Big Data HW #5

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41201-01

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1 Plotting the Actors' Network

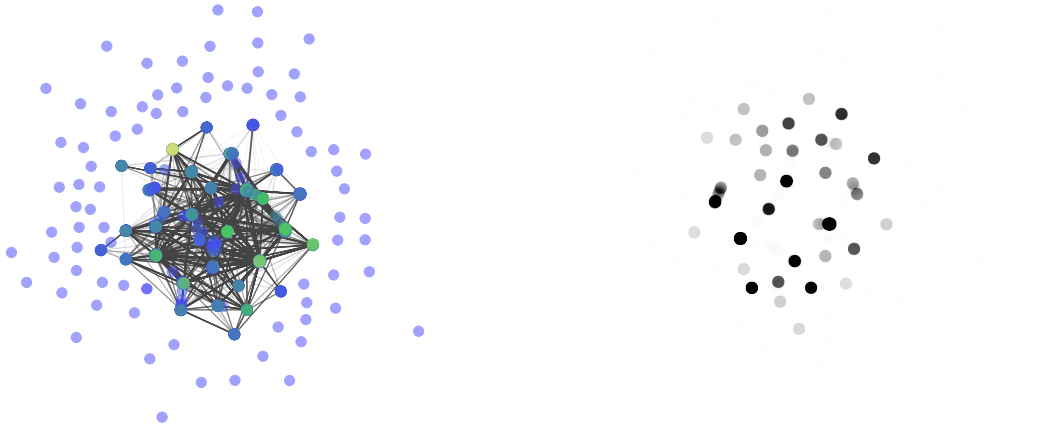
In this section we plot the actors' network as a whole (see Figure 1 on the following page). For the plot on the left 1a, the node-size remained constant with the vertex color varying based on an actor's degree of connectedness (more blue for less connected and more red for well connected). The data-set has 7015 actors in it. The degree of connectedness in the set of actors is shown in Figure 2 on the next page. This histogram shows that most actors have worked with between 40 and 60 other actors, although the heavy tail in this distribution indicates that many have worked with far more. For instance "Dobtcheff, Vernon" has worked with 378 others.

When initially inspecting 1a we got the impression we had dont something wrong. It seemed there were not many nodes plotted on the graph. To investigate this further, consider 1b. In this graph, we used alpha blending (partial transparency) on each vertex node with $1/256^{th}$ alpha per vertex. Therefore if 256 or more vertices happened to overlap, it would look as if there were one opaque vertex in its place. This plot clearly shows that the clusters we saw on the original graph were indeed that, clusters. This indicates that many groups of actors, possibly from a particular region, or sub-genre, tend to work together. Also, these two graphs indicate that there is a decent amount of cross-over.

2 Kevin Bacon

Kevin Bacon's network can be visualized in Figure 3 on page 3. In each of these plots, the node-size of each actor is sized according to their degree within the overall actors' network. That is, larger degree actors have bigger nodes. The coloring scheme used was to label 3rd-degree connections blue, 2nd-degree green, 1st-degree red, with Kevin Bacon's node colored black.

In Figure 3a we see his 1st-degree connections and note that while Kevin Bacon is relatively well connected with 96 connections, 22.68% of his connections have a higher degree than he does. In Figure 3b we visualize 2nd-degree connections and note that of the 2128 connections, 27.99% have a higher degree. Also because of the way R rendered the visualization, we cannot really see any 1st degree conenctions. In Figure 3c we visualize 3rd-degree connections and see a much better



(a) Connected Network (b) Network Clustering

Figure 1: Visualization of Actors' Network

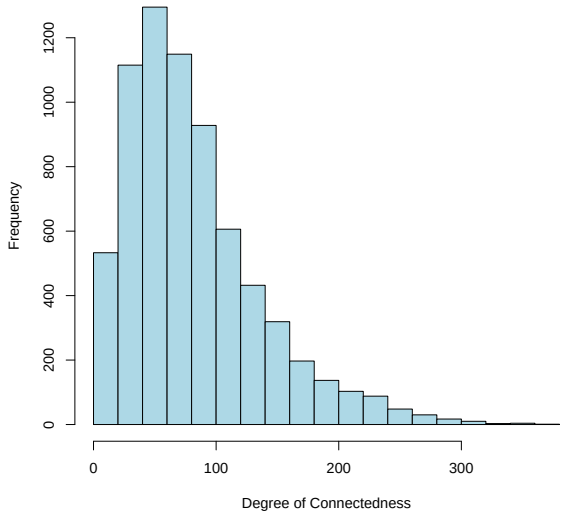
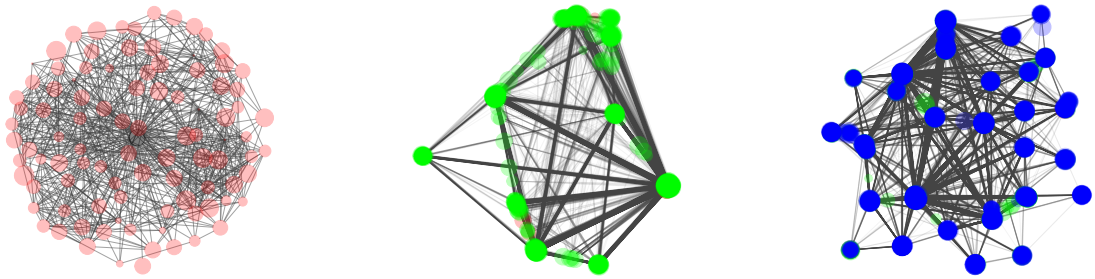


Figure 2: Histogram of Actors' Connectedness



(a) 1st Degree (b) 2nd Degree (c) 3rd Degree

Figure 3: Kevin Bacon's Network

visual dispersion of the three types of connections. Of the 5980 connections, 31.23% have more connections than Kevin Bacon.

3 Most Common and Connected Actors

We can determine the most common actors by summing up the columns of the actors' matrix and sorting the result. The actor appearing in the most films is **Velimir 'Bata' Zivojinovic**, who appeared in 57 films has appeared with 188 other actors. The most connected actor is **Vernon Dobtcheff** has been in 47 films and has worked with a total of 378 actors.

Tables showing the most connected actors and busiest actors (by # of movies completed) during the period are shown in Tables 1 and 2 on the current page and on the following page respectively. Not surprisingly there is some overlap between the two; **Vernon Dobtcheff** appears in both lists; it is also worth noting that Ron Jeremy is one of the busiest actors in the drama category where this data comes from.

	# of Connections	# of Films
Vernon Dobtcheff	378	47
Jean-François Stévenin	356	36
Jean-Paul Muel	355	40
Roland Blanche	351	40
Victor Garrivier	341	37

Table 1: Most Connected Actors

To see the shortest path between two actors, we randomly select two actors: **Takanori Jinnai** and **Benoît Régent**. Using R and iGraph, we found that the shortest path contains 3 vertices: Takanori Jinnai was in *Fuhô-taizai* with Renji Ishibashi, Renji Ishibashi was in *Fruits de la passion, Les* with Arielle Dombasle, Arielle Dombasle was in *Grand bonheur* with Benoît Régent. Figure 4 on page 6

	# of Connections	# of Films
Velimir 'Bata' Zivojinovic	188	57
Ron Jeremy	234	51
Dora Doll	331	47
Vernon Dobtcheff	378	47
François Berléand	277	42

Table 2: Busiest Actors

4 Association Rules

We first looked for association rules with at least 0.01 percent support and 10 percent confidence; there are around 93 thousand such rules. To make the list of rules more managable to look at, we changed the minimum level of support from 0.01 percent to 0.1 percent. This change resulted in a set of 18 rules, displayed in Table 3

lhs		rhs	support	confidence	lift
{Royle, David (I)}	=>	{Buchanan, Colin (I)}	0.00105	0.8824	743.56
{Buchanan, Colin (I)}	=>	{Royle, David (I)}	0.00105	0.8824	743.56
{Royle, David (I)}	=>	{Clarke, Warren}	0.00105	0.8824	468.17
{Clarke, Warren}	=>	{Royle, David (I)}	0.00105	0.5556	468.17
{Buchanan, Colin (I)}	=>	{Clarke, Warren}	0.00105	0.8824	468.17
{Clarke, Warren}	=>	{Buchanan, Colin (I)}	0.00105	0.5556	468.17
{George, Götz}	=>	{Feik, Eberhard}	0.00119	0.7083	307.50
{Feik, Eberhard}	=>	{George, Götz}	0.00119	0.5152	307.50
{Hegstrand, Michael}	=>	{Laurinaitis, Joe}	0.00105	1.0000	895.38
{Laurinaitis, Joe}	=>	{Hegstrand, Michael}	0.00105	0.9375	895.38
{Foley, Mick}	=>	{Austin, Steve (IV)}	0.00105	0.8824	665.29
{Austin, Steve (IV)}	=>	{Foley, Mick}	0.00105	0.7895	665.29
{Zivkovic, Vladan}	=>	{Cipranic, Ljubomir}	0.00105	0.5556	209.44
{Cipranic, Ljubomir}	=>	{Zivkovic, Vladan}	0.00105	0.3947	209.44
{Janicijevic, Dusan}	=>	{Zivojinovic, Velimir 'Bata'}	0.00119	0.4595	115.48
{Zivojinovic, Velimir 'Bata'}	=>	{Janicijevic, Dusan}	0.00119	0.2982	115.48
{Milinkovic, Predrag}	=>	{Cipranic, Ljubomir}	0.00105	0.3659	137.93
{Cipranic, Ljubomir}	=>	{Milinkovic, Predrag}	0.00105	0.3947	137.93

Table 3: Association Rules

We can take a close look at the first listed rule to understand what the association rules are telling us. The `lhs` variable is **David Royle** and the `rhs` variable is **Colin Buchanan**. The support of this rule is 0.00105, meaning that in our sample of films, there is a 0.105 percent chance of randomly drawing a film with both of these actors. The confidence of this rule is 0.882—given that **David Royle** is in a movie, there is an 88.2 percent chance that **Colin Buchanan** is in that movie as well. The lift of this rule is 744, which means that the probability of a movie having **Colin Buchanan** is 744 times higher if we know that **David Royle** is in the movie as well.

A more intuitive way of thinking about these results is that for two actors A and B:

- Support (for the rule) is the joint probability of A and B being in a film;
- Confidence is the probability that B is in a film conditional on A being in the film; and
- Lift is the ratio of confidence (conditional probability) to the unconditional probability (support) of B.

5 Regression Alternative to Association Rules

Here we look at one association rule and replicate its results with a binomial regression. We examine the association between **David Royle** and **Warren Clarke**:

```
lhs                     rhs                support  confidence  lift
{Royle, David (I)} =>  {Clarke, Warren}  0.00105       0.882   468
```

For notational purposes, we will abbreviate these two as R and C, respectively. First, recognize that the conditional probability (i.e. confidence) can be found by regressing C on R:

$$D_{i,C} = \alpha + \beta_R D_{i,R} + \epsilon$$

$D_{i,R}$ and $D_{i,C}$ are dummy variables that equal 1 if the actor is in movie i and 0 otherwise. The sum $\alpha + \beta_R$ is the odds multiplier on C given R; we can convert this to a probability using the logit link:

$$P(C|R) = \frac{1}{1 + \exp(\alpha + \beta_R)} = 0.882352941$$

This value matches the confidence of our selected rule. The support of our selected rule is the joint probability of R and C being in a film, which we can calculate as the mean of $D_{i,R} \cdot D_{i,C}$; since our variables are dummy variables with value 1 or 0, the mean of this product gives us the probability of both jointly occurring.

$$P(C, R) = \overline{D_{i,C} \cdot D_{i,R}} = 0.0010470$$

This matches the support of our given rule. The lift is just the conditional probability (confidence) divided by the unconditional probability of C, which we can similarly calulate as the mean of $D_{i,C}$. The lift is:

$$\frac{P(C|R)}{P(C)} = \frac{1}{1 + \exp(\alpha + \beta_R)} \frac{1}{\overline{D_{i,C}}} = 743.5640$$

This also matches the lift of our given rule.

6 Appendix

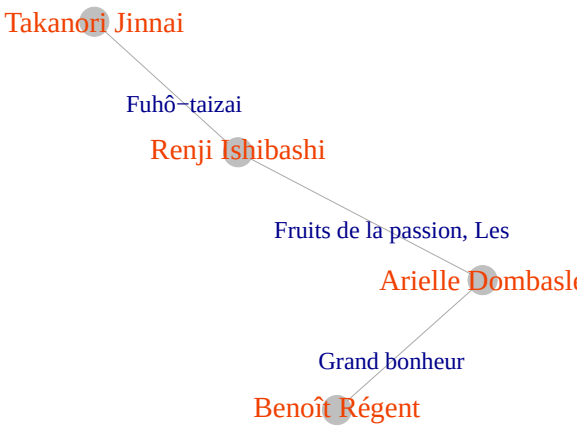


Figure 4: Shortest Path Between Actors