

Labor Market Analysis: 0799.00/Other Information Technology
AI Prompt Engineering - Certificate requiring 6 to < 18 semester units
 Los Angeles Center of Excellence, June 2023

Summary

Program Endorsement:	Endorsed: All Criteria Met <input type="checkbox"/>	Endorsed: Some Criteria Met <input checked="" type="checkbox"/>	Not Endorsed <input type="checkbox"/>
Program Endorsement Criteria			
Supply Gap:	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>	
Living Wage: (Entry-Level, 25th)	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>	
Education:	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	
Emerging Occupation(s)			
	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>	

The Los Angeles Center of Excellence for Labor Market Research (LA COE) prepared this report to provide regional labor market supply and demand data related to machine learning and artificial intelligence. According to Harvard Business Review, artificial intelligence (AI) can support business needs through automating business processes, gaining insight through data analysis and mining, and by engaging with customers and employees.¹ A recent article highlights the multitude of ways that PepsiCo is utilizing AI on a daily basis to create new products and flavors, determine which stores are selling the most of specific products, and to optimize product placement.² Since this field of technology is relatively new, the Standard Occupational Classification (SOC) system has yet to classify artificial intelligence occupations. Therefore, this report utilizes real-time job posting information from employer job advertisements to approximate demand for artificial intelligence-related jobs, as well as SOC codes that employ the skills necessary for artificial intelligence. Occupations included in this report are the following:

- **Software Developers (15-1252)** Research, design, and develop computer and network software or specialized utility programs. Analyze user needs and develop software solutions, applying principles and techniques of computer science, engineering, and mathematical analysis. Update software or enhance existing software capabilities. May work with computer hardware engineers to integrate hardware and software systems, and develop specifications and performance requirements. May maintain databases within an application area, working individually or coordinating database development as part of a team.³
- **Computer Occupations, All Other (15-1299)** All computer occupations not listed separately.⁴

¹ Harvard Business Review: <https://hbr.org/2018/01/artificial-intelligence-for-the-real-world>

² <https://www.axios.com/2023/04/06/pepsico-artificial-intelligence-kanioura>

³ [Software Developers, Quality Assurance Analysts, and Testers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics \(bls.gov\)](https://www.bls.gov/publications/outlook/handbook/occupational-outlook-handbook-2022-2030)

⁴ [Computer Occupations, All Other \(bls.gov\)](https://www.bls.gov/publications/outlook/handbook/occupational-outlook-handbook-2022-2030)

- **Data Scientists (15-2051)** Develop and implement a set of techniques or analytics applications to transform raw data into meaningful information using data-oriented programming languages and visualization software. Apply data mining, data modeling, natural language processing, and machine learning to extract and analyze information from large structured and unstructured datasets. Visualize, interpret, and report data findings. May create dynamic data reports.⁵

Currently, there is not a standard occupational classification (SOC) code for a middle-skill occupation in the field of artificial intelligence. While the occupations in this report typically require a bachelor's degree and are not traditionally considered middle-skill⁶, these occupations are most closely aligned with the knowledge, skills, and abilities required for an entry-level job seeker in the emerging field of artificial intelligence. This report is intended to help determine whether there is demand in the local labor market that is not being met by the supply from community college programs that align with the relevant occupations.

Based on the available data there appears to be a supply gap for these occupations in the region. Furthermore, entry-level wages exceed the self-sufficiency standard wage in both Los Angeles and Orange counties. However, the majority of annual openings for these occupations typically require a bachelor's degree for entry. **Therefore, due to some of the criteria being met, the LA COE endorses this proposed program.** Detailed reasons include:

Demand:

- **Supply Gap Criteria** – Over the next five years, **8,328 jobs are projected to be available annually** in the region due to new job growth and replacements, **which is more than the three-year average of 4,211 awards conferred** by educational institutions in the region.
 - Since the three occupations in this report do not focus solely on artificial intelligence, **the number of job openings is likely overstated** for jobs working exclusively with AI.
 - **There were 12,206 online job postings that mentioned artificial intelligence, machine learning and/or natural language processing (NLP) as a desired skill listed in the past 12 months.** The job titles listed most often in job postings were data scientists, software engineers, data engineers, machine learning engineers, and software development engineers.
 - Of these 12,206 online job postings, **96 job postings listed natural language processing (NLP) as a desired skill** for future employees. NLP software listed

⁵ [Data Scientists : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics \(bls.gov\)](#)

⁶ The COE classifies middle-skill jobs as the following:

- All occupations that require an educational requirement of some college, associate degree or apprenticeship;
- All occupations that require a bachelor's degree, but also have more than one-third of their existing labor force with an educational attainment of some college or associate degree; or
- All occupations that require a high school diploma or equivalent or no formal education, but also require short- to long-term on-the-job training where multiple community colleges have existing programs.

in these LA/OC job postings included NLTK, spaCy, BERT, Gensim, Hugging Face, and GPT-3.

- **Living Wage Criteria** – Within Los Angeles County, all **three artificial intelligence-related occupations in this report have entry-level wages above the self-sufficiency standard hourly wage** (\$18.10/hour).⁷
- **Educational Criteria** – The Bureau of Labor Statistics (BLS) lists a **bachelor’s degree** as the **typical entry-level education** for all three occupations in this report.
 - The national-level educational attainment data indicates between 11% and 27% of workers in the field have completed an associate degree or less education, **while between 65% and 86% hold a bachelor’s degree or more education.**

Supply:

- There are **27 community colleges** in the greater LA/OC region that issue awards in programs that train for the occupations in this report, conferring an average of **1,085 awards annually** between 2018 and 2021.
- Between 2017 and 2020, there was an average of **3,126 awards conferred annually** in related training programs by non-community college institutions throughout the greater LA/OC region.

Occupational Demand

Exhibit 1 shows the five-year occupational demand projections for these occupations related to artificial intelligence. In the greater Los Angeles/Orange County region, the number of jobs related to these occupations is projected to increase by 12% through 2026. There will be more than 8,300 job openings per year through 2026 due to job growth and replacements. It is important to note that all three occupations in this report require work in various capacities above and beyond artificial intelligence. Since these occupations do not focus solely on artificial intelligence, the data in Exhibit 1 is likely overstated for jobs working exclusively with AI.

Exhibit 1: Occupational demand in Los Angeles and Orange Counties⁸

Geography	2021 Jobs	2026 Jobs	2021-2026 Change	2021-2026 % Change	Annual Openings
Los Angeles	60,235	68,098	7,863	13%	5,910
Orange	26,486	29,211	2,726	10%	2,417
Total	86,721	97,309	10,588	12%	8,328

Wages

The labor market endorsement in this report considers the entry-level hourly wages for these artificial intelligence-related occupations in Los Angeles County as they relate to the county’s self-sufficiency standard wage. Orange County wages are included below in order to provide a

⁷ Self-Sufficiency Standard wage data was pulled from The Self-Sufficiency Standard Tool for California. For more information, visit: <http://selfsufficiencystandard.org/california>.

⁸ Five-year change represents new job additions to the workforce. Annual openings include new jobs and replacement jobs that result from retirements and separations.

complete analysis of the greater LA/OC region. Detailed wage information, by county, is included in Appendix A.

Los Angeles County

All three occupations in this report have entry-level wages above the self-sufficiency standard wage for one adult (\$18.10 in Los Angeles County). Typical entry-level hourly wages are in a range between \$27.68 and \$45.92. Experienced workers can expect to earn wages between \$60.93 and \$76.62.

Exhibit 2: Earnings for Occupations in LA County

Occupation	Entry-Level Hourly Earnings (25 th Percentile)	Median Hourly Earnings	Experienced Hourly Earnings (75 th Percentile)	Median Annual Earnings*
Software Developers (15-1252)	\$45.92	\$61.13	\$76.62	\$127,100
Computer Occupations, All Other (15-1299)	\$27.68	\$38.03	\$60.93	\$79,100
Data Scientists (15-2051)	\$36.87	\$56.14	\$70.96	\$116,800

*rounded to the nearest \$100

Orange County

All three occupations in this report have entry-level wages above the self-sufficiency standard wage for one adult (\$20.63 in Orange County). Typical entry-level hourly wages are in a range between \$27.67 and \$45.62. Experienced workers can expect to earn wages between \$59.41 and \$74.24.

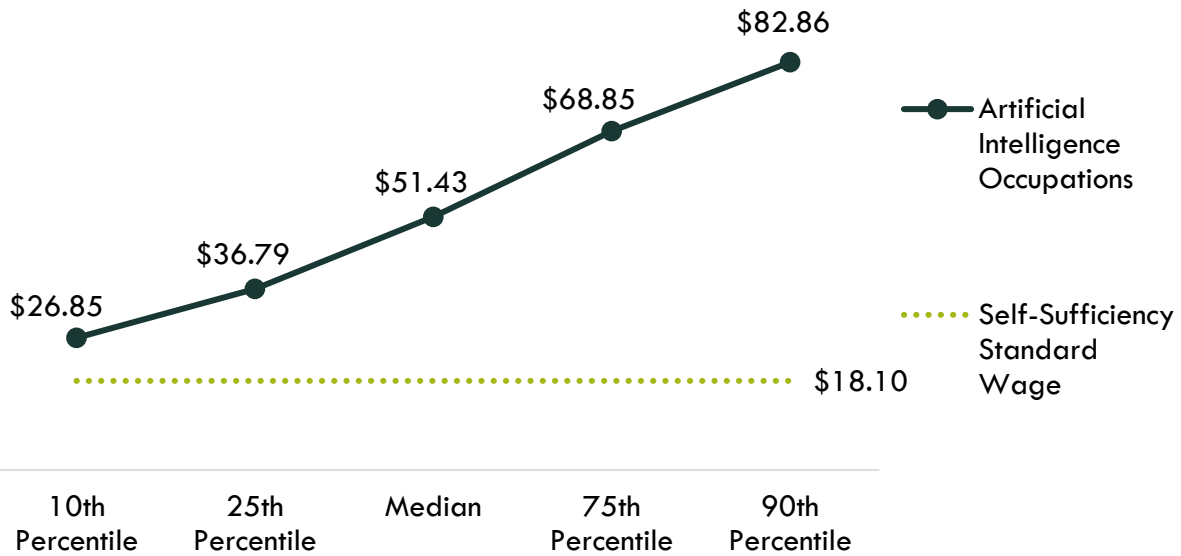
Exhibit 3: Earnings for Occupations in Orange County

Occupation	Entry-Level Hourly Earnings (25 th Percentile)	Median Hourly Earnings	Experienced Hourly Earnings (75 th Percentile)	Median Annual Earnings*
Software Developers (15-1252)	\$45.62	\$59.73	\$74.24	\$124,200
Computer Occupations, All Other (15-1299)	\$27.67	\$37.21	\$59.41	\$77,400
Data Scientists (15-2051)	\$36.76	\$54.95	\$68.46	\$114,300

*rounded to the nearest \$100

On average, the entry-level earnings for the occupations in this report are \$36.79; this is above the living wage for one single adult in Los Angeles County (\$18.10). Exhibit 4 shows the average wage for the occupations in this report, from entry-level to experienced workers.

Exhibit 4: Average Hourly Earnings for Artificial Intelligence Occupations in LA/OC

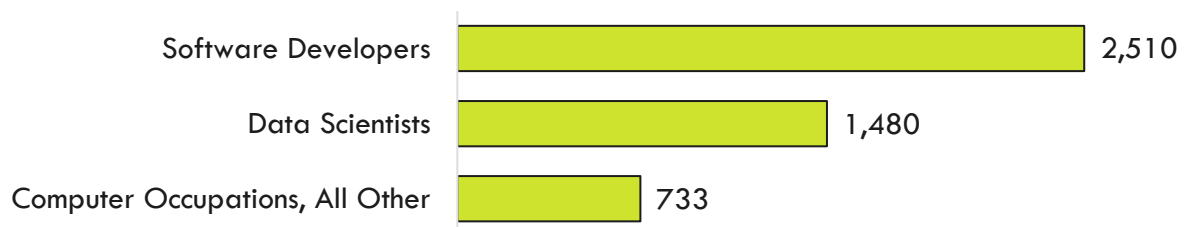


Job Postings

There were 12,206 online job postings that mentioned artificial intelligence, machine learning and/or natural language processing (NLP) as a desired skill listed in the past 12 months.

Exhibit 5 displays the number of job postings by occupation. While more than 50 different SOC occupations include artificial intelligence, machine learning, and/or natural language processing as a desired skill on job postings, the top three occupations were *software developers* (21% of online job postings), *data scientists* (12%), and *computer occupations, all other* (6%). The job titles listed most often in job postings were data scientists, software engineers, data engineers, machine learning engineers, and software development engineers. The knowledge, skills, and abilities (KSAs) listed most often in job postings were machine learning, artificial intelligence, Python (programming language), computer science, SQL (programming language), data science, data analysis, Amazon Web Services, software engineering, software development, agile methodology, and algorithms. The top employers, by number of job postings, in the region were Amazon, Boeing, Deloitte, CyberCoders (staffing company), and Jobot (staffing company).

Exhibit 5: Job postings by occupation (last 12 months)



Of these 12,206 online job postings, 96 job postings listed natural language processing (NLP) as a desired skill for future employees. NLP combines computational linguistics with statistical, machine learning and deep learning models. Together, these technologies enable computers to

process human language and ‘understand’ its full meaning.⁹ NLP software listed in these LA/OC job postings included NLTK, SpaCy, BERT, Gensim, Hugging Face, and GPT-3. The job titles listed most often in these NLP job postings were data scientists, machine learning engineers, lead data scientists, natural language processing scientists, cloud modernization application consultants, and Full Stack software engineers. The top twenty skills listed most often in job postings are shown below in Exhibit 6. The top employers by number of NLP-related job postings in the region were CyberCoders (staffing company), Deloitte, Humana, First American Financial, Raytheon Technologies, SecureAuth Corporation, and The Aerospace Corporation. Of the 62 job postings that listed a minimum education level, all required a bachelor’s degree or more education.

Exhibit 6: Top skills listed in Natural Language Processing job postings (last 12 months)

Top Specialized Skills	Unique Postings	Top Specialized Skills	Unique Postings
Python (<i>Programming Language</i>)	87	Scikit-Learn (<i>Python Package</i>)	37
Machine Learning	83	Deep Learning	34
Natural Language Processing	67	NLTK (<i>NLP Analysis</i>)	34
TensorFlow	50	PyTorch (<i>Machine Learning Library</i>)	33
Data Science	48	Algorithms	29
Computer Science	47	BERT (<i>NLP Model</i>)	28
Artificial Intelligence	46	Microsoft Azure	28
SQL (<i>Programming Language</i>)	43	Scalability	25
SpaCy (<i>NLP Software</i>)	43	Apache Spark	24
Amazon Web Services	37	R (<i>Programming Language</i>)	24

Educational Attainment

The Bureau of Labor Statistics (BLS) lists a bachelor’s degree as the typical entry-level education for these three artificial intelligence-related occupations. The national-level educational attainment data indicates between 11% and 27% of workers in the field have completed an associate degree or less education, while between 65% and 86% hold a bachelor’s degree or more education. Of the 66% of artificial intelligence, machine learning, and/or natural language processing job postings listing a minimum education requirement in the greater Los Angeles/Orange County region, 4% (343) requested high school or vocational training, 1% (113) requested an associate degree, and 94% (7,577) requested a bachelor’s degree.

Educational Supply

Community College Supply

Exhibit 7 shows the annual and three-year average number of awards conferred by community colleges in programs that have historically trained for the occupations of interest. The colleges with the most completions in the region are Orange Coast, Mt. San Antonio, and Santa Monica. One college in the LA/OC region currently offers a program in Artificial Intelligence: Artificial Intelligence in Business (0799.00) at Mt. San Antonio College.

⁹ [What is Natural Language Processing? | IBM](#)

Exhibit 7: Regional community college awards (certificates and degrees), 2018-2021

TOP	Program	College	2018-19 Awards	2019-20 Awards	2020-21 Awards	3-Year Average
0701.00	Information Technology, General	East LA	23	10	4	12
		Glendale	-	-	3	1
		LA Harbor	-	-	1	0
		LA Mission	1	3	1	2
		LA Southwest	-	-	2	1
		Long Beach	34	64	106	68
		Mt San Antonio	74	90	49	71
		Santa Monica	39	-	1	13
		West LA	4	5	-	3
		LA Subtotal	175	172	167	171
		Santa Ana	-	-	3	1
		OC Subtotal	-	-	3	1
Supply Subtotal/Average			175	172	170	172
0702.00	Computer Information Systems	Citrus	5	8	4	6
		Compton	1	-	-	0
		East LA	19	15	23	19
		El Camino	14	21	11	15
		Glendale	-	5	6	4
		LA City	1	1	4	2
		LA Mission	5	1	1	2
		LA Trade	8	20	15	14
		Long Beach	-	-	3	1
		Mt San Antonio	-	79	6	28
		Rio Hondo	21	10	6	12
		West LA	8	10	9	9
		LA Subtotal	82	170	88	113
		Cypress	5	4	-	3
		Fullerton	15	11	31	19
		Irvine	-	2	-	1
		Orange Coast	4	2	-	2
		Saddleback	-	-	1	0
		Santa Ana	4	2	16	7
		Santiago Canyon	3	4	1	3
OC Subtotal	31	25	49	35		

TOP	Program	College	2018-19 Awards	2019-20 Awards	2020-21 Awards	3-Year Average
Supply Subtotal/Average			113	195	137	148
0706.00	Computer Science (Transfer)	Cerritos	12	21	35	23
		Citrus	-	15	27	14
		Compton	1	-	-	0
		El Camino	37	22	31	30
		Glendale	7	6	7	7
		LA City	6	9	10	8
		LA Mission	3	6	6	5
		LA Southwest	-	-	2	1
		Long Beach	27	25	30	27
		Santa Monica	19	43	73	45
		West LA	-	-	1	0
		LA Subtotal	112	147	222	160
		Cypress	-	-	3	1
		Golden West	5	-	1	2
		Irvine	40	36	48	41
		Orange Coast	95	81	66	81
		Saddleback	23	22	29	25
		Santa Ana	12	15	21	16
		Santiago Canyon	7	7	7	7
		OC Subtotal	182	161	175	173
Supply Subtotal/Average			294	308	397	333
0707.00	Computer Software Development	LA City	1	-	-	0
		LA Pierce	-	-	4	1
		Santa Monica	-	-	1	0
		LA Subtotal	1	-	5	2
		Cypress	1	1	-	1
		Golden West	4	2	6	4
		Orange Coast	7	2	2	4
		Saddleback	13	3	10	9
		OC Subtotal	25	8	18	17
Supply Subtotal/Average			26	8	23	19
0707.10	Computer Programming	Cerritos	-	2	3	2
		Citrus	-	1	3	1
		East LA	8	4	1	4

TOP	Program	College	2018-19 Awards	2019-20 Awards	2020-21 Awards	3-Year Average
		Glendale	2	3	-	2
		LA City	-	6	8	5
		LA Harbor	-	-	2	1
		LA Mission	6	4	7	6
		LA Pierce	18	4	5	9
		LA Southwest	-	1	2	1
		LA Valley	7	6	13	9
		Long Beach	4	5	3	4
		Mt San Antonio	119	114	83	105
		Pasadena	11	21	23	18
		Santa Monica	44	46	65	52
		West LA	1	-	-	0
		LA Subtotal	220	217	218	218
		Cypress	22	20	6	16
		Fullerton	16	28	24	23
		Irvine	8	4	-	4
		Orange Coast	31	157	206	131
		Santa Ana	13	1	-	5
		Santiago Canyon	9	3	2	5
		OC Subtotal	99	213	238	183
		Supply Subtotal/Average	319	430	456	402
0799.00	Other Information Technology	Mt San Antonio	13	15	4	11
		LA Subtotal	13	15	4	11
		Orange Coast	-	-	1	0
		OC Subtotal	-	-	1	0
		Supply Subtotal/Average	13	15	5	11
		Supply Total/Average	940	1,128	1,188	1,085

Non-Community College Supply

For a comprehensive regional supply analysis, it is important to consider the supply from other institutions in the region that provide training programs for these occupations related to artificial intelligence. Exhibit 8 shows the annual and three-year average number of awards conferred by these institutions in relevant programs. Due to different data collection periods, the most recent three-year period of available data is from 2017 to 2020. Since a bachelor's degree is typically required for all three of the occupations in this report, bachelor's awards are included in Exhibit 8. Between 2017 and 2020, non-community college institutions in the region conferred an

average of 3,126 bachelor's and sub-baccalaureate awards. Sub-baccalaureate awards include associate degrees, postsecondary awards, and other academic awards that typically take less than four years to complete.

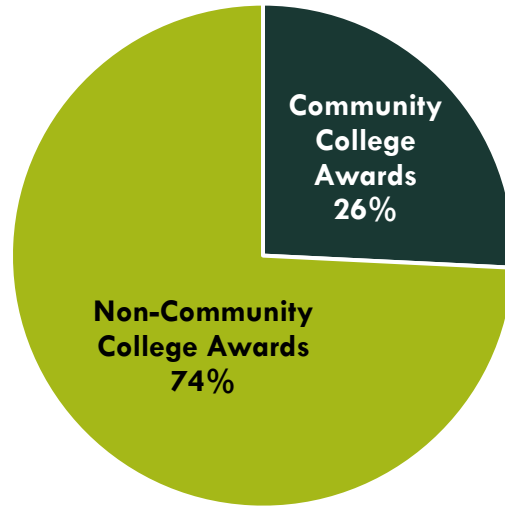
Exhibit 8: Regional non-community college awards, 2017-2020

CIP	Program	Institution	2017-18 Awards	2018-19 Awards	2019-20 Awards	3-Year Average
11.0101	Computer and Information Sciences, General	Azusa Pacific University	26	30	21	26
		Brand College	2	-	-	1
		Brandman University	20	20	30	23
		Chapman University	12	13	18	14
		LA Pacific College	-	-	6	2
		Loyola Marymount Univ.	42	32	27	34
		Pacific States University	-	2	-	1
		The Master's University and Seminary	6	7	11	8
		UC-Irvine	-	1	-	0
		University of La Verne	18	39	23	27
		University of the People	100	80	203	128
		Vanguard University of Southern California	1	-	-	0
11.0103	Information Technology	Abraham Lincoln University	1	1	-	1
		Brand College	37	50	13	33
		CA Intercontinental Univ.	-	-	2	1
		CSU-Dominguez Hills	1	5	4	3
		CSU-Los Angeles	127	122	166	138
		CSU-Northridge	54	54	29	46
		Platt College-Anaheim	1	11	15	9
		Platt College-Los Angeles	-	6	12	6
		Trident Univ. International	87	71	-	53
		University of La Verne	-	3	2	2
11.0199	Computer and Information Sciences, Other	Antioch University-LA	47	4	-	17
		Brand College	-	2	-	1
		CSU-Dominguez Hills	59	55	65	60
		CSU-Northridge	77	87	73	79

CIP	Program	Institution	2017-18 Awards	2018-19 Awards	2019-20 Awards	3-Year Average
11.0201	Computer Programming/ Programmer, General	ABCO Technology	23	29	46	33
		Platt College-Anaheim	4	4	4	4
		Biola University	21	20	18	20
		California Institute of Technology	57	64	72	64
		CA State Polytechnic University-Pomona	207	186	238	210
		CSU-Dominguez Hills	33	38	57	43
		CSU-Fullerton	193	246	264	234
		CSU-Long Beach	179	201	220	200
		CSU-Los Angeles	101	122	119	114
		CSU-Northridge	141	120	160	140
		Chapman University	32	31	30	31
		Claremont McKenna College	12	15	35	21
		E. San Gabriel Valley ROP	16	12	-	9
		Harvey Mudd College	45	42	47	45
		Occidental College	3	20	18	14
		Pitzer College	3	5	10	6
		Pomona College	50	36	34	40
		Scripps College	2	12	11	8
		Southern California Institute of Technology	4	2	10	5
		Trident Univ. International	62	76	-	46
UC-Irvine	521	558	805	628		
UC-Los Angeles	213	242	283	246		
USC	202	228	247	226		
11.0899	Computer Software and Media Applications, Other	Art Center College of Design	8	12	20	13
		CA Institute of the Arts	-	7	8	5
		Learnet Academy	14	-	10	8
15.1202	Computer/Computer Systems Technology/Technician	Learnet Academy Inc	1	-	4	2
Supply Total/Average			2,865	3,023	3,490	3,126

Exhibit 9 shows the proportion of community college awards conferred in LA/OC compared to the number of non-community college awards for the programs in this report. One out of four awards conferred in these programs are awarded by community colleges in the LA/OC region.

Exhibit 9: Community College Awards Compared to Non-Community College Awards in LA/OC Region, 3-Year Average



Appendix A: Occupational demand and wage data by county

Exhibit 10. Los Angeles County

Occupation (SOC)	2021 Jobs	2026 Jobs	5-Yr Change	5-Yr % Change	Annual Openings	Entry-Level Hourly Earnings (25 th Percentile)	Median Hourly Earnings	Experienced Hourly Earnings (75 th Percentile)
Software Developers (15-1252)	37,484	43,412	5,928	16%	3,841	\$45.92	\$61.13	\$76.62
Computer Occupations, All Other (15-1299)	19,803	21,060	1,257	6%	1,702	\$27.68	\$38.03	\$60.93
Data Scientists (15-2051)	2,949	3,627	678	23%	367	\$36.87	\$56.14	\$70.96
Total	60,235	68,098	7,863	13%	5,910	-	-	-

Exhibit 11. Orange County

Occupation (SOC)	2021 Jobs	2026 Jobs	5-Yr Change	5-Yr % Change	Annual Openings	Entry-Level Hourly Earnings (25th Percentile)	Median Hourly Earnings	Experienced Hourly Earnings (75th Percentile)
Software Developers (15-1252)	17,378	19,544	2,166	12%	1,641	\$45.62	\$59.73	\$74.24
Computer Occupations, All Other (15-1299)	7,925	8,256	330	4%	639	\$27.67	\$37.21	\$59.41
Data Scientists (15-2051)	1,182	1,412	230	19%	137	\$36.76	\$54.95	\$68.46
Total	26,486	29,211	2,726	10%	2,417	-	-	-

Exhibit 12. Los Angeles and Orange Counties

Occupation (SOC)	2021 Jobs	2026 Jobs	5-Yr Change	5-Yr % Change	Annual Openings	% Age 55 and older*	Typical Entry-Level Education
Software Developers (15-1252)	54,862	62,956	8,094	15%	5,482	15%	Bachelor's degree
Computer Occupations, All Other (15-1299)	27,728	29,315	1,587	6%	2,342	19%	Bachelor's degree
Data Scientists (15-2051)	4,131	5,038	907	22%	504	17%	Bachelor's degree
Total	86,721	97,309	10,588	12%	8,328	16%	-

*The average percentage of workers age 55 and older across all occupations in the greater LA/OC region is 27%. These occupations have a smaller share of older workers, which typically indicates fewer replacements needs to offset the amount of impending retirements.

Appendix B: Sources

- O*NET Online
- Lightcast (formerly Emsi)
- Bureau of Labor Statistics (BLS)
- California Employment Development Department, Labor Market Information Division, OES
- California Community Colleges Chancellor's Office Management Information Systems (MIS)
- Self-Sufficiency Standard at the Center for Women's Welfare, University of Washington
- Chancellor's Office Curriculum Inventory (COCI 2.0)

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