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A Social Network Analysis of Jobs and Skills

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Abstract—**In this study, we analyzed job roles and skills across industries in Singapore. Using social network analysis, we identified job roles with similar required skills, and we also identified relationships between job skills. Our analysis visualizes such relationships in an intuitive way. Insights derived from our analyses are expected to assist job seekers, employers as well as recruitment agencies wanting to understand trending and required job roles and skills in today's fast changing world.**

Keywords—analytics, jobs, skills, career, social network analysis

I. Introduction

Accredify Pte. Ltd. provides a turnkey portal for education institutes to issue, receive and verify digital tamper-proof credentials such as certificates and transcripts. With Accredify, education institutes can communicate seamlessly from student registration, inter-school programs, graduation and lifelong learning programs. As Accredify seeks to gain a strong foothold in the industry, it has to constantly think of ways to add business value for its clients. Clients that engage in Accredify's services are mainly higher learning institutes and private education institutes. There are 2 problems identified by Accredify's clients:

1. Low visibility into the current job market trends

2. Need greater understanding of what skills are relevant and in demand in the Singapore job market

When course providers understand what kind of skills are being sought after in Singapore for which types of jobs, they can plan their courses more effectively in order to meet the demand of the skills market. This helps the course providers better meet the needs of learners and plan their marketing strategies, and ultimately, attract more of the learners to take up courses. This will then in turn create value for Accredify when the number of certificates issued increases as a result.
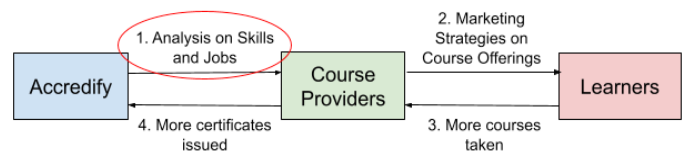

Fig. 1. Relationship between Accredify and their stakeholders

Therefore, the analysis on skills and jobs will be where we seek to help Accredify achieve. In-depth analysis on the skills needed in the various industries and job roles can be done by understanding:

1. Exploratory information on industries, jobs in the market and the course providers

2. Relationship between job roles in the market

3. Relationship between skills that exist in the market

On top of the main business problem of helping Accredify's clients, we also identified an additional problem that potential learners faced. Typically, people take up courses and certifications to pick up skills to increase their productivity at work, make themselves more employable or to make career switches and progressions. They have a set of skills but are usually unaware of:

1. The jobs they can apply for with their skills

2. Useful skills that boost their employability.

II. Data Collection and Pre-processing

As the project revolves around the demand of skills needed in each industry, we performed web crawling and scraping on multiple job portals and course provider websites. Our dataset will be limited to the top 5 industries namely Technology, Healthcare, Engineering, Finance and Accounting, and Marketing and Advertising.

A. Job Portals in Singapore

In order to find out the job roles available and the skills required by different job industries, we performed web scraping of two popular Singapore job portals - Indeed and JobsDB. The web scraping was done using a tool called Octoparse (Fig. 2).

Job_Role	Job Description
1 year contract admin executive sales sentosa	['Far East Hospitality Holdings Pte Ltd (Far East Hospitality), a
1data business analyst	['Job Summary A challenging opportunity awaits you! Our clie
2020 apac graduate programme g10 rates aud	['In Asia Pacific, BNP Paribas is one of the best-positioned inte
2020 apac graduate programme global markets	['In Asia Pacific, BNP Paribas is one of the best-positioned inte
2020 apac graduate programme marketing ana	['In Asia Pacific, BNP Paribas is one of the best-positioned inte
2020 apac summer intern programme quantita	['In Asia Pacific, BNP Paribas is one of the best-positioned inte
2020 digital marketing apprentice	['As the world's #1 Beauty Company, L'Oréalites are entrepren

Fig. 2.   Raw Job Listings retrieved from Octoparse (without URL & Industry Column)

We manually labelled the job listing roles as it was not possible to preprocess this data without looking at the job description. A new column called "Cleaned Job Roles" was created as a result. Furthermore, we also realized that a similar job position might have different seniority levels that require different skill sets to apply. We looked through and labelled the job listings to create a new column called "Position" (Fig. 3). The "Position" column now contains categorical variables such as "intern", "manager" to distinguish between them.

Job_Role	Cleaned_Job_Role	Position	Job_Description
1 year contract admin executive sales sentosa	admin	executive	Far East Hospitality Holdings Pte Ltd (Fa
1data business analyst	data business analyst		Job Summary A challenging opportunit
2020 apac graduate programme g10 rates aud	trader	graduate	In Asia Pacific, BNP Paribas is one of the
2020 apac graduate programme global market	market analyst	graduate	In Asia Pacific, BNP Paribas is one of the
2020 apac graduate programme marketing ana	marketing analyst	graduate	In Asia Pacific, BNP Paribas is one of the
2020 apac summer intern programme quantita	quantitative analyst	intern	In Asia Pacific, BNP Paribas is one of the
2020 finance analyst internship	finance analyst	intern	Req. ID: 169606\n\nThis internship give

Fig. 3.   Job Listings data with cleaned Job Roles and new Position column

B. LinkedIn Skills List

To extract out the skills from the job description, we needed a list of skills that are relevant in the current job market. However, there are too many skills that are required for different job roles and it is not realistic for us to list down all the skills from scratch. Hence, we decided to turn to an available skills list in LinkedIn [1] that includes all the skills that LinkedIn users have listed down before (Fig. 4).

Skills
.net
a+
a/b testing
a/r management
a/v systems
abra suite
acceptance testing
access control management
account management

Fig. 4.   Skills list obtained from LinkedIn with 1 column called Skills

We extracted skills from job descriptions (Fig. 5) but noticed that certain skills should not be included as they either do not entail as a skill or are irrelevant in today's context. These skills are removed and the remaining are re-grouped together using Tableau. For example, skills such as "excel", "powerpoint" and "word" can also refer to "microsoft tools" and can be grouped together to form an additional skill.

Job_Title	Cleaned_Job_Title	Position	Skills
1 year contract admin	admin	executive	microsoft office,hospitality
1data business analys	data business analyst		data warehousing,hadoop,information technology,
2020 apac graduate p	trader	graduate	banking,word,excel
2020 apac graduate p	market analyst	graduate	banking,word,statistics,finance,excel
2020 apac graduate p	marketing analyst	graduate	banking,word,excel
2020 apac summer int	quantitative analyst	intern	banking,word,excel
2020 finance analyst i	finance analyst	intern	accounting,finance,ongoing

Fig. 5.   Job Listings data with new column called Skills

C. Course Providers

As we seek to find out the courses that were available, we scraped the course providers' websites of 10 major players in Singapore including tertiary institutions, NTUC Learning Hub and other course providers whose courses were applicable to claim from SkillsFuture (Fig. 6).

Course Provider	Course Title	Course Description
Singapore University of Social Sciences	A Design Thinking Mindset	This course introduces the idea of design as a model for innovation based
Singapore University of Social Sciences	Human Centred Design: Re-Imagined	This course examines how a SERVICE which is a non-physical transaction
Singapore University of Social Sciences	Smart Contract Programming for Businesses	The course will provide an introduction to the Ethereum blockchain, discu
Singapore University of Social Sciences	Digital Photography as an Art Form	This course covers the theoretical aspects of digital photography so that
Singapore University of Social Sciences	Photography: the Creative Medium	This course will equip you with skills to be an all-rounded photographer, e
Singapore University of Social Sciences	Data Mining for Decision Making	Business leaders have many reasons to be interested in data mining.
Singapore University of Social Sciences	Text Mining and Big Data for Decision Making	Discover how big data analytics and text mining can be integrated into th
Singapore University of Social Sciences	Visualisation for Decision Making	See how data visualisation transforms data into meaningful insights for su

Fig. 6.   Raw Course Provider retrieved from Octoparse

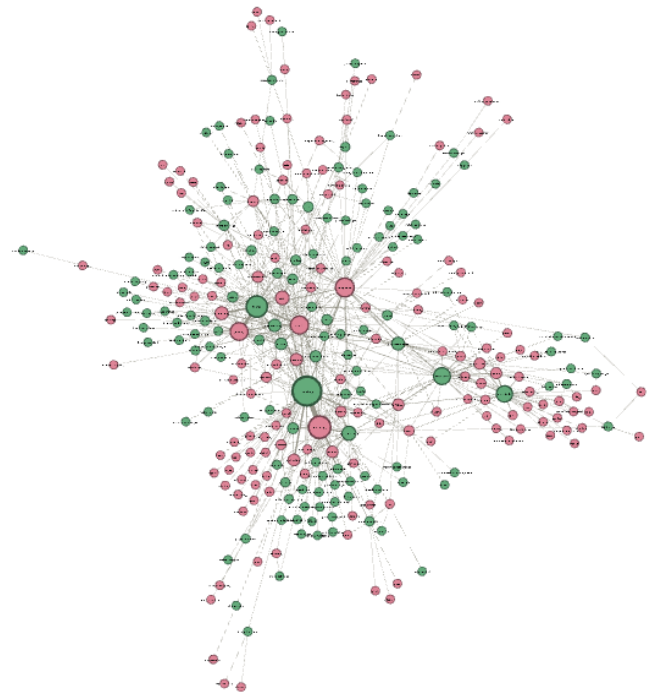## III.   SOCIAL NETWORK ANALYSIS

Fig. 7.   Bipartite Network Graph of Job Roles and Skills

Job roles & skills bipartite network (Fig. 7) shows not only common skills associated with each job role but also common skills across job roles. This insight is particularly useful to job seekers wanting to switch to a new job role. On top of their existing skills, what additional job skills should they acquire in order to make a successful job switch?
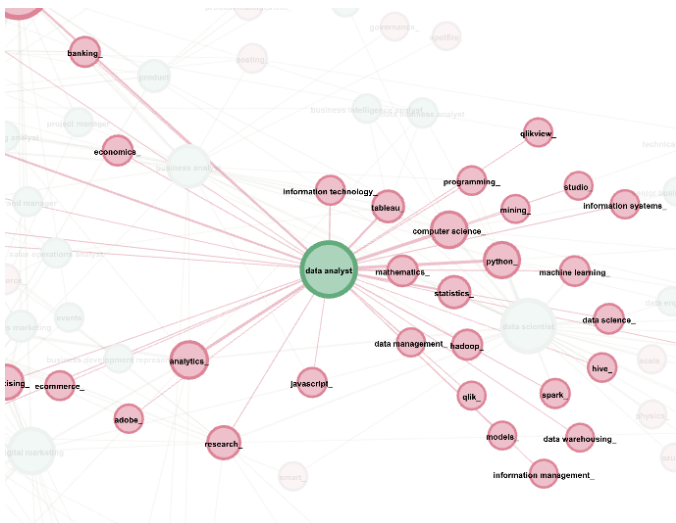
Fig. 8.   Bipartite Network Graph zoomed into Data Analyst role

As shown in Fig. 8, the network graph makes it easy to see what skills are linked to the Data Analyst job role.
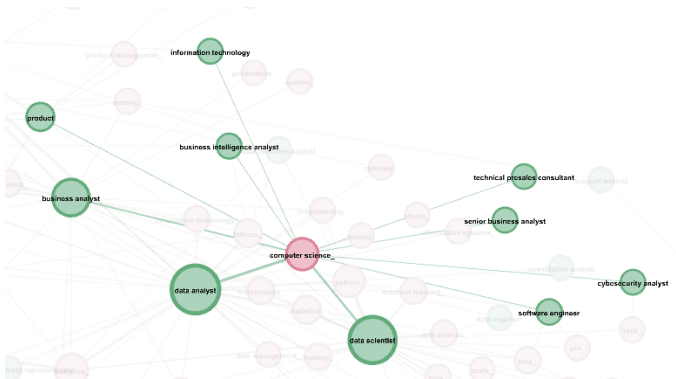

Fig. 9.   Bipartite Network Graph zoomed into Computer Science skill

Fig. 9 shows different job roles that require the Computer Science skill.
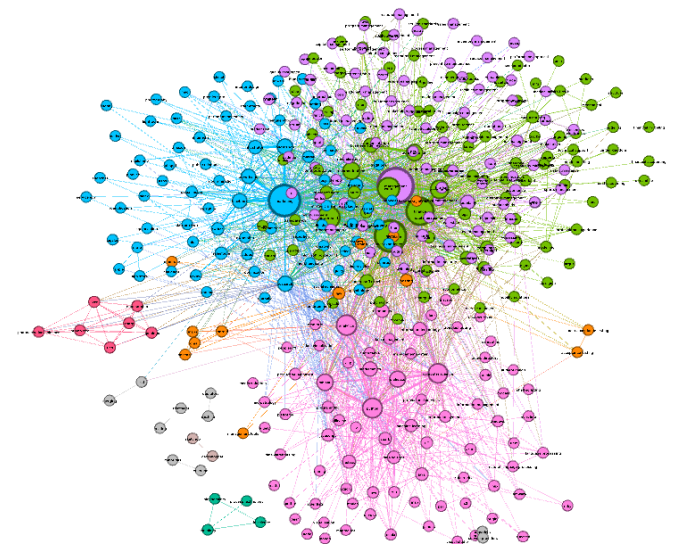

Fig. 10. Skills Network Graph after Weight Filtering

Fig. 10 shows different clusters of job skills. This graph was created with each skill as a node and the number of common job roles as the weight. The network graph is created with the aim to show the relationship between each skill and how important it is to have both skills in order to apply for job positions. The network consists of 381 job roles.
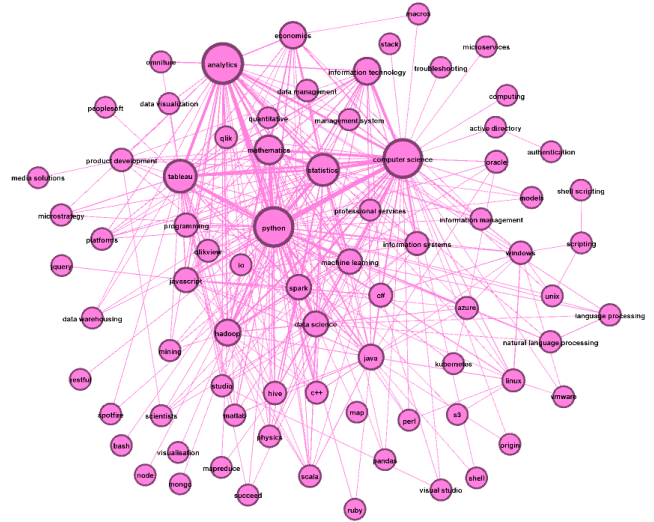

Fig. 11. Skills Cluster - Technology Skills

Fig. 11 shows a subgraph from the Skills Network Graph (Fig. 10), and it shows job skills found in Technology job roles. This cluster is very well-connected, with many skills having a connection to one another. This insight can help working professionals wanting to upskill and cross skill to advance their career in the current career track. It can also benefit employers wanting to re-allocate existing employees to new job functions. Employers can easily identify one or more job roles that existing employees can be immediately deployed to – with little to no additional skills training.

IV. CONCLUSION

In this study, we analyzed job roles and skills across industries in Singapore. Using social network analysis, we identified job roles with similar required skills, and we also identified relationships between job skills. Insights derived from our analyses are expected to assist job seekers, employers as well as recruitment agencies wanting to understand trending and required job roles and skills in today's fast changing world.

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