



Using Taxonomies in Large-Scale Job Matching

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WCC Smart Search & Match

- **ELISE: advanced technology for searching and matching for large organizations:**
 - Optimize decision support by leveraging many heterogeneous data sources
 - Exact/inexact, structured/unstructured, and private/public data
 - Highly scalable
- Large customers in public and private sectors all around the world
- Vast experience and expertise in specific applications of our technology

WCC's Expertise

- Employment domain:
 - Public employment services:
 - Helping the unemployed from social welfare to a job
 - Workforce development
 - Staffing agencies: filling jobs faster than the competition, while maximizing profits
- Identity domain:
 - Combining biometric and biographic information in order to timely and accurately identify people
 - Applications in:
 - Justice and public safety: multi-cultural name matching, searching through police databases
 - Civil identity: data de-duplication
 - Border management and remote UNHCR refugee camps: identification of people

Matching in ELISE (1)

- Data objects in ELISE are essentially collections of key-value pairs, that can be offered or demanded

Candidate			
Offered		Demanded	
Skill:	Administration	Salary:	> € 1,500
Education:	High school	Job title:	Nurse

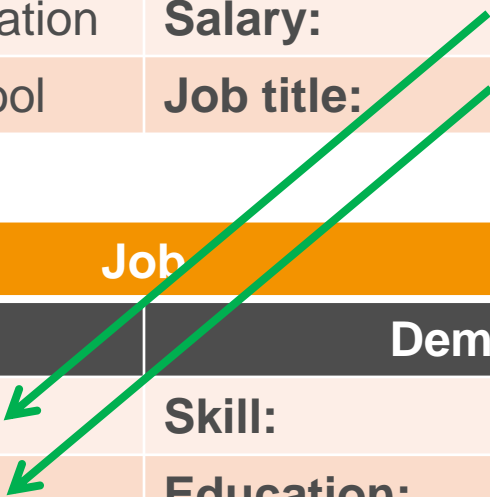
Job			
Offered		Demanded	
Salary:	€ 2,000	Skill:	Nursing
Job title:	Nurse	Education:	Nursing school

Matching in ELISE (2)

- A search for data objects is uni-directional: constraints hold for the values of specific properties of the targeted data objects

Candidate			
Offered		Demanded	
Skill:	Administration	Salary:	> € 1,500
Education:	High school	Job title:	Nurse

Job			
Offered		Demanded	
Salary:	€ 2,000	Skill:	Nursing
Job title:	Nurse	Education:	Nursing school



Matching in ELISE (3)

- A match between two data objects is bi-directional: the demanded values of both objects are compared to one another's offered values

Candidate			
Offered		Demanded	
Skill:	Administration	Salary:	> € 1,500
Education:	High school	Job title:	Nurse

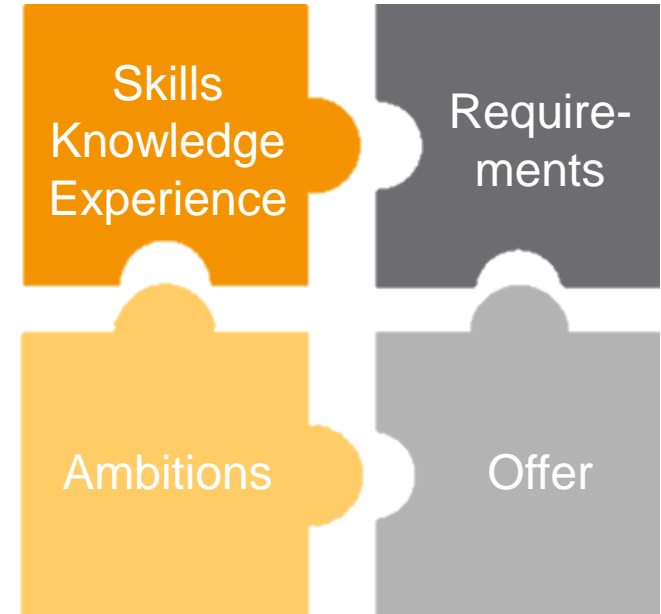
Job			
Offered		Demanded	
Salary:	€ 2,000	Skill:	Nursing
Job title:	Nurse	Education:	Nursing school

Matching in ELISE (4)

- Fuzzy matching:
 - Flexible numeric/date/distance ranges and gliding scales
 - Approximate text matching by accounting for, e.g., typos, affinities, names, and proximity
 - Flexible way of dealing with multiple values
 - Weighted criteria

Job Matching Challenges (1)

- Matching in the employment domain:
 - Find best matching jobs/candidates for a given candidate/job
 - Skills-based matching: match based on skills rather than desired job titles or fields
 - Value-based matching: account for estimated/perceived value of a placement



Job Matching Challenges (2)

- Gap analysis: identify what constitutes a candidate's distance to the labor market
- Profiling: characterizes a candidate as a member of a certain target group
- Referral:
 - Find the best support measures to address identified gaps
 - Optimize resource allocation over candidates, gaps, and support measures
- Data quality is key: reliance upon complete, correct, and current information

Taxonomies in Job Matching (1)

- Taxonomies can help get data quality up to par for effective matching
- Taxonomy-based data quality improvements:
 - Identify taxonomy concepts:
 - Guide data entry process (autocomplete, suggestions)
 - Classify free text
 - Enrich data for better matching using taxonomy information (infer or correct information)

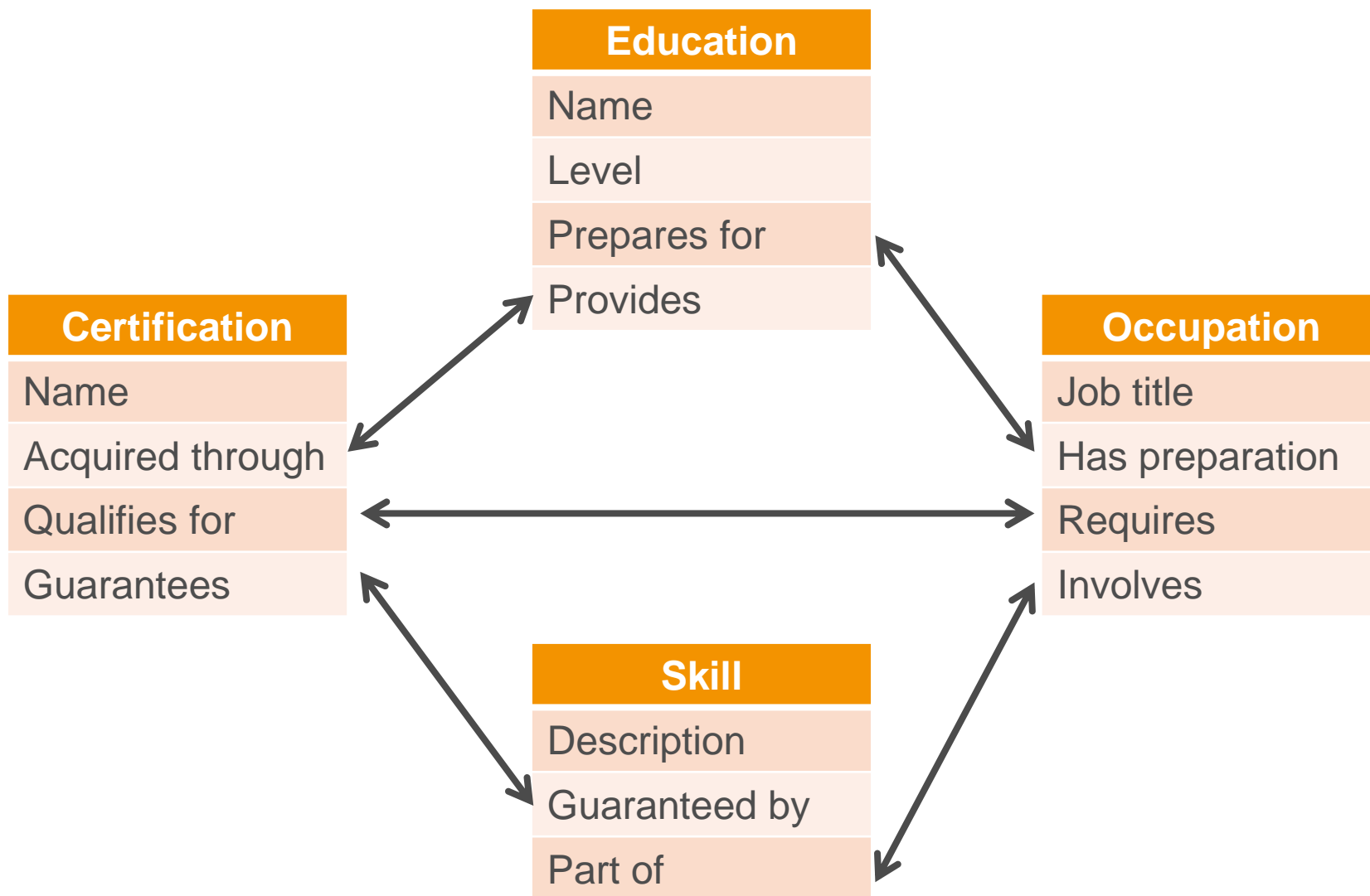
Taxonomies in Job Matching (2)

- Taxonomy-driven matching: use taxonomy information in match strategies, e.g.:
 - Expand match with jobs that require a large part of the skillset that a candidate obtained through their education
 - Expand match with jobs that are considered similar under certain conditions like long-term unemployment
- Taxonomy-driven market insights:
 - Map actual data to taxonomy concepts and analyze patterns
 - Identify issues and how to tackle these, e.g., in workforce development, identify mismatch between demand and supply and how to best address this
 - Improve taxonomies based on insights

Challenge 1: Modeling the Domain (1)

- Domain model describes concepts, their properties, and potential relations between concepts
- Determining the domain structure:
 - Data-driven
 - Expert-driven

Challenge 1: Modeling the Domain (2)



Challenge 2: Knowledge Management (1)

- Populate the taxonomies for the distinct concepts in the domain model (e.g., describe a hierarchy of occupations, another one of skills, etc.)
- Our Taxonomy Manager tool can be used for this
- This could also be done (semi-)automatically based on actual data

Challenge 2: Knowledge Management (2)

The screenshot displays a web application interface for knowledge management. At the top, there is a navigation bar with 'TM', 'Overview', and 'Taxonomy' (the active tab), and a version number '0.13.0BUILD01' on the right. Below the navigation bar is a breadcrumb trail: 'Occupation > Managers > Chief executives, senior offic... > Legislators and senior officials > Senior government officials'. On the left side, a vertical list shows a hierarchy of roles under 'Senior government officials', with a '+ Add node' button at the top. The main content area on the right shows the details for 'Administrative Inspection Manager'. It includes sections for 'NAME', 'CODE', 'DESCRIPTION', and 'SYNONYMS'. The 'SYNONYMS' section contains two tags: 'Inspector' and 'Administrative Inspection Supervisor', with a '+ Add' button to the right. Below the synonyms is a highlighted orange button that says 'See pending changes'. At the bottom of the details section, there is a section for 'REQUIRES CERTIFICATION' with an expandable arrow and a '+ Add' button.

TM Overview Taxonomy 0.13.0BUILD01

Occupation > Managers > Chief executives, senior offic... > Legislators and senior officials > Senior government officials

← Senior government officials + Add node

- Administrative Inspection Manager >
- Civil Registry Manager >
- Commerce Supervision Manager >
- Commercial Registry Manager >
- Court Administration Manager >
- Cultural Affairs Manager >
- Customs Manager >
- Daawa Manager >
- Endowments and Mosque Affairs Manager >
- Fatwa Manager >
- Fire Commissioner >

Overview History

NAME
Administrative Inspection Manager

CODE
111201

DESCRIPTION
Plan, direct and coordinate administrative inspection activities. Audit public sector organisations and recommend improvements in policies and procedures.

SYNONYMS

Inspector Administrative Inspection Supervisor +

See pending changes

REQUIRES CERTIFICATION + Add

[Prototype]

Challenge 3: Taxonomy Mappings (1)

- Mappings between taxonomy concepts can be created in our Taxonomy Manager tool:
 - Within a domain model (e.g., an occupation requires a particular skill)
 - Across domain models that are used for different purposes (e.g., a Java Programmer in one occupation taxonomy is a Software Engineer in another)

Challenge 3: Taxonomy Mappings (2)

The screenshot displays a web application interface for taxonomy management. At the top, there is a navigation bar with 'TM', 'Overview', and 'Taxonomy' tabs, and a version number '0.13.0BUILD01' on the right. Below the navigation bar, a breadcrumb trail shows the path: 'Chief executives, senior offic...' > 'Legislators and senior officials' > 'Senior government officials'. On the left, a sidebar contains a list of nodes with a '+ Add node' button. The main content area has an 'Overview' tab and a 'History' icon. It features three expandable sections: 'CONSISTS OF WORK ACTIVITY' with items like 'Identify violations', 'Promote transparency', 'Liaise with stakeholders', and 'Manage inspections'; 'PART OF INDUSTRY'; and 'HAS PREPARING EDUCATION' with a 'Select' button. On the right, a sidebar shows a list of related terms under the heading 'Bachelor degree or equivalent', with a '+ Add relation' button. The list includes: 'Finance, banking and insurance', 'Fine arts', 'Fisheries', 'History and archaeology', 'Horticulture', 'Journalism and reporting', 'Law', 'Library, information and archival studies', 'Literature and linguistics', 'Management and administration', 'Marketing and advertising', and 'Materials (glass, paper, plastic and wood)'.

[Prototype]

Challenge 3: Taxonomy Mappings (3)

- Mappings within a domain model could be generated (semi-)automatically based on actual data linked to taxonomy concepts
- Cross-domain mappings could also be generated (semi-)automatically based on, e.g., lexico-semantic similarity and common ancestors
- Open challenge: which mappings are relevant in what context?

Challenge 4: Taxonomy Concept Classification

- Job ads and CVs do not always contain all information on job positions, educations, etc.
- Identifying the relevant taxonomy concepts can help inferring or correcting information
- Our Vacancy Classifier tool uses machine learning to classify vacancies as occupations in a taxonomy



IMMEDIATELY REQUIRED
A reputed restaurant is looking to recruit experienced and well trained professionals, with attractive salaries and benefits.

▪ RESTAURANT MANAGER	▪ COMMI CHEF
▪ RECEPTIONIST	▪ STEWARDS
▪ WAITERS	▪ BARISTA

PREFERENCE FOR SAUDI NATIONALS.
Well qualified and experienced staff kindly forward your CV's to E-mail: info@saudigaia.com
The company will notify you with a date and time the interviews will be conducted.



A firm in Saudi Arabia, with headquarters in Riyadh, is in need of the following for their branches in Riyadh, Jeddah and Dammam:

(3) MECHANICAL ENGINEERS (1 bachelor graduate & 2 diploma graduates)
(5) MARKETING REPRESENTATIVES
(4) PURCHASE COORDINATORS
(2) ACCOUNTANTS

Applicants should have the following qualifications:
• Fresh graduate or either bachelor or diploma degrees
• Communication skills, preferably spoken and written English

PRIORITY FOR SAUDI NATIONALS
Interested applicants may send CV by e-mail to: hr.ksa@sosgroup.com

Challenge 5: Smart Enrollment

- Data entry can be done in an interactive process:
 - Autocomplete can suggest or enforce users to select taxonomy concepts
 - Based on selected taxonomy concepts, additional information can be suggested to, prepopulated for, and/or verified with the user
- When automatically entering data through parsing, taxonomy concepts can be identified by the parser

Challenge 6: Leveraging Taxonomy Data (1)

- Matches can be expanded based on information in taxonomies
- Our match configuration screens allow for the creation of rules that specify how taxonomy data can be used
- Other modules like Gap analysis and Referral can benefit from such rules as well

Challenge 6: Leveraging Taxonomy Data (2)

WCC
Program Strategy Manager

Home
Scenarios
Perspectives
Target Groups
Gap Configuration
Referral Configuration

Perspectives

Perspective configuration

Perspective name	Perspective explanation
Occupations for which you have skills	This perspective will find show you available occupations based on similarity with your skills level.
Match from	Match to
Job seeker	Vacancy

Taxonomy rules

Input	Output	Method	Parameter
Previous occupation: 91%	Offered occupation: 100%	consists of skill	10%

Add Method

ELISE rules

From Job Seeker Profile	To Job Profile	Method	Parameter
Add Element			

Default sorting occupations

Order	Order
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[Prototype]

Challenge 6: Leveraging Taxonomy Data (3)

The screenshot displays the 'Gap Configuration' interface in the WCC Program Strategy Manager. The page is titled 'Gap perspective configuration' and includes a sidebar with navigation options: Home, Scenarios, Perspectives, Target Groups, Gap Configuration, and Referral Configuration. The main content area is divided into two sections: 'Perspective name' and 'Taxonomy rules'.

Perspective name: The name is 'Gaps between occupation an' and the explanation is 'This perspective shows which gaps are present for certain occupation.' A heart icon is visible next to the name.

Match from: Job seeker (dropdown)

Match to: Vacancy (dropdown)

Taxonomy rules: This section is highlighted with an orange oval and contains a table of rules:

Input	Method	Parameter	
Completed education: 64% (dropdown)	prepares for occupation (dropdown)	1% (input)	x
Skills: 100% (dropdown)	part of occupation (dropdown)	1% (input)	x

Below the table is an 'Add Method' button. At the bottom of the configuration area are 'Save' and 'Cancel' buttons.

[Prototype]

Challenge 6: Leveraging Taxonomy Data (4)

The screenshot displays the 'Referral Configuration' interface within the WCC Program Strategy Manager. The left sidebar contains navigation links: Home, Scenarios, Perspectives, Target Groups, Gap Configuration, and Referral Configuration. The main panel is titled 'Referral configuration' and contains a section for 'Referral rules'. This section features a table with two columns: 'Input' and 'Method'. Two rules are currently defined and are highlighted with an orange oval:

Input	Method	
Education code	direct	x
Skill code	is taught by support meas	x

Below the table is an 'Add rule' button. At the bottom of the configuration area are 'Save' and 'Cancel' buttons.

[Prototype]

Challenge 7: User Acceptance (1)

- End users tend to reject the system when confronted with matches that do not make sense
- Our solution:
 - Involve users in the match process by increasing complexity step by step (opt-in)
 - Explain match results

Challenge 7: User Acceptance (2)

The screenshot shows a web interface for job recommendations. At the top, there is a navigation bar with the WCC logo and menu items: SEARCH, PERSPECTIVES, PROFILE, and ABOUT. A user profile icon is in the top right. The main content area is titled "Recommended occupations based on Occupations based on your skills". Below this title, a message states "No suitable occupations? We recommend to change your viewpoint" with a "change viewpoint" button. A sorting dropdown is set to "Number of vacancies". A section titled "Occupations based on your skills" explains that the perspective shows available occupations based on skill similarity. A list of occupations follows, each with a job count in a blue button: Salesmanager (82 jobs), Marketingmanager (43 jobs), Bouwkundig projectleider (27 jobs), Business development manager (23 jobs), and Bedrijfsmanager detailhandel. Orange ovals highlight the "change viewpoint" button, the "Occupations based on your skills" section header, and the "Find out what you can improve to better suit this occupation" link for the Salesmanager role.

Recommended occupations based on Occupations based on your skills

No suitable occupations? We recommend to change your viewpoint [change viewpoint](#)

Sorted by:

Occupations based on your skills
This perspective will find show you available occupations based on similarity with your skills level

Salesmanager Salesmanager Find out what you can improve to better suit this occupation	82 jobs
Marketingmanager Marketingmanager Find out what you can improve to better suit this occupation	43 jobs
Bouwkundig projectleider Bouwkundig projectleider Find out what you can improve to better suit this occupation	27 jobs
Business development manager Business development manager Find out what you can improve to better suit this occupation	23 jobs
Bedrijfsmanager detailhandel	

[Prototype]

Challenge 7: User Acceptance (3)

- Even more than end users, domain experts using our software need to feel in control
- Using machine learning black boxes is particularly challenging
- We offer management tools that allow control over, e.g., classifiers - this includes manual overrides
- Machine learning can also be used for decision support rather than actual decision making (e.g., only suggest new mappings)

Challenge 7: User Acceptance (4)

VCAT

☰ Pending Items

MAIN NAVIGATION

- Dashboard
- Pending Items
- Configuration
 - Filter rules configuration
 - Classifier configuration
 - Publication configuration
- Monitoring
- Reporting
- Webform
- Logout

⚙️ Jobtitle: Klantadviseur verzekeringen in Dordrecht

Classification suggestions

Code	Description	Confidence	Approve
1000402534	Medewerker binnendienst assurantiën	50 %	<input checked="" type="checkbox"/> Approve
1000402501	Assurantieadviseur	50 %	<input checked="" type="checkbox"/> Approve
1000412272	Programmeur dot.net	30 %	<input checked="" type="checkbox"/> Approve
123	Administratief medewerker bankbedrijf	10 %	<input checked="" type="checkbox"/> Approve
1000402462	Clientadviseur bankbedrijf	10 %	<input checked="" type="checkbox"/> Approve

↩ Next vacancy ↩ Next category ⚪ Not classifiable

+ Add a manual classification

* Details

Over de functie Als klantadviseur verzekeringen bij één van de leukste en meest groeiende bedrijven in de Drechtsteden bestaan je belangrijkste werkzaamheden uit: * klanten telefonisch en schriftelijk te woord staan * vragen en klachten afhandelen * mailbox behandelen * werklijsten bijwerken * commerciële acties met klanten bespreken * afspraken voor de buitendienstmedewerker maken Deze functie is zowel fulltime als parttime (min. 32 uur) te vervullen. Het betreft zorg-, schade-, reis- en autoverzekeringen waar je inhoudelijk advies over geeft aan klanten en prospects. Wat wij bieden De salarisindicatie bij deze functie is € 2200,- bruto per maand op basis van een 40-urige werkweek. Verder biedt onze opdrachtgever uitstekende doorgroeimogelijkheden. Het is de insteek dat je minimaal een aantal jaren bij de organisatie blijft werken, derhalve is het mogelijk om een contract voor onbepaalde tijd te verkrijgen bij goed functioneren. Onze opdrachtgever biedt tevens goede secundaire arbeidsvoorwaarden zoals een winstdeling aan het einde van het jaar, korting op de zorgverzekering, een uitgebreide pensioenregeling en de mogelijkheid parttime te werken (32 uur per week).

+ Properties

[Prototype]

Lessons Learned

- Constructing a taxonomy that can be used in job matching is a challenge in and of itself
- A well-defined and well-maintained taxonomy:
 - Enables us to use complete, correct, and current data in job matching by:
 - Structuring unstructured data
 - Enriching structured data
 - Facilitates knowledge-driven job matching
- Harnessing the power of taxonomies, we can go beyond job matching and support workforce development

A photograph of a business meeting in a high-rise office. Two men in suits are shaking hands in the foreground, smiling. In the background, other business professionals are engaged in conversations. The office has large windows overlooking a city skyline, with a prominent skyscraper visible. The lighting is bright, suggesting daytime.

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