



#### Depiction of Multivariate Data through Flow Maps

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#### Data

- Geographical data, origin-destination data.
- Examples: migration, GPS tracklog analysis, interaction between actors in social networks, movements of goods, etc...

Origin Name	Origin Position	Destination Name	Destination Position	Attr. 1 (# migrants)	Gender		Ethnicity		
					Attr. 2 (# males)	Attr. 3 (# females)	Attr. 4 (# Asian)	Attr. 5 (# Caucasian)	
Italy	44.902 <i>,</i> 10.806	Portugal	40.014, -8.416	120	100	20	26	42	
Germany	50.652 <i>,</i> 9.971	Italy	44.902, 10.806	57	25	32	21	13	
Spain	40.061 <i>,</i> -3.760	Germany	50.652, 9.971	59	30	29	32	23	



# 1

#### **Representations for OD-Data**















### Challenge

Develop a static and simple representation

to depict spatial origin-destination data with multiple attributes. The requirements fulfilled by our approach can be clustered in two groups:

- Constraint requirements
- Analytical requirements



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- Constraint requirements:
  - The mapping must be static.
  - The information must be depicted on a limited space (e.g. the computer screen or a page on a newspaper) in such a way that it is clearly understandable by the viewer.
  - The number of visual primitives must be minimized to reduce the cognitive overload.
- Analytical requirements:
  - Possibility to reason about the geographic patterns.
  - Must enable, simultaneously, the visualization of the flow structure and its multivariate patterns.
  - Possibility to analyse the outliers and commonality between each destination.
  - Possibility to analyse the outliers and commonality for groups of moving entities.



#### Good candidate

 Flow map is a static representation that is suitable to communicate univariate spatial origin-destination data.





### **Our Approach**

 We propose a new approach that capitalizes on the aggregation feature of flow maps, and on the value of color techniques.



### Our Approach: Color models

 Our work employs a technique designed by Gossett et al. (Gossett & Chen, 2004); inspired by paint mixing using a subtractive color space with Red, Yellow and Blue as primary colors.



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## Our Approach: Color models

- Generating a large number of colors from a limited range of values can be challenging. If users cannot distinguish between colors then they cannot perceive the magnitude of the value it represents.
- Hence, in our work, we normalize each primary color interval using their minimum and maximum value





#### Implementation

 Our approach extends the existing algorithms for the automatic generation of univariate flow maps.



### Automatic generation of flow map

Algorithms for the automatic generation of flow maps creating a tree structure:



• Flow Map Layout – Phan et al. 2005



Flow Map Layout via Spiral Trees – Verbeek et al. 2011







- Supervised Force Directed Algorithm for the Generation of Flow Maps Debiasi et al. 2014
- Stub Bundling and Confluent Spirals for Geographic Networks - Nocaj et al. 2014



#### Implementation

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 The algorithm for the automatic generation of flow map returns a tree structure composed by the origin (the root), the intermediate nodes, and the destinations (the leaves).















# Our Approach: Nodes representation

- In Flow maps an optional feature is the circle used to represent the destinations.
- It can help to better identify the target of the flows, and its size can be used to communicate the magnitude of an attribute.



![](_page_20_Figure_4.jpeg)

# Our Approach: Nodes representation

- The primary colors that compose the flow line are used to create the pie chart.
- The root node is represented as a pie chart depicting the percentage of each attribute from the whole amount of moving entities.

![](_page_21_Figure_3.jpeg)

![](_page_22_Picture_0.jpeg)

### **Migrants from California**

![](_page_22_Figure_2.jpeg)

![](_page_23_Picture_0.jpeg)

### **Migrants from California**

![](_page_23_Figure_2.jpeg)

![](_page_24_Picture_0.jpeg)

### **Migrants from Colorado**

![](_page_24_Figure_2.jpeg)

![](_page_25_Picture_0.jpeg)

### **Migrants from Colorado**

![](_page_25_Figure_2.jpeg)

![](_page_26_Picture_0.jpeg)

### Migrants from Texas

![](_page_26_Figure_2.jpeg)

30<age<54

![](_page_27_Picture_0.jpeg)

#### **Migrants from Texas**

![](_page_27_Figure_2.jpeg)

![](_page_28_Picture_0.jpeg)

### Conclusion

- A color scheme blending is used in conjunction with the aggregation aspects of flow maps and pie charts, to visualize in a static representation spatial origindestination data with multiple attributes.
- The presented method is independent to the algorithm used for automatically generate univariate flow map.
- To further validate our work a user study must be performed.

![](_page_29_Picture_0.jpeg)

#### Thank you for the attention!