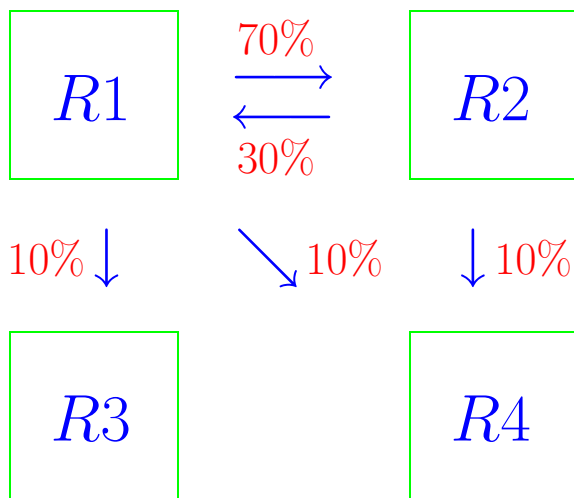


# Shipping of Commodities

**Situation:** Four regions (or cities)  $R1, R2, R3, R4$  ship (non-renewable) commodities (such as antique paintings, rental cars) among themselves according to the following diagram:



The figures represent the percentage of goods each region ships per week. (Percentage: in terms of goods present)

## Today's distribution:

$R1$  has \$300,000 worth of goods

$R2$  has \$200,000 worth of goods

$R3$  has \$100,000 worth of goods

$R4$  has \$100,000 worth of goods

**Question:** What happens in the long run?

**Analysis:** This is a discrete linear system  $\vec{v}_{n+1} = A\vec{v}_n$  with

$$A = \frac{1}{10} \begin{pmatrix} 1 & 3 & 0 & 0 \\ 7 & 6 & 0 & 0 \\ 1 & 0 & 10 & 0 \\ 1 & 1 & 0 & 10 \end{pmatrix} = \begin{pmatrix} T & 0 \\ B & I \end{pmatrix}, \quad \vec{v}_0 = \begin{pmatrix} 3 \\ 2 \\ 1 \\ 1 \end{pmatrix}.$$