Visualizing Human Migration through Space and Time

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What is Human Migration?

Migration (human) is the movement of people from one place in the world to another for the purpose of taking up permanent or semipermanent residence, usually across a political boundary. An example of "semipermanent residence" would be the seasonal movements of migrant farm laborers. People can either choose to move ("voluntary migration") or be forced to move ("involuntary migration").

Migrations have occurred throughout human history, beginning with the movements of the first human groups from their origins in East Africa to their current location in the world.

Migration occurs at a variety of scales: intercontinental (between continents), intracontinental (between countries on a given continent), and interregional (within countries). One of the most significant migration patterns has been rural to urban migration—the movement of people from the countryside to cities in search of opportunities.
How to Map Human Migration
THE GLOBAL FLOW OF PEOPLE

Explore new estimates of migration flows between and within regions for five-year periods, 1990 to 2010. Click on a region to discover flows country-by-country.

by Nikola Sander, Guy J. Abel & Ramon Bauer
at the Wittgenstein Centre for Demography and Global Human Capital
The Challenge

• Given 232 countries and regions in the world, there are $232 \times 232 = 53824$ possible migration streams in just one time snap.
Objectives

• Build a **map-centric** visualization tool
• Take in **simple input** data formats
• **Quickly** and **dynamically** render migration flows
• **Easy to access** – web based
• **User friendly** interface
• Visualize human migration at any geographic and temporal **scale**
• Lay the foundation for a **generic** platform to visualize the movement of any object in space and time
Platform Design – Key Requirements

- Select locations by map click or pulldown
- Toggle between Origin and Destination
- Arcs symbolized by migration flow with legend
- Mouse over any arc brings up statistics
- Time bar for temporal selection and auto-play
- Map zoom/pan and automatic centering

Constrains:
- Low budget, short development time
**ArcGIS for Desktop**

- File geodatabase

**ArcGIS for Server**

- File geodatabase

**Web Map User Interface**

- JavaScript code base

**Web application**

- User interface widgets
- Display layers from ArcGIS for Server WMS
  - Base map for navigation
  - Location polygons for query
  - Migration arcs returned per query
- Report, legend, and introduction

**Web map service**

- Publish MXD prepared in ArcGIS for Desktop
- Serve out polygon and arc layers as WMS
- Enable feature attribute query for WMS layers

**Desktop for data processing**

- Create centroid points from location polygons
- Create great circle arcs between centroids
- Join migration data to arcs
- Symbolize arcs based on migration data
- Enable time

**System components**

- Publish MXD

- WMS service

- ArcGIS for Server

- Web Map User Interface
Data Flow

Year 1:
- Location polygons
- Total population
- Migration counts
- Migration flow percentage

Year n:
- Location polygons
- Location centroids
- Migration arcs (two directions)
- Migration counts
- Migration flow percentage
## Input Data Structure

- **Origin**
- **Destination**
- **Year**
- **Migration count**
- **Origin’s population**
- **Origin’s total emigrant**
- **Destination’s population**
- **Destination’s total immigrant**
- **Migration as % of**
  - Origin’s population
  - Origin’s total emigrant
  - Destination’s population
  - Destinations’ total immigrant

### Table

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Three Cases

• Global Migration between Countries
  • Annual data from 1990 to 2013
  • 232 countries and territories
  • United Nations (2013) compilation of demographic reports

• US Domestic Migration between States
  • Annual data from 2005 to 2013
  • 50 states, DC and Puerto Rico
  • US Census Bureau State-to-State Migration Flows

• China Domestic Migration between Provinces
  • 1995, 2000, 2005 and 2010 data
  • 22 provinces, 5 autonomous regions, and 4 central municipalities
  • China National Population Census data (2000, 2010) and 0.95% sample (2000)
Technical Challenges

• Data Preparation
  – Understanding the meaning of numbers - difference between the cases (birth place – residence; last year – this year residence)
  – Missing geographic units in certain years (South Sudan, Chongqing, etc.)

• Performance
  – Generalization of geometry – migration arcs
  – Cached tile images – polygon boundaries

• Visualization
  – Arc vs. straight line
  – Color ramp vs. line width
  – Grey vs. thematic background
Future Enhancements

- User controlled flow symbology
  - Changing the color ramp
- User determined classification
  - Changing the breaking points of the values
- User selected flow measurement
  - Showing one of the percentages of migration
- User selected background map
  - Shading the polygons by their population
- User uploaded dataset
  - Visualizing other connections such as goods, capital investments, technology transfers, partnerships, communications, etc.
THANK YOU!

QUESTIONS?

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