2914           0           0           0           0           1           0
## 2915           0           0           0           0           1           0
## 2916           0           0           0           0           1           0
## 2917           0           0           0           0           1           0
## 2918           0           0           0           0           1           0
## 2919           0           0           0           0           1           0
## 2920           0           0           0           0           1           0
## 2921           0           0           0           0           1           0
## 2922           0           0           0           0           1           0
## 2923           0           0           0           0           1           0
## 2924           0           0           0           0           1           0
## 2925           0           0           0           0           1           0
## 2926           0           0           0           0           1           0
## 2927           0           0           0           0           1           0
## 2928           0           0           0           0           1           0
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## 2933           0           0           0           0           1           0
## 2934           0           0           0           0           1           0
## 2935           0           0           0           0           1           0
## 2936           0           0           0           0           1           0
## 2937           0           0           0           0           1           0
## 2938           0           0           0           0           1           0
## 2939           0           0           0           0           1           0
## 2940           0           0           0           0           1           0
```

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## 2942          0          0          0          0          1          0
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## 2944          0          0          0          0          1          0
## 2945          0          0          0          0          1          0
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## 2947          0          0          0          0          1          0
## 2948          0          0          0          0          1          0
## 2949          0          0          0          0          1          0
## 2950          0          0          0          0          1          0
## 2951          0          0          0          0          1          0
## 2952          0          0          0          0          1          0
## 2953          0          0          0          0          1          0
## 2954          0          0          0          0          1          0
## 2955          0          0          0          0          1          0
## 2956          0          0          0          0          1          0
## 2957          0          0          0          0          1          0
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## 2959          0          0          0          0          1          0
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## 2962          0          0          0          0          1          0
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## 2964          0          0          0          0          1          0
## 2965          0          0          0          0          1          0
## 2966          0          0          0          0          1          0
## 2967          0          0          0          0          1          0
## 2968          0          0          0          0          1          0
## 2969          0          0          0          0          1          0
## 2970          0          0          0          0          1          0
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## 2976          0          0          0          0          1          0
## 2977          0          0          0          0          1          0
## 2978          0          0          0          0          1          0
## 2979          0          0          0          0          1          0
## 2980          0          0          0          0          1          0
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## 2982          0          0          0          0          1          0
## 2983          0          0          0          0          1          0
## 2984          0          0          0          0          1          0
## 2985          0          0          0          0          1          0
## 2986          0          0          0          0          1          0
## 2987          0          0          0          0          1          0
## 2988          0          0          0          0          1          0
## 2989          0          0          0          0          1          0
## 2990          0          0          0          0          1          0
## 2991          0          0          0          0          1          0
## 2992          0          0          0          0          1          0
## 2993          0          0          0          0          1          0
## 2994          0          0          0          0          1          0
```

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## 2995          0         0         0         0         1         0
## 2996          0         0         0         0         1         0
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## 2998          0         0         0         0         1         0
## 2999          0         0         0         0         1         0
## 3000          0         0         0         0         1         0
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## 3003          0         0         0         0         1         0
## 3004          0         0         0         0         1         0
## 3005          0         0         0         0         1         0
## 3006          0         0         0         0         1         0
## 3007          0         0         0         0         1         0
## 3008          0         0         0         0         1         0
## 3009          0         0         0         0         1         0
## 3010          0         0         0         0         1         0
## 3011          0         0         0         0         1         0
## 3012          0         0         0         0         1         0
## 3013          0         0         0         0         1         0
## 3014          0         0         0         0         1         0
## 3015          0         0         0         0         1         0
## 3016          0         0         0         0         1         0
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## 3018          0         0         0         0         1         0
## 3019          0         0         0         0         1         0
## 3020          0         0         0         0         1         0
## 3021          0         0         0         0         1         0
## 3022          0         0         0         0         1         0
## 3023          0         0         0         0         1         0
## 3024          0         0         0         0         1         0
## 3025          0         0         0         0         1         0
## 3026          0         0         0         0         1         0
## 3027          0         0         0         0         1         0
## 3028          0         0         0         0         1         0
## 3029          0         0         0         0         1         0
## 3030          0         0         0         0         1         0
## 3031          0         0         0         0         1         0
## 3032          0         0         0         0         1         0
## 3033          0         0         0         0         1         0
## 3034          0         0         0         0         1         0
## 3035          0         0         0         0         1         0
## 3036          0         0         0         0         1         0
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## 3039          0         0         0         0         1         0
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## 3042          0         0         0         0         1         0
## 3043          0         0         0         0         1         0
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## 3046          0         0         0         0         1         0
## 3047          0         0         0         0         1         0
## 3048          0         0         0         0         1         0
```

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## 3049       0        0        0        0        1        0
## 3050       0        0        0        0        1        0
## 3051       0        0        0        0        1        0
## 3052       0        0        0        0        1        0
## 3053       0        0        0        0        1        0
## 3054       0        0        0        0        1        0
## 3055       0        0        0        0        1        0
## 3056       0        0        0        0        1        0
## 3057       0        0        0        0        1        0
## 3058       0        0        0        0        1        0
## 3059       0        0        0        0        1        0
## 3060       0        0        0        0        1        0
## 3061       0        0        0        0        1        0
## 3062       0        0        0        0        1        0
## 3063       0        0        0        0        1        0
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## 3065       0        0        0        0        1        0
## 3066       0        0        0        0        1        0
## 3067       0        0        0        0        1        0
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## 3069       0        0        0        0        1        0
## 3070       0        0        0        0        1        0
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## 3075       0        0        0        0        1        0
## 3076       0        0        0        0        1        0
## 3077       0        0        0        0        1        0
## 3078       0        0        0        0        1        0
## 3079       0        0        0        0        1        0
## 3080       0        0        0        0        1        0
## 3081       0        0        0        0        1        0
## 3082       0        0        0        0        1        0
## 3083       0        0        0        0        1        0
## 3084       0        0        0        0        1        0
## 3085       0        0        0        0        1        0
## 3086       0        0        0        0        1        0
## 3087       0        0        0        0        1        0
## 3088       0        0        0        0        1        0
## 3089       0        0        0        0        1        0
## 3090       0        0        0        0        1        0
## 3091       0        0        0        0        1        0
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## 3093       0        0        0        0        1        0
## 3094       0        0        0        0        1        0
## 3095       0        0        0        0        1        0
## 3096       0        0        0        0        1        0
## 3097       0        0        0        0        1        0
## 3098       0        0        0        0        1        0
## 3099       0        0        0        0        1        0
## 3100       0        0        0        0        1        0
## 3101       0        0        0        0        1        0
## 3102       0        0        0        0        1        0
```

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## 3156          0          0          0          0          1          0
```

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## 3158        0         0         0         0         1         0
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## 3185        0         0         0         0         1         0
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## 3208        0         0         0         0         1         0
## 3209        0         0         0         0         1         0
## 3210        0         0         0         0         1         0
```

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## 3480          0          0          0          0          1          0
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## 3534         0         0         0         0         1         0
```

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## 3696          0          0          0          0          1          0
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##      Gender_Transgender Severity_Mild Severity_Moderate Severity_None
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220

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223

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226

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## 1179                0                 1                    0                 0
## 1180                0                 0                    1                 0
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```

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## 2301	0	0	0	0
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## 2313	0	0	0	0
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## 2868	0	0	0	1
## 2869	0	1	0	0
## 2870	0	1	0	0
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## 2908	0	0	1	0

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## 3326             0              0              1              0    China
## 3327             0              1              0              0    China
## 3328             0              0              0              1    China
## 3329             0              0              1              0    China
## 3330             0              1              0              0    China
## 3331             1              0              0              1    China
## 3332             1              0              1              0    China
## 3333             1              1              0              0    China
## 3334             0              0              0              1    China
## 3335             0              0              1              0    China
## 3336             0              1              0              0    China
## 3337             0              0              0              1    China
## 3338             0              0              1              0    China
## 3339             0              1              0              0    China
## 3340             0              0              0              1    China
## 3341             0              0              1              0    China
## 3342             0              1              0              0    China
## 3343             1              0              0              1    China
## 3344             1              0              1              0    China
## 3345             1              1              0              0    China
## 3346             0              0              0              1    China
## 3347             0              0              1              0    China
## 3348             0              1              0              0    China
## 3349             0              0              0              1    China
## 3350             0              0              1              0    China
## 3351             0              1              0              0    China
## 3352             0              0              0              1    China
## 3353             0              0              1              0    China
## 3354             0              1              0              0    China
## 3355             1              0              0              1    China
## 3356             1              0              1              0    China
## 3357             1              1              0              0    China
## 3358             0              0              0              1    China
## 3359             0              0              1              0    China
## 3360             0              1              0              0    China
## 3361             0              0              0              1    China
## 3362             0              0              1              0    China
```

```
## 3363               0               1               0               0     China
## 3364               0               0               0               1     China
## 3365               0               0               1               0     China
## 3366               0               1               0               0     China
## 3367               1               0               0               1     China
## 3368               1               0               1               0     China
## 3369               1               1               0               0     China
## 3370               0               0               0               1     China
## 3371               0               0               1               0     China
## 3372               0               1               0               0     China
## 3373               0               0               0               1     China
## 3374               0               0               1               0     China
## 3375               0               1               0               0     China
## 3376               0               0               0               1     China
## 3377               0               0               1               0     China
## 3378               0               1               0               0     China
## 3379               1               0               0               1     China
## 3380               1               0               1               0     China
## 3381               1               1               0               0     China
## 3382               0               0               0               1     China
## 3383               0               0               1               0     China
## 3384               0               1               0               0     China
## 3385               0               0               0               1     China
## 3386               0               0               1               0     China
## 3387               0               1               0               0     China
## 3388               0               0               0               1     China
## 3389               0               0               1               0     China
## 3390               0               1               0               0     China
## 3391               1               0               0               1     China
## 3392               1               0               1               0     China
## 3393               1               1               0               0     China
## 3394               0               0               0               1     China
## 3395               0               0               1               0     China
## 3396               0               1               0               0     China
## 3397               0               0               0               1     China
## 3398               0               0               1               0     China
## 3399               0               1               0               0     China
## 3400               0               0               0               1     China
## 3401               0               0               1               0     China
## 3402               0               1               0               0     China
## 3403               1               0               0               1     China
## 3404               1               0               1               0     China
## 3405               1               1               0               0     China
## 3406               0               0               0               1     China
## 3407               0               0               1               0     China
## 3408               0               1               0               0     China
## 3409               0               0               0               1     China
## 3410               0               0               1               0     China
## 3411               0               1               0               0     China
## 3412               0               0               0               1     China
## 3413               0               0               1               0     China
## 3414               0               1               0               0     China
## 3415               1               0               0               1     China
## 3416               1               0               1               0     China
```

```
## 3417              1              1              0              0    China
## 3418              0              0              0              1    China
## 3419              0              0              1              0    China
## 3420              0              1              0              0    China
## 3421              0              0              0              1    China
## 3422              0              0              1              0    China
## 3423              0              1              0              0    China
## 3424              0              0              0              1    China
## 3425              0              0              1              0    China
## 3426              0              1              0              0    China
## 3427              1              0              0              1    China
## 3428              1              0              1              0    China
## 3429              1              1              0              0    China
## 3430              0              0              0              1    China
## 3431              0              0              1              0    China
## 3432              0              1              0              0    China
## 3433              0              0              0              1    China
## 3434              0              0              1              0    China
## 3435              0              1              0              0    China
## 3436              0              0              0              1    China
## 3437              0              0              1              0    China
## 3438              0              1              0              0    China
## 3439              1              0              0              1    China
## 3440              1              0              1              0    China
## 3441              1              1              0              0    China
## 3442              0              0              0              1    China
## 3443              0              0              1              0    China
## 3444              0              1              0              0    China
## 3445              0              0              0              1    China
## 3446              0              0              1              0    China
## 3447              0              1              0              0    China
## 3448              0              0              0              1    China
## 3449              0              0              1              0    China
## 3450              0              1              0              0    China
## 3451              1              0              0              1    China
## 3452              1              0              1              0    China
## 3453              1              1              0              0    China
## 3454              0              0              0              1    China
## 3455              0              0              1              0    China
## 3456              0              1              0              0    China
## 3457              0              0              0              1    China
## 3458              0              0              1              0    China
## 3459              0              1              0              0    China
## 3460              0              0              0              1    China
## 3461              0              0              1              0    China
## 3462              0              1              0              0    China
## 3463              1              0              0              1    China
## 3464              1              0              1              0    China
## 3465              1              1              0              0    China
## 3466              0              0              0              1    China
## 3467              0              0              1              0    China
## 3468              0              1              0              0    China
## 3469              0              0              0              1    China
## 3470              0              0              1              0    China
```

```
## 3471          0              1              0              0    China
## 3472          0              0              0              1    China
## 3473          0              0              1              0    China
## 3474          0              1              0              0    China
## 3475          1              0              0              1    China
## 3476          1              0              1              0    China
## 3477          1              1              0              0    China
## 3478          0              0              0              1    China
## 3479          0              0              1              0    China
## 3480          0              1              0              0    China
## 3481          0              0              0              1    China
## 3482          0              0              1              0    China
## 3483          0              1              0              0    China
## 3484          0              0              0              1    China
## 3485          0              0              1              0    China
## 3486          0              1              0              0    China
## 3487          1              0              0              1    China
## 3488          1              0              1              0    China
## 3489          1              1              0              0    China
## 3490          0              0              0              1    China
## 3491          0              0              1              0    China
## 3492          0              1              0              0    China
## 3493          0              0              0              1    China
## 3494          0              0              1              0    China
## 3495          0              1              0              0    China
## 3496          0              0              0              1    China
## 3497          0              0              1              0    China
## 3498          0              1              0              0    China
## 3499          1              0              0              1    China
## 3500          1              0              1              0    China
## 3501          1              1              0              0    China
## 3502          0              0              0              1    China
## 3503          0              0              1              0    China
## 3504          0              1              0              0    China
## 3505          0              0              0              1    China
## 3506          0              0              1              0    China
## 3507          0              1              0              0    China
## 3508          0              0              0              1    China
## 3509          0              0              1              0    China
## 3510          0              1              0              0    China
## 3511          1              0              0              1    China
## 3512          1              0              1              0    China
## 3513          1              1              0              0    China
## 3514          0              0              0              1    China
## 3515          0              0              1              0    China
## 3516          0              1              0              0    China
## 3517          0              0              0              1    China
## 3518          0              0              1              0    China
## 3519          0              1              0              0    China
## 3520          0              0              0              1    China
## 3521          0              0              1              0    China
## 3522          0              1              0              0    China
## 3523          1              0              0              1    China
## 3524          1              0              1              0    China
```

```
## 3525            1              1              0              0    China
## 3526            0              0              0              1    China
## 3527            0              0              1              0    China
## 3528            0              1              0              0    China
## 3529            0              0              0              1    China
## 3530            0              0              1              0    China
## 3531            0              1              0              0    China
## 3532            0              0              0              1    China
## 3533            0              0              1              0    China
## 3534            0              1              0              0    China
## 3535            1              0              0              1    China
## 3536            1              0              1              0    China
## 3537            1              1              0              0    China
## 3538            0              0              0              1    China
## 3539            0              0              1              0    China
## 3540            0              1              0              0    China
## 3541            0              0              0              1    China
## 3542            0              0              1              0    China
## 3543            0              1              0              0    China
## 3544            0              0              0              1    China
## 3545            0              0              1              0    China
## 3546            0              1              0              0    China
## 3547            1              0              0              1    China
## 3548            1              0              1              0    China
## 3549            1              1              0              0    China
## 3550            0              0              0              1    China
## 3551            0              0              1              0    China
## 3552            0              1              0              0    China
## 3553            0              0              0              1    China
## 3554            0              0              1              0    China
## 3555            0              1              0              0    China
## 3556            0              0              0              1    China
## 3557            0              0              1              0    China
## 3558            0              1              0              0    China
## 3559            1              0              0              1    China
## 3560            1              0              1              0    China
## 3561            1              1              0              0    China
## 3562            0              0              0              1    China
## 3563            0              0              1              0    China
## 3564            0              1              0              0    China
## 3565            0              0              0              1    China
## 3566            0              0              1              0    China
## 3567            0              1              0              0    China
## 3568            0              0              0              1    China
## 3569            0              0              1              0    China
## 3570            0              1              0              0    China
## 3571            1              0              0              1    China
## 3572            1              0              1              0    China
## 3573            1              1              0              0    China
## 3574            0              0              0              1    China
## 3575            0              0              1              0    China
## 3576            0              1              0              0    China
## 3577            0              0              0              1    China
## 3578            0              0              1              0    China
```

```
## 3579          0              1              0              0    China
## 3580          0              0              0              1    China
## 3581          0              0              1              0    China
## 3582          0              1              0              0    China
## 3583          1              0              0              1    China
## 3584          1              0              1              0    China
## 3585          1              1              0              0    China
## 3586          0              0              0              1    China
## 3587          0              0              1              0    China
## 3588          0              1              0              0    China
## 3589          0              0              0              1    China
## 3590          0              0              1              0    China
## 3591          0              1              0              0    China
## 3592          0              0              0              1    China
## 3593          0              0              1              0    China
## 3594          0              1              0              0    China
## 3595          1              0              0              1    China
## 3596          1              0              1              0    China
## 3597          1              1              0              0    China
## 3598          0              0              0              1    China
## 3599          0              0              1              0    China
## 3600          0              1              0              0    China
## 3601          0              0              0              1    China
## 3602          0              0              1              0    China
## 3603          0              1              0              0    China
## 3604          0              0              0              1    China
## 3605          0              0              1              0    China
## 3606          0              1              0              0    China
## 3607          1              0              0              1    China
## 3608          1              0              1              0    China
## 3609          1              1              0              0    China
## 3610          0              0              0              1    China
## 3611          0              0              1              0    China
## 3612          0              1              0              0    China
## 3613          0              0              0              1    China
## 3614          0              0              1              0    China
## 3615          0              1              0              0    China
## 3616          0              0              0              1    China
## 3617          0              0              1              0    China
## 3618          0              1              0              0    China
## 3619          1              0              0              1    China
## 3620          1              0              1              0    China
## 3621          1              1              0              0    China
## 3622          0              0              0              1    China
## 3623          0              0              1              0    China
## 3624          0              1              0              0    China
## 3625          0              0              0              1    China
## 3626          0              0              1              0    China
## 3627          0              1              0              0    China
## 3628          0              0              0              1    China
## 3629          0              0              1              0    China
## 3630          0              1              0              0    China
## 3631          1              0              0              1    China
## 3632          1              0              1              0    China
```

```
## 3633           1            1            0            0    China
## 3634           0            0            0            1    China
## 3635           0            0            1            0    China
## 3636           0            1            0            0    China
## 3637           0            0            0            1    China
## 3638           0            0            1            0    China
## 3639           0            1            0            0    China
## 3640           0            0            0            1    China
## 3641           0            0            1            0    China
## 3642           0            1            0            0    China
## 3643           1            0            0            1    China
## 3644           1            0            1            0    China
## 3645           1            1            0            0    China
## 3646           0            0            0            1    China
## 3647           0            0            1            0    China
## 3648           0            1            0            0    China
## 3649           0            0            0            1    China
## 3650           0            0            1            0    China
## 3651           0            1            0            0    China
## 3652           0            0            0            1    China
## 3653           0            0            1            0    China
## 3654           0            1            0            0    China
## 3655           1            0            0            1    China
## 3656           1            0            1            0    China
## 3657           1            1            0            0    China
## 3658           0            0            0            1    China
## 3659           0            0            1            0    China
## 3660           0            1            0            0    China
## 3661           0            0            0            1    China
## 3662           0            0            1            0    China
## 3663           0            1            0            0    China
## 3664           0            0            0            1    China
## 3665           0            0            1            0    China
## 3666           0            1            0            0    China
## 3667           1            0            0            1    China
## 3668           1            0            1            0    China
## 3669           1            1            0            0    China
## 3670           0            0            0            1    China
## 3671           0            0            1            0    China
## 3672           0            1            0            0    China
## 3673           0            0            0            1    China
## 3674           0            0            1            0    China
## 3675           0            1            0            0    China
## 3676           0            0            0            1    China
## 3677           0            0            1            0    China
## 3678           0            1            0            0    China
## 3679           1            0            0            1    China
## 3680           1            0            1            0    China
## 3681           1            1            0            0    China
## 3682           0            0            0            1    China
## 3683           0            0            1            0    China
## 3684           0            1            0            0    China
## 3685           0            0            0            1    China
## 3686           0            0            1            0    China
```

```
## 3687                0               1          0          0    China
## 3688                0               0          0          1    China
## 3689                0               0          1          0    China
## 3690                0               1          0          0    China
## 3691                1               0          0          1    China
## 3692                1               0          1          0    China
## 3693                1               1          0          0    China
## 3694                0               0          0          1    China
## 3695                0               0          1          0    China
## 3696                0               1          0          0    China
## 3697                0               0          0          1    China
## 3698                0               0          1          0    China
## 3699                0               1          0          0    China
## 3700                0               0          0          1    China
## 3701                0               0          1          0    China
## 3702                0               1          0          0    China
## 3703                1               0          0          1    China
##  [ reached 'max' / getOption("max.print") -- omitted 313097 rows ]
```

Preparing the dataset for bnlearn package to have all factor variables

Removing Country and making sure we have factor variables for Bayesian networks

```
d <- subset(data_assignment_3, select = -c(Country))
summary(d)
```

```
##     Fever              Tiredness            Dry.Cough
##  Length:316800      Length:316800       Length:316800
##  Class :character   Class :character    Class :character
##  Mode  :character   Mode  :character    Mode  :character
##  Difficulty.in.Breathing Sore.Throat        None_Sympton
##  Length:316800           Length:316800      Length:316800
##  Class :character        Class :character   Class :character
##  Mode  :character        Mode  :character   Mode  :character
##     Pains             Nasal.Congestion   Runny.Nose          Diarrhea
##  Length:316800      Length:316800      Length:316800      Length:316800
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##  None_Experiencing    Age_0.9            Age_10.19          Age_20.24
##  Length:316800      Length:316800      Length:316800      Length:316800
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##   Age_25.59           Age_60.            Gender_Female      Gender_Male
##  Length:316800      Length:316800      Length:316800      Length:316800
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##  Gender_Transgender Severity_Mild      Severity_Moderate  Severity_None
##  Length:316800      Length:316800      Length:316800      Length:316800
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
```

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```
##   Severity_Severe    Contact_Dont.Know    Contact_No         Contact_Yes
##   Length:316800      Length:316800        Length:316800      Length:316800
##   Class :character   Class :character     Class :character   Class :character
##   Mode  :character   Mode  :character     Mode  :character   Mode  :character
```

```r
for(j in 1:ncol(d)){
  d[,j] <- factor(as.numeric(d[,j]))}
summary(d)
```

```
##  Fever        Tiredness  Dry.Cough  Difficulty.in.Breathing Sore.Throat
##  0:217800     0:158400   0:138600   0:158400                0:217800
##  1: 99000     1:158400   1:178200   1:158400                1: 99000
##  None_Sympton Pains       Nasal.Congestion Runny.Nose Diarrhea
##  0:297000     0:201600    0:144000         0:144000   0:201600
##  1: 19800     1:115200    1:172800         1:172800   1:115200
##  None_Experiencing Age_0.9     Age_10.19  Age_20.24  Age_25.59  Age_60.
##  0:288000          0:253440    0:253440   0:253440   0:253440   0:253440
##  1: 28800          1: 63360    1: 63360   1: 63360   1: 63360   1: 63360
##  Gender_Female Gender_Male Gender_Transgender Severity_Mild Severity_Moderate
##  0:211200      0:211200    0:211200           0:237600      0:237600
##  1:105600      1:105600    1:105600           1: 79200      1: 79200
##  Severity_None Severity_Severe Contact_Dont.Know Contact_No Contact_Yes
##  0:237600      0:237600        0:211200          0:211200   0:211200
##  1: 79200      1: 79200        1:105600          1:105600   1:105600
```

Building the Bayesian Network Models

Constructing the Bayesian Models using a constraint-based, score-based, hybrid, and a local discovery algorithm. Using the the algorithms benchmarked by Dr. Smith with regards to computation time.

```r
require(bnlearn)
```

```
## Loading required package: bnlearn
```

```r
d_algorithms <- c("iamb.fdr", "hc", "h2pc", "aracne")
list_bnlearn <- list()
for(j in d_algorithms) try({
  list_bnlearn[[j]] <- do.call(
    what = j,
    args = list(x = d)
    )
  }
  )
```

```
## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug = debug):
## vstructure Fever -> Tiredness <- Dry.Cough is not applicable, because one or
## both arcs are oriented in the opposite direction.
```

```
## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug = debug):
## vstructure Tiredness -> Dry.Cough <- Difficulty.in.Breathing is not applicable,
## because one or both arcs are oriented in the opposite direction.
```

```
## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug = debug):
## vstructure Fever -> Difficulty.in.Breathing <- Dry.Cough is not applicable,
## because one or both arcs are oriented in the opposite direction.


## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug =
## debug): vstructure Tiredness -> Sore.Throat <- Difficulty.in.Breathing is not
## applicable, because one or both arcs are oriented in the opposite direction.
```

list_bnlearn

```
## $iamb.fdr
##
##   Bayesian network learned via Constraint-based methods
##
##   model:
##     [partially directed graph]
##   nodes:                                26
##   arcs:                                 44
##     undirected arcs:                    34
##     directed arcs:                      10
##   average markov blanket size:          3.54
##   average neighbourhood size:           3.38
##   average branching factor:             0.38
##
##   learning algorithm:                   IAMB-FDR
##   conditional independence test:        Mutual Information (disc.)
##   alpha threshold:                      0.05
##   tests used in the learning procedure: 3968
##
##
## $hc
##
##   Bayesian network learned via Score-based methods
##
##   model:
##     [Dry.Cough][Pains][Age_0.9][Gender_Female][Severity_Mild][Contact_Dont.Know]
##     [None_Sympton|Dry.Cough][Runny.Nose|Pains][Age_60.|Age_0.9]
##     [Gender_Transgender|Gender_Female][Severity_Severe|Severity_Mild]
##     [Contact_Yes|Contact_Dont.Know][Fever|None_Sympton]
##     [Nasal.Congestion|Pains:Runny.Nose][Age_25.59|Age_0.9:Age_60.]
##     [Gender_Male|Gender_Female:Gender_Transgender]
##     [Severity_None|Severity_Mild:Severity_Severe]
##     [Contact_No|Contact_Dont.Know:Contact_Yes]
##     [Tiredness|Fever:Dry.Cough:None_Sympton]
##     [Diarrhea|Pains:Nasal.Congestion:Runny.Nose]
##     [Age_20.24|Age_0.9:Age_25.59:Age_60.]
##     [Severity_Moderate|Severity_Mild:Severity_None:Severity_Severe]
##     [Difficulty.in.Breathing|Fever:Tiredness:Dry.Cough:None_Sympton]
##     [None_Experiencing|Pains:Nasal.Congestion:Runny.Nose:Diarrhea]
##     [Age_10.19|Age_0.9:Age_20.24:Age_25.59:Age_60.]
##     [Sore.Throat|Fever:Tiredness:Dry.Cough:Difficulty.in.Breathing:None_Sympton]
##   nodes:                                26
##   arcs:                                 46
```

```
##       undirected arcs:                  0
##        directed arcs:                  46
##    average markov blanket size:         3.62
##    average neighbourhood size:          3.54
##    average branching factor:            1.77
##
##    learning algorithm:                  Hill-Climbing
##    score:                               BIC (disc.)
##    penalization coefficient:            6.333013
##    tests used in the learning procedure: 1520
##    optimized:                           TRUE
##
##
## $h2pc
##
##    Bayesian network learned via Hybrid methods
##
##    model:
##     [Dry.Cough][Pains][Age_0.9][Gender_Female][Severity_Mild][Contact_Dont.Know]
##     [None_Sympton|Dry.Cough][Runny.Nose|Pains][Age_60.|Age_0.9]
##     [Gender_Transgender|Gender_Female][Severity_Severe|Severity_Mild]
##     [Contact_Yes|Contact_Dont.Know][Fever|None_Sympton]
##     [Nasal.Congestion|Pains:Runny.Nose][Age_25.59|Age_0.9:Age_60.]
##     [Gender_Male|Gender_Female:Gender_Transgender]
##     [Severity_None|Severity_Mild:Severity_Severe]
##     [Contact_No|Contact_Dont.Know:Contact_Yes]
##     [Tiredness|Fever:Dry.Cough:None_Sympton]
##     [Difficulty.in.Breathing|Fever:Dry.Cough:None_Sympton]
##     [Diarrhea|Pains:Nasal.Congestion:Runny.Nose]
##     [Age_20.24|Age_0.9:Age_25.59:Age_60.]
##     [Severity_Moderate|Severity_Mild:Severity_None:Severity_Severe]
##     [Sore.Throat|Fever:Tiredness:Difficulty.in.Breathing:None_Sympton]
##     [None_Experiencing|Pains:Nasal.Congestion:Runny.Nose:Diarrhea]
##     [Age_10.19|Age_0.9:Age_20.24:Age_25.59:Age_60.]
##    nodes:                               26
##    arcs:                                44
##       undirected arcs:                  0
##        directed arcs:                  44
##    average markov blanket size:         3.54
##    average neighbourhood size:          3.38
##    average branching factor:            1.69
##
##    learning algorithm:                  Hybrid^2 Parent Children
##    constraint-based method:             Hybrid Parents and Children
##    conditional independence test:       Mutual Information (disc.)
##    score-based method:                  Hill-Climbing
##    score:                               BIC (disc.)
##    alpha threshold:                     0.05
##    penalization coefficient:            6.333013
##    tests used in the learning procedure: 4104
##    optimized:                           TRUE
##
##
## $aracne
```

```
## 
##   Bayesian network learned via Pairwise Mutual Information methods
## 
##   model:
##      [undirected graph]
##   nodes:                                26
##   arcs:                                 309
##     undirected arcs:                    309
##     directed arcs:                      0
##   average markov blanket size:          23.77
##   average neighbourhood size:           23.77
##   average branching factor:             0.00
## 
##   learning algorithm:                   ARACNE
##   mutual information estimator:         Maximum Likelihood (disc.)
##   tests used in the learning procedure: 325
```

The score-based algorithm hc() and the hybrid algorithm h2pc() produce directed graphs. Lets see if we can produce directed graphs with any other constraint-based and local discovery algorithms

```r
d_algorithms <- c("pc.stable", "gs", "iamb", "inter.iamb", "mmpc", "si.hiton.pc", "hpc", "chow.liu")
list2_bnlearn <- list()
for(j in d_algorithms) try({
  list2_bnlearn[[j]] <- do.call(
    what = j,
    args = list(x = d)
    )
  },silent = TRUE
  )
```

```
## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug = debug):
## vstructure Fever -> Tiredness <- Dry.Cough is not applicable, because one or
## both arcs are oriented in the opposite direction.
```

```
## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug = debug):
## vstructure Tiredness -> Dry.Cough <- Difficulty.in.Breathing is not applicable,
## because one or both arcs are oriented in the opposite direction.
```

```
## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug = debug):
## vstructure Fever -> Difficulty.in.Breathing <- Dry.Cough is not applicable,
## because one or both arcs are oriented in the opposite direction.
```

```
## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug =
## debug): vstructure Tiredness -> Sore.Throat <- Difficulty.in.Breathing is not
## applicable, because one or both arcs are oriented in the opposite direction.
```

```
## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug = debug):
## vstructure Fever -> Tiredness <- Dry.Cough is not applicable, because one or
## both arcs are oriented in the opposite direction.
```

```
## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug = debug):
## vstructure Tiredness -> Dry.Cough <- Difficulty.in.Breathing is not applicable,
## because one or both arcs are oriented in the opposite direction.
```

```
## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug = debug):
## vstructure Fever -> Difficulty.in.Breathing <- Dry.Cough is not applicable,
## because one or both arcs are oriented in the opposite direction.

## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug =
## debug): vstructure Tiredness -> Sore.Throat <- Difficulty.in.Breathing is not
## applicable, because one or both arcs are oriented in the opposite direction.

## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug = debug):
## vstructure Fever -> Tiredness <- Dry.Cough is not applicable, because one or
## both arcs are oriented in the opposite direction.

## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug = debug):
## vstructure Tiredness -> Dry.Cough <- Difficulty.in.Breathing is not applicable,
## because one or both arcs are oriented in the opposite direction.

## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug = debug):
## vstructure Fever -> Difficulty.in.Breathing <- Dry.Cough is not applicable,
## because one or both arcs are oriented in the opposite direction.

## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug =
## debug): vstructure Tiredness -> Sore.Throat <- Difficulty.in.Breathing is not
## applicable, because one or both arcs are oriented in the opposite direction.

## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug = debug):
## vstructure Fever -> Tiredness <- Dry.Cough is not applicable, because one or
## both arcs are oriented in the opposite direction.

## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug = debug):
## vstructure Tiredness -> Dry.Cough <- Difficulty.in.Breathing is not applicable,
## because one or both arcs are oriented in the opposite direction.

## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug = debug):
## vstructure Fever -> Difficulty.in.Breathing <- Dry.Cough is not applicable,
## because one or both arcs are oriented in the opposite direction.

## Warning in vstruct.apply(arcs = arcs, vs = vs, nodes = nodes, debug =
## debug): vstructure Tiredness -> Sore.Throat <- Difficulty.in.Breathing is not
## applicable, because one or both arcs are oriented in the opposite direction.
```

list2_bnlearn

```
## $pc.stable
##
##   Bayesian network learned via Constraint-based methods
##
##   model:
##     [partially directed graph]
##   nodes:                         26
##   arcs:                          44
##     undirected arcs:             34
```

```
##      directed arcs:                  10
##    average markov blanket size:      3.54
##    average neighbourhood size:       3.38
##    average branching factor:         0.38
##
##    learning algorithm:               PC (Stable)
##    conditional independence test:    Mutual Information (disc.)
##    alpha threshold:                  0.05
##    tests used in the learning procedure: 988
##
##
## $gs
##
##    Bayesian network learned via Constraint-based methods
##
##    model:
##      [partially directed graph]
##    nodes:                            26
##    arcs:                             44
##      undirected arcs:                34
##      directed arcs:                  10
##    average markov blanket size:      3.54
##    average neighbourhood size:       3.38
##    average branching factor:         0.38
##
##    learning algorithm:               Grow-Shrink
##    conditional independence test:    Mutual Information (disc.)
##    alpha threshold:                  0.05
##    tests used in the learning procedure: 2514
##
##
## $iamb
##
##    Bayesian network learned via Constraint-based methods
##
##    model:
##      [partially directed graph]
##    nodes:                            26
##    arcs:                             44
##      undirected arcs:                34
##      directed arcs:                  10
##    average markov blanket size:      3.54
##    average neighbourhood size:       3.38
##    average branching factor:         0.38
##
##    learning algorithm:               IAMB
##    conditional independence test:    Mutual Information (disc.)
##    alpha threshold:                  0.05
##    tests used in the learning procedure: 3804
##
##
## $inter.iamb
##
##    Bayesian network learned via Constraint-based methods
```

```
##
##   model:
##      [partially directed graph]
##   nodes:                                26
##   arcs:                                 44
##     undirected arcs:                    34
##     directed arcs:                      10
##   average markov blanket size:          3.54
##   average neighbourhood size:           3.38
##   average branching factor:             0.38
##
##   learning algorithm:                   Inter-IAMB
##   conditional independence test:        Mutual Information (disc.)
##   alpha threshold:                      0.05
##   tests used in the learning procedure: 3874
##
##
## $mmpc
##
##   Bayesian network learned via Constraint-based methods
##
##   model:
##      [undirected graph]
##   nodes:                                26
##   arcs:                                 44
##     undirected arcs:                    44
##     directed arcs:                      0
##   average markov blanket size:          3.38
##   average neighbourhood size:           3.38
##   average branching factor:             0.00
##
##   learning algorithm:                   Max-Min Parent Children
##   conditional independence test:        Mutual Information (disc.)
##   alpha threshold:                      0.05
##   tests used in the learning procedure: 2359
##
##
## $si.hiton.pc
##
##   Bayesian network learned via Constraint-based methods
##
##   model:
##      [undirected graph]
##   nodes:                                26
##   arcs:                                 44
##     undirected arcs:                    44
##     directed arcs:                      0
##   average markov blanket size:          3.38
##   average neighbourhood size:           3.38
##   average branching factor:             0.00
##
##   learning algorithm:                   Semi-Interleaved HITON-PC
##   conditional independence test:        Mutual Information (disc.)
##   alpha threshold:                      0.05
```

```
##    tests used in the learning procedure:   1394
##
##
## $hpc
##
##    Bayesian network learned via Constraint-based methods
##
##    model:
##       [undirected graph]
##    nodes:                               26
##    arcs:                                44
##      undirected arcs:                   44
##      directed arcs:                     0
##    average markov blanket size:         3.38
##    average neighbourhood size:          3.38
##    average branching factor:            0.00
##
##    learning algorithm:                  Hybrid Parents and Children
##    conditional independence test:       Mutual Information (disc.)
##    alpha threshold:                     0.05
##    tests used in the learning procedure: 3894
##
##
## $chow.liu
##
##    Bayesian network learned via Pairwise Mutual Information methods
##
##    model:
##       [undirected graph]
##    nodes:                               26
##    arcs:                                25
##      undirected arcs:                   25
##      directed arcs:                     0
##    average markov blanket size:         1.92
##    average neighbourhood size:          1.92
##    average branching factor:            0.00
##
##    learning algorithm:                  Chow-Liu
##    mutual information estimator:        Maximum Likelihood (disc.)
##    tests used in the learning procedure: 325
```

bic

```r
d_algorithms <- c("iamb.fdr", "hc", "h2pc", "aracne")

M_score_bic <- list()
for (j in d_algorithms) try({
  M_score_bic[j] <- score(
    x=list_bnlearn[[j]],
    data = d,
    type = "bic"
  )
```

```
}
)
```

```
## Error in network.score(x = x, data = data, type = type, ..., by.node = by.node,  :
##   the graph is only partially directed.
## Error in network.score(x = x, data = data, type = type, ..., by.node = by.node,  :
##   the graph is only partially directed.
```

```
M_score_bic <- data.frame(M_score_bic)
M_score_bic
```

```
##         hc      h2pc
## 1 -3284101 -3328486
```

aic

```
d_algorithms <- c("iamb.fdr", "hc", "h2pc", "aracne")

M_score_aic <- list()
for (j in d_algorithms) try({
  M_score_aic[j] <- score(
    x=list_bnlearn[[j]],
    data = d,
    type = "aic"
  )
}
)
```

```
## Error in network.score(x = x, data = data, type = type, ..., by.node = by.node,  :
##   the graph is only partially directed.
## Error in network.score(x = x, data = data, type = type, ..., by.node = by.node,  :
##   the graph is only partially directed.
```

```
M_score_aic <- data.frame(M_score_aic)
M_score_aic
```

```
##         hc      h2pc
## 1 -3283290 -3327803
```

loglik

```
d_algorithms <- c("iamb.fdr", "hc", "h2pc", "aracne")

M_score_loglik <- list()
for (j in d_algorithms) try({
  M_score_loglik[j] <- score(
    x=list_bnlearn[[j]],
```

```
    data = d,
    type = "loglik"
  )
}
)
```

```
## Error in network.score(x = x, data = data, type = type, ..., by.node = by.node,  :
##   the graph is only partially directed.
## Error in network.score(x = x, data = data, type = type, ..., by.node = by.node,  :
##   the graph is only partially directed.
```

```
M_score_loglik <- data.frame(M_score_loglik)
M_score_loglik
```

```
##         hc     h2pc
## 1 -3283138 -3327675
```

bde

```
d_algorithms <- c("iamb.fdr", "hc", "h2pc", "aracne")

M_score_bde <- list()
for (j in d_algorithms) try({
  M_score_bde[j] <- score(
    x=list_bnlearn[[j]],
    data = d,
    type = "bde"
  )
}
)
```

```
## Error in network.score(x = x, data = data, type = type, ..., by.node = by.node,  :
##   the graph is only partially directed.
## Error in network.score(x = x, data = data, type = type, ..., by.node = by.node,  :
##   the graph is only partially directed.
```

```
M_score_bde <- data.frame(M_score_bde)
M_score_bde
```

```
##         hc     h2pc
## 1 -3283483 -3328004
```

bds

```
d_algorithms <- c("iamb.fdr", "hc", "h2pc", "aracne")

M_score_bds <- list()
```

```r
for (j in d_algorithms) try({
  M_score_bds[j] <- score(
    x=list_bnlearn[[j]],
    data = d,
    type = "bds"
  )
}
)
```

```
## Error in network.score(x = x, data = data, type = type, ..., by.node = by.node,  :
##   the graph is only partially directed.
## Error in network.score(x = x, data = data, type = type, ..., by.node = by.node,  :
##   the graph is only partially directed.
```

```r
M_score_bds <- data.frame(M_score_bds)
M_score_bds
```

```
##         hc      h2pc
## 1 -3283493 -3328016
```

Model Score Comparison

```r
#Combining the scores in a table df
g <- rbind(M_score_bic,M_score_aic,M_score_loglik, M_score_bde, M_score_bds)
rownames(g) <- c("bic", "aic", "loglik", "bde", "bds")
g
```

```
##              hc      h2pc
## bic    -3284101 -3328486
## aic    -3283290 -3327803
## loglik -3283138 -3327675
## bde    -3283483 -3328004
## bds    -3283493 -3328016
```

```r
#Formatting the table to see which algorithm performs better
h <- data.frame(t(g))
colnames(h) <- rownames(g)
h
```

```
##           bic      aic   loglik      bde      bds
## hc   -3284101 -3283290 -3283138 -3283483 -3283493
## h2pc -3328486 -3327803 -3327675 -3328004 -3328016
```

```r
#Sorting largest to smallest in terms of performance of algorithms
sorted_h <- h[order(h$bic,h$aic,h$loglik,h$bde,h$bds),]
sorted_h
```

```
##           bic      aic   loglik      bde      bds
## h2pc -3328486 -3327803 -3327675 -3328004 -3328016
## hc   -3284101 -3283290 -3283138 -3283483 -3283493
```

```
apply(sorted_h, 2, FUN=max)
```

```
##      bic      aic   loglik      bde      bds
## -3284101 -3283290 -3283138 -3283483 -3283493
```

Visualizing the model hc()

Setting the node and edge attributes

```
#Node Attributes
hc_covid <- hc(d)
v_nodes <- nodes(hc_covid)
names(v_nodes) <- v_nodes
strength_covid <- arc.strength(
  x = hc_covid,
  data = d
)
n_nodes <- nnodes(hc_covid)

v_fillcolor <- viridis::viridis(n_nodes)
names(v_fillcolor) <- v_nodes

v_shape <- c(
  rep("circle",floor(n_nodes/3)),
  rep("ellipse",floor(n_nodes/3)),
  rep("box",n_nodes - 2*floor(n_nodes/3))
  )
names(v_shape) <- v_nodes

#Edge Attributes
v_edges <- paste0(strength_covid[,"from"],"~",
                  strength_covid[,"to"])
names(v_edges) <- v_edges

v_edgecolor <- v_fillcolor[strength_covid[,"from"]]
names(v_edgecolor) <- v_edges
```

Plotting the model

```
#Converting the bnlearn model to a graphNEL model
# library(BiocManager)
# install.packages("BiocManager")
# BiocManager::install(c("graph", "RBGL", "Rgraphviz"))
graphNEL_covid <- as.graphNEL(hc_covid)
```

```
## Loading required namespace: graph
```

```
Rgraphviz::plot(
  x = graphNEL_covid,
  y = "twopi",  attrs = list(),
  nodeAttrs = list(
    fillcolor = v_fillcolor,
    shape = v_shape
    ),
  edgeAttrs = list(
    label = v_edges,
    weight = graph::edgeWeights(graphNEL_covid),
    color = v_edgecolor,
    fontcolor = v_edgecolor
    )
  )
```
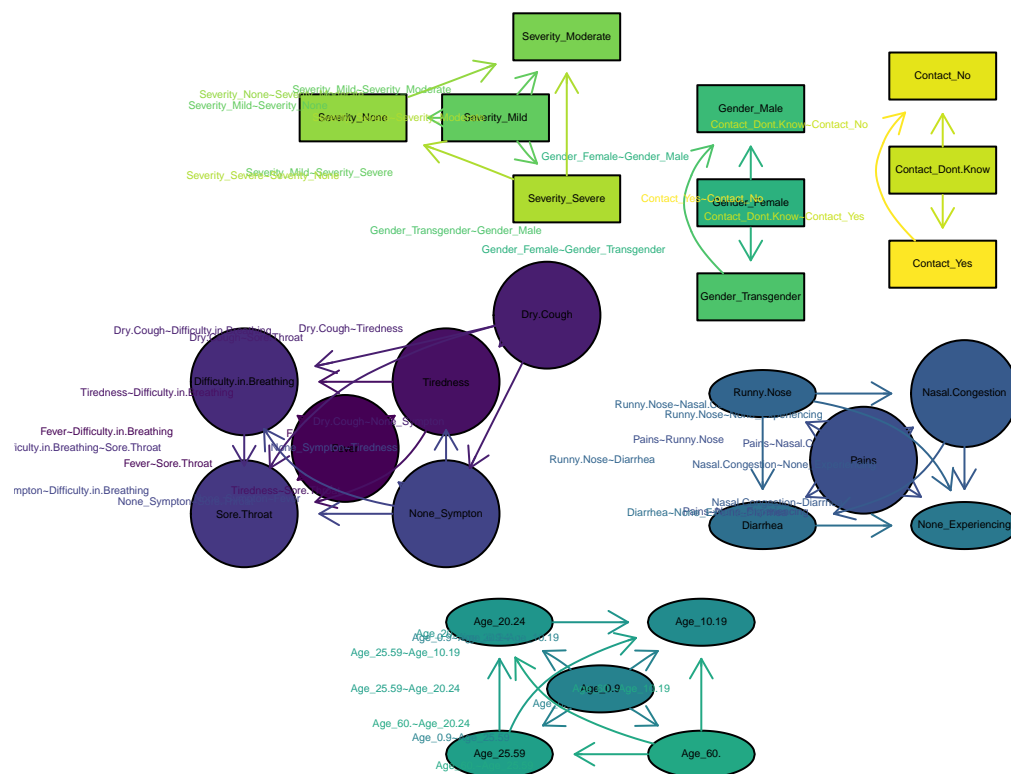

Predict the target variable

Predicting the target

```
fit_model <- bn.fit(
  x = hc_covid,
  data = d
```

```
)
pred_table <- data.frame(pred = predict(fit_model, node = "Nasal.Congestion", data = d),actual = d$Nasal
summary(pred_table)
```

```
##   pred         actual
##   0:172640     0:144000
##   1:144160     1:172800
```

Evaluating Model Fit

```
#Calculating AUC
AUC_model <- Metrics::auc(pred_table$actual,pred_table$pred)
print(paste0("AUC:", AUC_model))
```

```
## [1] "AUC:0.641034722222222"
```

```
#Calculating Model Accuracy
Accuracy_model <- Metrics::accuracy(pred_table$actual,pred_table$pred)
print(paste0("Accuracy: ", Accuracy_model))
```

```
## [1] "Accuracy: 0.635782828282828"
```

```
# Constructing the confusion matrix
# remove.packages("rlang")
# install.packages("rlang")
# install.packages("vctrs")
# install.packages("pillar")

confusion_matrix_model <- caret::confusionMatrix(pred_table$pred,pred_table$actual,"1")

cm <- data.frame(confusion_matrix_model$byClass)
cm
```

```
##                       confusion_matrix_model.byClass
## Sensitivity                         0.5832639
## Specificity                         0.6988056
## Pos Pred Value                      0.6991398
## Neg Pred Value                      0.5828777
## Precision                           0.6991398
## Recall                              0.5832639
## F1                                  0.6359667
## Prevalence                          0.5454545
## Detection Rate                      0.3181439
## Detection Prevalence                0.4550505
## Balanced Accuracy                   0.6410347
```

```
# Repeated 2-fold Cross-validation
cv_model <- bn.cv(
  data = d,
```

```
  bn = "hc",
  k = 2,
  runs = 2
)
cv_model
```

```
## 
##   k-fold cross-validation for Bayesian networks
## 
##   target learning algorithm:          Hill-Climbing
##   number of folds:                    2
##   loss function:                      Log-Likelihood Loss (disc.)
##   number of runs:                     2
##   average loss over the runs:         10.36358
##   standard deviation of the loss:     2.913623e-05
```