

Labor Market Analysis for Program Recommendation: 0707.10/Computer Programming (Machine Learning)

Orange County Center of Excellence, December 2023



Summary

Program LMI Endorsement	Endorsed: All LMI Criteria Met <input type="checkbox"/>	Endorsed: Some LMI Criteria Met <input type="checkbox"/>	Not LMI Endorsed <input type="checkbox"/>
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Program LMI Endorsement Criteria

	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Supply Gap:	<i>Comments:</i> The OC COE predicates endorsement only for middle-skill occupations. Since this proposed new program includes above middle-skill occupations only, we are unable to evaluate the labor market information endorsement criteria.	
Living Wage: (Entry-Level, 25 th)	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	<i>Comments:</i> See comment above.	
Education:	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	<i>Comments:</i> See comment above.	

Emerging Occupation(s)

	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>
	<i>Comments:</i> According to IBM, “machine learning is a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy.” ¹ Machine learning models have been implemented for facial recognition, product recommendations when online shopping, predictive text, and more. ² Machine learning jobs are currently grouped with other software, programming, and data science occupations and there is currently no single occupation for machine learning engineers.	

The Orange County Center of Excellence for Labor Market Research (OC COE) prepared this report to determine whether there is a supply gap in the Los Angeles/Orange County regional labor market related to three above middle-skill occupations that are most closely related to machine learning:

- Computer Programmers (15-1251)
- Software Developers (15-1252)
- Data Scientists (15-2051)

Currently, these three Standard Occupational Classification (SOC) codes are those that are most closely related to machine learning. It is important to note that there are currently no middle-skill occupations that are directly related to machine learning and typical education requirements for machine learning occupations are high; it is unclear if a community college degree or certificate will be sufficient to obtain machine learning jobs. This report analyzes traditional labor market information for these three above

¹ <https://www.ibm.com/topics/machine-learning>

² <https://www.tableau.com/learn/articles/machine-learning-examples>

middle-skill machine learning occupations and also includes an analysis of online job postings that request machine learning skills.

Though machine learning jobs typically require at least a bachelor’s degree, community colleges throughout the country have developed social media programs. There is no singular source that includes data on all these programs. However, the OC COE was able to identify programs in numerous states including California, Arizona, Illinois, New Mexico, and Pennsylvania. According to Indeed’s Career Guide, a bachelor’s degree is required for machine learning positions and some roles may require a master’s or doctoral degree.³

The OC COE predicates endorsement only for middle-skill occupations. **Since this proposed new program includes all above middle-skill occupations, we are unable to evaluate the labor market information endorsement criteria.**

Exhibit 1, on the following page, lists the occupational demand, supply, typical entry-level education, and educational attainment for the occupations included in this report.

Exhibit 1: Labor Market Summary

Occupation (SOC)	Demand (Annual Openings)	Supply (CC and Non-CC)	Entry-Level Hourly Earnings (25 th Percentile)	Typical Entry-Level Education	Community College Educational Attainment
Computer Programmers (15-1251)	LA: 245 OC: 112 TTL: 357	Accounted for Below	OC: \$33.54	Bachelor's degree	20%
Software Developers (15-1252)	LA: 3,480 OC: 1,649 TTL: 5,128	LA: 3,158 OC: 1,805 TTL: 4,963	OC: \$50.42	Bachelor's degree	12%
Data Scientists (15-1252)	LA: 548 OC: 233 TTL: 781	Accounted for Above	OC: \$34.97	Bachelor's degree	11%
Total	6,266	4,963	N/A	N/A	N/A

Demand:

- The number of jobs related to these machine learning occupations are projected to increase 11% through 2027, equating to 6,266 annual job openings.
- Hourly entry-level wages for these machine learning occupations range from \$33.54 to \$50.42 in Orange County; all annual job openings have entry-level wages above the living wage.
- There were 31,870 online job postings related to these machine learning occupations over the past 12 months. The highest number of postings were for software engineers, data analysts, and data scientists.
 - There were 7,191 online job postings that requested machine learning skills, regardless of occupation, over the past 12 months. The highest number of postings were for data scientists, software engineers, and machine learning engineers.
- The typical entry-level education for these machine learning occupations is a bachelor’s degree.
- Between 11% and 20% of workers in the field have completed some college or an associate degree as their highest level of educational attainment.

³ <https://www.indeed.com/career/machine-learning-engineer/career-advice>

Supply:

- There was an average of 1,453 awards conferred by 28 community colleges in Los Angeles and Orange Counties from 2019 to 2022.
 - Though these community college programs are most closely related to the machine learning occupations in this report, it is important to note that they train for a variety of occupations, including middle-skill occupations. However, these machine learning-related occupations have high education requirements and employers typically require more than a community college education for these occupations. Therefore, community college programs do not align with the education requirements requested by employers and community college supply does not directly correspond to these above middle-skill occupations. However, the COE includes community college supply so regional community colleges can address potential pathways for advancement to these above middle-skill occupations.
- Non-community college institutions conferred an average of 3,510 awards from 2019 to 2021.
- Orange County community college students that exited computer programming programs in the 2020-21 academic year had a median annual wage of \$40,730 after exiting the program and 46% of students attained the living wage.
- Throughout Orange County, 75% of computer programming students that exited their program in 2019-20 reported that they are working in a job closely related to their field of study.

Demand

Occupational Projections:

Exhibit 2 shows the annual percent change in jobs for these machine learning occupations from 2017 through 2027. Though there was a 7% decline across all occupations from 2019 to 2020 due to the COVID-19 pandemic, employment in these machine learning occupations decreased only 1% in Orange County during the same period. These machine learning occupations are projected to grow at a slightly higher rate compared to all occupations through 2027.

Exhibit 2: Annual Percent Change in Jobs for Machine Learning Occupations, 2017-2027

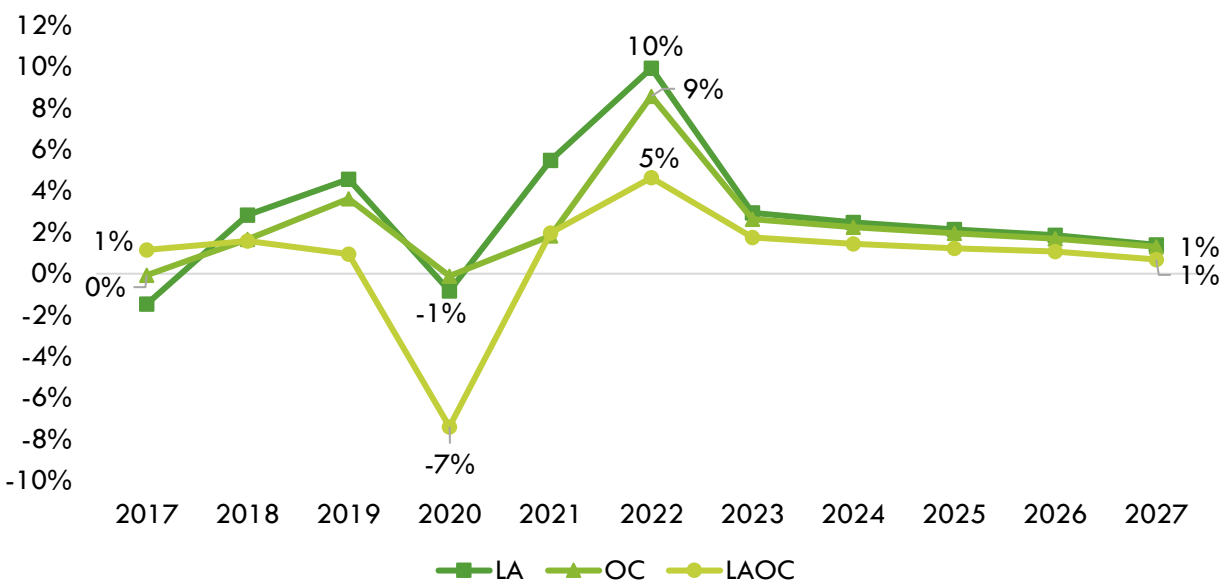


Exhibit 3 shows the five-year occupational demand projections for these machine learning occupations. In Los Angeles/Orange County, the number of jobs related to these occupations is projected to increase by 11% through 2027. There is projected to be 6,266 jobs available annually.

Exhibit 3: Occupational Demand in Los Angeles and Orange Counties⁴

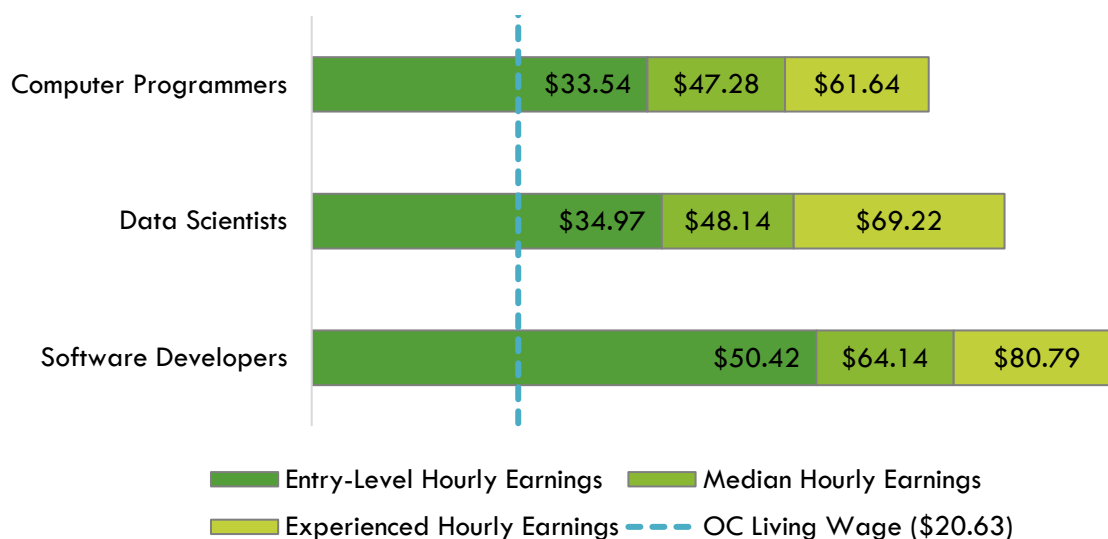
Geography	2022 Jobs	2027 Jobs	2022-2027 Change	2022-2027 % Change	Annual Openings
Los Angeles	45,820	50,997	5,177	11%	4,273
Orange	21,964	24,207	2,242	10%	1,993
Total	67,784	75,204	7,419	11%	6,266

Wages:

The labor market analysis in this report considers the entry-level hourly wages for these machine learning occupations in Orange County as they relate to the county’s living wage. Los Angeles County wages are included below in order to provide a complete analysis of the LA/OC region.

All annual openings for these machine learning occupations have entry-level wages above the living wage for one adult (\$20.63 in Orange County). Typical entry-level hourly wages range between \$33.54 and \$50.42. Orange County’s average wages (\$67.63) are below the average statewide wage of \$83.55 for these occupations. Exhibit 4 shows the wage range for each of these machine learning occupations in Orange County and how they compare to the regional living wage, sorted from lowest to highest entry-level wage.

Exhibit 4: Wages by Occupation in Orange County

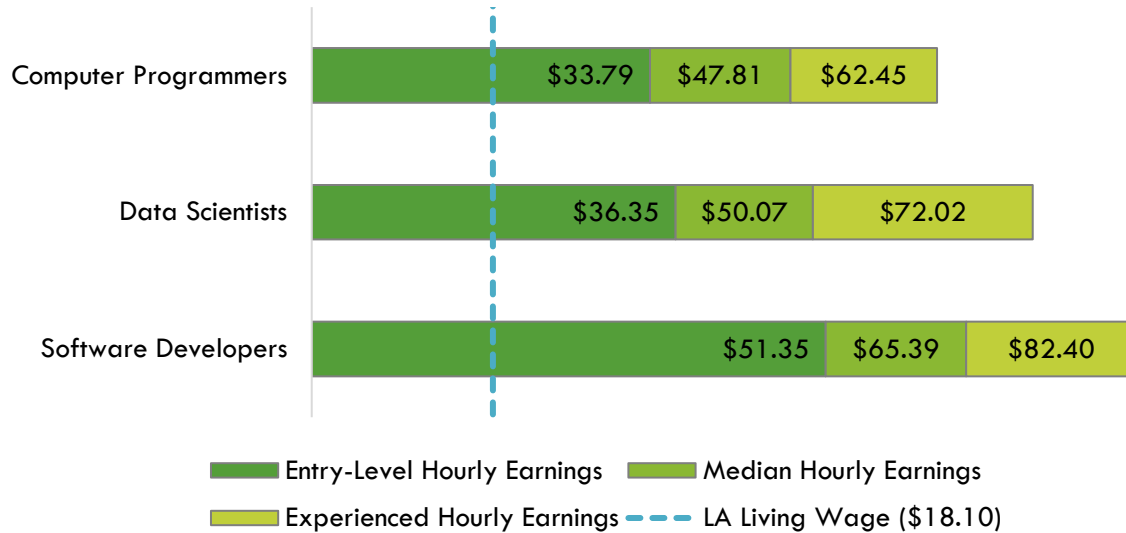


All annual openings for these machine learning occupations have entry-level wages above the living wage for one adult (\$18.10 in Los Angeles County). Typical entry-level hourly wages are in a range between \$33.79 and \$51.35. Los Angeles County’s average wages (\$68.79) are below the average statewide wage of \$83.86 for these occupations. Exhibit 5 shows the wage range for each of these machine learning

⁴ Five-year change represents new job additions to the workforce. Annual openings include new jobs and replacement jobs that result from retirements and separations.

occupations in Los Angeles County how they compare to the regional living wage, sorted from lowest to highest entry-level wage.

Exhibit 5: Wages by Occupation in Los Angeles County



Job Postings:

Important Online Job Postings Data Note: Online job postings data is sourced from Lightcast, a labor market analytics firm that scrapes, collects, and organizes data from online job boards such as LinkedIn, Indeed, Glassdoor, Monster, GovernmentJobs.com, and thousands more. Lightcast uses natural language processing (NLP) to determine the related company, industry, occupation, and other information for each job posting. However, NLP has limitations that include understanding contextual words or phrases; determining differences in words that can be used as nouns, verbs, and/or adjectives; and misspellings or grammatical errors.⁵ For these reasons, job postings could be assigned to the wrong employer, industry, or occupation within Lightcast’s database.

Additionally, there are several limitations when analyzing job postings. A single job posting may not represent a single job opening, as employers may be creating a pool of candidates for future openings or hiring for multiple positions with a single posting. Additionally, not all jobs are posted online, and jobs may be filled through other methods such as internal promotion, word-of-mouth advertising, physical job boards, or a variety of other channels.

This section includes two analyses of online job postings in Los Angeles and Orange counties over the past 12 months. The first analysis examines online job postings for the machine learning occupations analyzed in this report. To better understand how machine learning skills can be applied to other occupations, the second analysis examines all online job postings that requested these skills and not only those that are specifically related to these occupations.

Occupation Job Postings

There were 31,870 online job postings related to these machine learning occupations listed in the past 12 months in Los Angeles and Orange counties. Exhibit 6 shows the number of job postings by occupation. The vast majority (76%) of postings were for software developers.

⁵ K. R. Chowdhary, Fundamentals of Machine learning (Basingstoke: Springer Nature, 2020), <https://link.springer.com/book/10.1007/978-81-322-3972-7>.

Exhibit 6: Number of Job Postings by Occupation (n=31,870)

Occupation	Job Postings	Percentage of Job Postings
Software Developers	24,127	76%
Data Scientists	5,655	18%
Computer Programmers	2,088	7%
Total Postings	31,870	100%

The top employers in the region, by number of job postings, are shown in Exhibit 7.

Exhibit 7: Top Employers by Number of Job Postings (n=31,870)

Employer	Job Postings	Percentage of Job Postings
Boeing	1,116	4%
Motion Recruitment	913	3%
CyberCoders	693	2%
Northrop Grumman	629	2%
SpaceX	359	1%
University of California	321	1%
Actalent	294	1%
Randstad	278	1%
UnitedHealth Group	274	1%
Anduril Industries	252	1%

The top specialized, soft, and computer skills listed by those most frequently mentioned in job postings (denoted in parentheses) are shown in Exhibit 8.

Exhibit 8: Top Skills by Number of Job Postings (n=31,870)

Top Specialized Skills	Top Soft Skills	Top Computer Skills
Computer Science (11,791)	Communication (11,540)	Python (Programming Language) (8,252)
Software Engineering (8,890)	Management (7,150)	SQL (Programming Language) (7,966)
Python (Programming Language) (8,252)	Problem Solving (6,050)	Java (Programming Language) (5,449)
SQL (Programming Language) (7,966)	Troubleshooting (Problem Solving) (5,065)	Amazon Web Services (5,342)
Software Development (7,268)	Leadership (4,937)	C++ (Programming Language) (4,847)
Agile Methodology (6,340)	Operations (4,796)	JavaScript (Programming Language) (4,819)
Java (Programming Language) (5,449)	Mathematics (4,335)	Application Programming Interface (API) (4,643)
Amazon Web Services (5,342)	Planning (4,250)	C# (Programming Language) (3,715)
C++ (Programming Language) (4,847)	Writing (4,243)	Linux (3,465)

Top Specialized Skills	Top Soft Skills	Top Computer Skills
JavaScript (Programming Language) (4,819)	Research (4,185)	C (Programming Language) (3,343)

Machine Learning Job Postings

Over the past 12 months, there were 7,191 online job postings that requested machine learning skills in Los Angeles and Orange counties,. Exhibit 10 shows the top 10 occupations for which employers requested these skills.

Notably, in addition to traditional machine learning-related roles such as *software developers* and *data scientists*, the top occupations include marketing, operations, and medical science occupations.

Exhibit 10: Top Machine Learning Occupations (n=7,191)

Occupation	Total Postings	% of Postings
Software Developers	1,381	19%
Data Scientists	1,166	16%
Computer Occupations, All Other	527	7%
Marketing Managers	268	4%
Database Administrators	220	3%
Operations Research Analysts	183	3%
Web Developers	155	2%
Managers, All Other	154	2%
Medical Scientists, Except Epidemiologists	138	2%
Engineers, All Other	128	2%

Exhibit 11 shows the number of job postings by job title.

Exhibit 11: Number of Machine Learning Job Postings by Title (n=7,191)

Occupation	Job Postings	Percentage of Job Postings
Data Scientists	471	7%
Software Engineers	228	3%
Machine Learning Engineers	173	2%
Data Engineers	133	2%
Front End Software Engineers	90	1%
Systems Requirements Engineers	76	1%
Data Analysts	59	1%
DevSecOps Engineers	55	1%
Postdoctoral Scientists	47	1%
Expert Software Engineers	45	1%

The top employers that requested machine learning skills across all occupations, by number of job postings, are shown in Exhibit 12.

**Exhibit 12: Top Machine Learning Employers by
Number of Job Postings (n=7,191)**

Employer	Job Postings	Percentage of Job Postings
Boeing	630	9%
Cedars-Sinai	162	2%
Meta	147	2%
University of California	136	2%
The Aerospace Corporation	126	2%
Snap Inc.	108	2%
CyberCoders	104	1%
The RealReal	102	1%
Motion Recruitment	88	1%
PricewaterhouseCoopers	88	1%

The top specialized, soft, and computer skills listed by those most frequently mentioned in job postings (denoted in parentheses) are shown in Exhibit 13.

Exhibit 13: Top Skills by Number of Job Postings (n=7,191)

Top Specialized Skills	Top Soft Skills	Top Computer Skills
Machine Learning (6,969)	Communication (2,953)	Python (Programming Language) (3,949)
Python (Programming Language) (3,949)	Research (2,459)	SQL (Programming Language) (2,123)
Computer Science (3,590)	Mathematics (1,985)	R (Programming Language) (1,653)
Artificial Intelligence (3,300)	Management (1,698)	C++ (Programming Language) (1,405)
Data Science (2,274)	Leadership (1,627)	Amazon Web Services (1,384)
SQL (Programming Language) (2,123)	Innovation (1,379)	Java (Programming Language) (1,337)
Data Analysis (1,915)	Operations (1,292)	C (Programming Language) (1,025)
Software Engineering (1,781)	Problem Solving (1,275)	Microsoft Azure (822)
Algorithms (1,698)	Presentations (1,069)	Tableau (Business Intelligence Software) (810)
R (Programming Language) (1,653)	Writing (945)	Apache Spark (774)

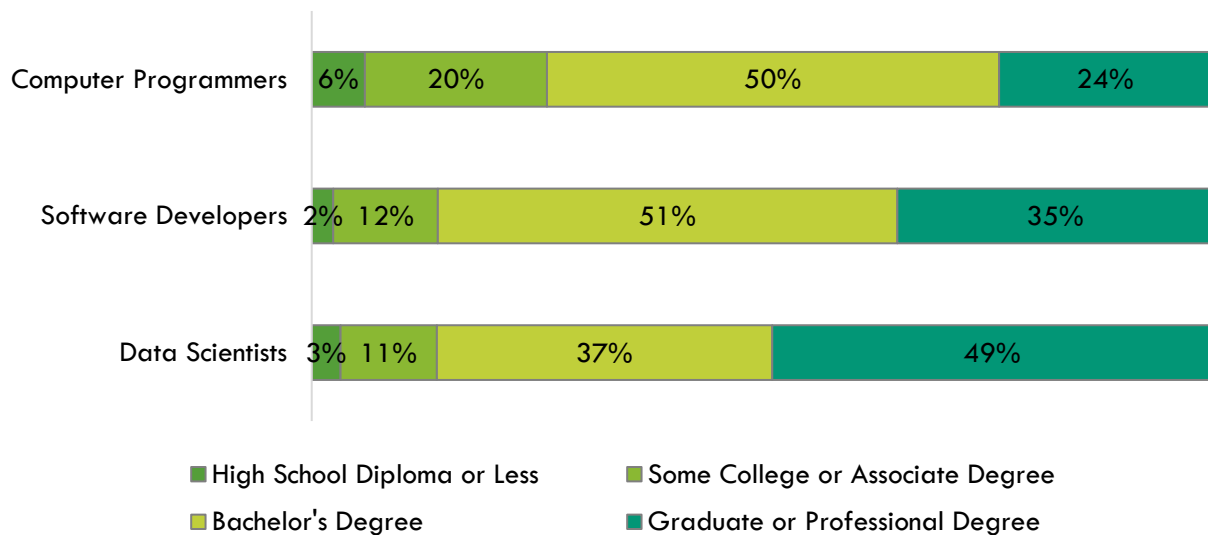
Educational Attainment:

The Bureau of Labor Statistics (BLS) lists a bachelor's degree as the typical entry-level education for these machine learning occupations. Additionally, the national-level educational attainment data indicates between 11% and 20% of workers in the field have completed some college or an associate degree as their highest level of education. The vast majority of workers in these occupations have completed a bachelor's, master's, or doctoral degree as their highest level of education. Exhibit 9 shows the educational attainment for each occupation, sorted by highest community college educational attainment to lowest.

Of the 65% of the cumulative job postings for these machine learning occupations in Los Angeles/Orange County, 91% (18,870) requested a bachelor's, master's, or doctoral degree and only 9% (1,805) requested a high school diploma, vocational training, or an associate degree.

Of the 77% of the cumulative job postings for machine learning skills across all occupations that listed a minimum education requirement in Los Angeles/Orange County, 96% (5,334) requested a bachelor's, master's, or doctoral degree and only 4% (239) requested a high school diploma or an associate degree.

Exhibit 9: National-level Educational Attainment for Occupations



Educational Supply

Community College Supply:

Exhibit 10 shows the three-year average number of awards conferred by community colleges in the related TOP codes: Information Technology, General (0701.00), Computer Information Systems (0702.00), Computer Software Development (0707.00), Computer Programming (0707.10), Database Design and Administration (0707.20), Computer Infrastructure and Support (0708.00), and Computer Networking (0708.10). The colleges with the most completions are Mt. San Antonio, Orange Coast, and Long Beach. Over the past 12 months, there were no other related program recommendation requests from regional community colleges.

Though these programs are most closely related to the machine learning occupations in this report, it is important to note that they train for a variety of occupations, including middle-skill occupations such as *computer network support specialists*, *computer network architects*, and *computer user support specialists*. However, the machine learning-related occupations in this report have high education requirements and employers typically require more than a community college education for these occupations. Therefore, community college programs do not align with the education requirements requested by employers and community college supply does not directly correspond to these above middle-skill occupations. However, the COE includes community college supply so regional community colleges can address potential pathways for advancement to these above middle-skill occupations.

Exhibit 10: Regional Community College Awards (Certificates and Degrees), 2019-2022

TOP Code	Program	College	2019-2020 Awards	2020-2021 Awards	2021-2022 Awards	3-Year Award Average
0701.00	Information Technology, General	East LA	10	4	30	15
		Glendale	0	3	17	7
		LA Harbor	0	1	2	1
		LA Mission	3	1	4	3
		LA Southwest	0	2	12	5
		Long Beach	64	106	88	85
		Mt San Antonio	90	49	23	53
		Santa Monica	0	1	0	0
		West LA	5	0	6	4
		LA Subtotal	172	167	182	173
		Santa Ana	0	3	9	4
		OC Subtotal	0	3	9	4
		Supply Subtotal/Average			172	170
0702.00	Computer Information Systems	Citrus	8	4	6	6
		Compton	0	0	12	4
		East LA	15	23	11	16
		El Camino	21	11	28	20
		Glendale	5	6	8	6
		LA City	1	4	3	3

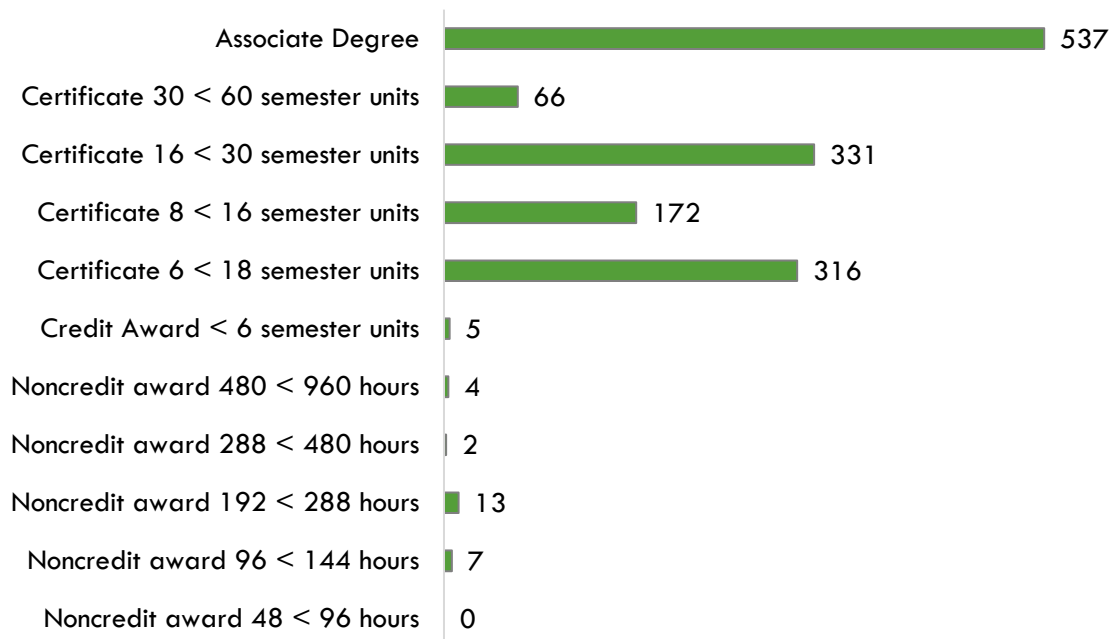
TOP Code	Program	College	2019-2020 Awards	2020-2021 Awards	2021-2022 Awards	3-Year Award Average		
		LA Harbor	0	0	1	0		
		LA Mission	1	1	1	1		
		LA Southwest	0	0	21	7		
		LA Trade	20	15	17	17		
		Long Beach	0	3	0	1		
		Mt San Antonio	79	6	68	51		
		Rio Hondo	10	6	15	11		
		West LA	10	9	14	11		
		LA Subtotal	170	88	205	154		
		Coastline	0	0	2	0		
		Cypress	4	0	0	1		
		Fullerton	11	31	49	30		
		Irvine	2	0	0	1		
		Orange Coast	2	0	1	1		
		Saddleback	0	1	0	0		
		Santa Ana	2	16	18	12		
		Santiago Canyon	4	1	1	2		
		OC Subtotal	25	49	71	47		
		Supply Subtotal/Average			195	137	276	201
		0707.00	Computer Software Development	LA City	0	0	1	0
LA Harbor	0			0	2	1		
LA Mission	0			0	2	1		
LA Pierce	0			4	7	4		
Santa Monica	0			1	1	1		
West LA	0			0	6	2		
LA Subtotal	0			5	19	9		
Cypress	1			0	0	0		
Golden West	2			6	4	4		
Orange Coast	2			2	0	2		
Saddleback	3			10	15	10		
OC Subtotal	8			18	19	16		
Supply Subtotal/Average				8	23	38	25	
0707.10	Computer Programming	Cerritos	2	3	7	4		
		Citrus	1	3	9	4		
		East LA	4	1	0	2		
		Glendale	3	0	0	1		
		LA City	6	8	10	8		

TOP Code	Program	College	2019-2020 Awards	2020-2021 Awards	2021-2022 Awards	3-Year Award Average		
		LA Harbor	0	2	4	2		
		LA Mission	4	7	7	7		
		LA Pierce	4	5	5	4		
		LA Southwest	1	2	2	2		
		LA Valley	6	13	8	9		
		Long Beach	5	3	7	5		
		Mt San Antonio	114	83	125	107		
		Pasadena	21	23	23	22		
		Santa Monica	46	65	71	61		
		LA Subtotal	217	218	278	238		
		Coastline	0	0	1	0		
		Cypress	20	6	5	11		
		Fullerton	28	24	28	27		
		Irvine	4	0	0	1		
		Orange Coast	157	206	160	175		
		Santa Ana	1	0	0	0		
		Santiago Canyon	3	2	2	2		
		OC Subtotal	213	238	196	216		
		Supply Subtotal/Average			430	456	474	454
		0707.20	Database Design and Administration	Citrus	1	0	1	1
Long Beach	1			13	11	8		
Mt San Antonio	12			8	16	12		
Pasadena	4			24	14	14		
Santa Monica	5			2	4	3		
LA Subtotal	23			47	46	38		
Santa Ana	8			2	2	4		
OC Subtotal	8			2	2	4		
Supply Subtotal/Average			31	49	48	42		
0708.00	Computer Infrastructure and Support	Cerritos	4	4	9	5		
		East LA	0	0	3	1		
		El Camino	0	0	5	2		
		Glendale	3	4	11	6		
		LA City	3	5	12	6		
		LA Harbor	1	1	2	1		
		LA Mission	12	17	32	20		
		LA Valley	2	4	3	3		
		Long Beach	8	8	2	6		

TOP Code	Program	College	2019-2020 Awards	2020-2021 Awards	2021-2022 Awards	3-Year Award Average
		Mt San Antonio	24	24	36	28
		Pasadena	1	24	8	11
		Rio Hondo	10	11	19	13
		West LA	15	16	7	13
		LA Subtotal	83	118	149	115
		Coastline	46	73	91	70
		Cypress	3	1	1	1
		Orange Coast	7	5	7	6
		Saddleback	0	3	13	5
		Santa Ana	0	27	14	13
		OC Subtotal	56	109	126	95
		Supply Subtotal/Average	139	227	275	210
0708.10	Computer Networking	Cerritos	9	8	6	8
		Glendale	3	0	2	1
		LA City	0	4	8	4
		LA Pierce	20	12	19	16
		Long Beach	47	48	52	49
		Mt San Antonio	11	4	25	13
		Rio Hondo	7	2	5	5
		West LA	48	58	24	43
		LA Subtotal	145	136	141	139
		Coastline	59	92	49	67
		Cypress	95	61	71	76
		Fullerton	0	1	0	0
		Irvine	21	10	18	16
		Saddleback	21	19	15	19
		Santa Ana	12	23	45	27
		OC Subtotal	208	206	198	205
				Supply Subtotal/Average	353	342
		Supply Subtotal/Average	1,328	1,404	1,641	1,453

Exhibit 11 shows the annual average community college awards by type from 2019-20 through 2021-22. The plurality of the awards are for associate degrees, followed by certificates between 16 and less than 30 semester units and certificates between 6 and less than 18 semester units.

Exhibit 11: Annual Average Community College Awards by Type, 2018-2021



Community College Student Outcomes:

Exhibit 12 shows the Strong Workforce Program (SWP) metrics for computer programming programs in Rancho Santiago Community College District (RSCCD), the Orange County Region, and California.

RSCCD students that exited computer programming programs in the 2020-21 academic year had higher median annual earnings (\$46,400) when compared to students throughout Orange County (\$40,730). Additionally, a higher percentage of RSCCD students attained the living wage (57%) compared to students throughout Orange County (46%).

Exhibit 18: Computer Programming (0707.20) Strong Workforce Program Metrics, 2020-21⁶

SWP Metric	RSCCD	OC Region	California
SWP Students	621	2,905	39,210
SWP Students Who Earned 9 or More Career Education Units in the District in a Single Year	21%	19%	24%
SWP Students Who Completed a Noncredit CTE or Workforce Preparation Course	Insufficient Data	94%	76%
SWP Students Who Earned a Degree or Certificate or Attained Apprenticeship Journey Status	Insufficient Data	128	745
SWP Students Who Transferred to a Three-Year Postsecondary Institution	46	306	4166

⁶ All SWP metrics are for 2020-21 unless otherwise noted.

SWP Metric	RSCCD	OC Region	California
SWP Students with a Job Closely Related to Their Field of Study (2019-20)	Insufficient Data	75%	67%
Median Annual Earnings for SWP Exiting Students	\$46,400 (\$22.31)	\$40,730 (\$19.58)	\$46,810 (\$22.50)
Median Change in Earnings for SWP Exiting Students	32%	19%	24%
SWP Exiting Students Who Attained the Living Wage	57%	46%	59%

Non-Community College Supply:

For a comprehensive regional supply analysis, it is also important to consider the supply from other institutions in the region that provide training programs for these machine learning occupations. Exhibit 13 shows the annual and three-year average number of awards conferred by these institutions in the related Classification of Instructional Programs (CIP) Codes:

- Computer and Information Sciences, General (11.0101)
- Information Technology (11.0103)
- Computer Programming/Programmer, General (11.0201)
- Computer Science (11.0701)
- Computer/Computer Systems Technology/Technician (15.1202)
- Data Analytics, General (30.7101)

Due to different data collection periods, the most recent two-year period of available data is from 2019 to 2021. Currently, only two years of data are currently available due to changes in the CIP Taxonomy. Between 2019 and 2021, three-year colleges in the region conferred an average of 3,510 awards annually in related training programs.

Exhibit 13: Regional Non-Community College Awards, 2017-2020

CIP Code	Program	College	2019-2020 Awards	2020-2021 Awards	2-Year Award Average
11.0101	Computer and Information Sciences, General	Azusa Pacific University	21	25	23
		Chapman University	18	23	20
		Los Angeles Pacific College	6	2	4
		Loyola Marymount University	27	45	36
		Mount Saint Mary's University	0	0	0
		Pacific States University	0	0	0
		Pitzer College	0	1	0
		The Master's University and Seminary	11	5	8
		University of California-Irvine	0	1	0
		University of La Verne	23	36	30

CIP Code	Program	College	2019-2020 Awards	2020-2021 Awards	2-Year Award Average
		University of Massachusetts Global	30	36	33
		University of the People	203	292	248
		Westcliff University	0	0	0
		Supply Subtotal/Average	339	466	402
11.0103	Information Technology	Bethesda University	0	0	0
		Brand College	13	17	15
		California Intercontinental University	2	0	1
		California State University-Dominguez Hills	4	10	7
		California State University-Los Angeles	166	116	141
		California State University-Northridge	29	51	40
		Platt College-Anaheim	15	17	16
		Platt College-Los Angeles	12	6	9
		University of La Verne	2	3	2
		Westcliff University	0	0	0
				Supply Subtotal/Average	243
11.0201	Computer Programming/ Programmer, General	ABCO Technology	46	34	40
		Platt College-Anaheim	4	0	2
		Supply Subtotal/Average	243	220	231
11.0701	Computer Science	Biola University	18	19	18
		California Institute of Technology	72	83	78
		California State Polytechnic University-Pomona	238	270	254
		California State University-Dominguez Hills	57	66	62
		California State University-Fullerton	264	308	286
		California State University-Long Beach	220	221	220
		California State University-Los Angeles	119	152	136
		California State University-Northridge	160	214	187
		Chapman University	30	45	38
		Claremont McKenna College	35	17	26
		Harvey Mudd College	47	48	48

CIP Code	Program	College	2019-2020 Awards	2020-2021 Awards	2-Year Award Average
		Occidental College	18	18	18
		Pitzer College	10	5	8
		Pomona College	34	33	34
		Scripps College	11	5	8
		Southern California Institute of Technology	10	7	8
		The Master's University and Seminary	0	0	0
		University of California-Irvine	805	822	814
		University of California-Los Angeles	287	342	314
		University of Southern California	247	293	270
Supply Subtotal/Average			2,682	2,968	2,827
15.1202	Computer/Computer Systems Technology/Technician	Learnet Academy Inc	4	2	3
		University of La Verne	0	0	0
Supply Subtotal/Average			4	2	3
30.7101	Computer/Computer Systems Technology/Technician	Touro University Worldwide	3	7	5
Supply Subtotal/Average			3	7	5
Supply Subtotal/Average			3,321	3,697	3,510

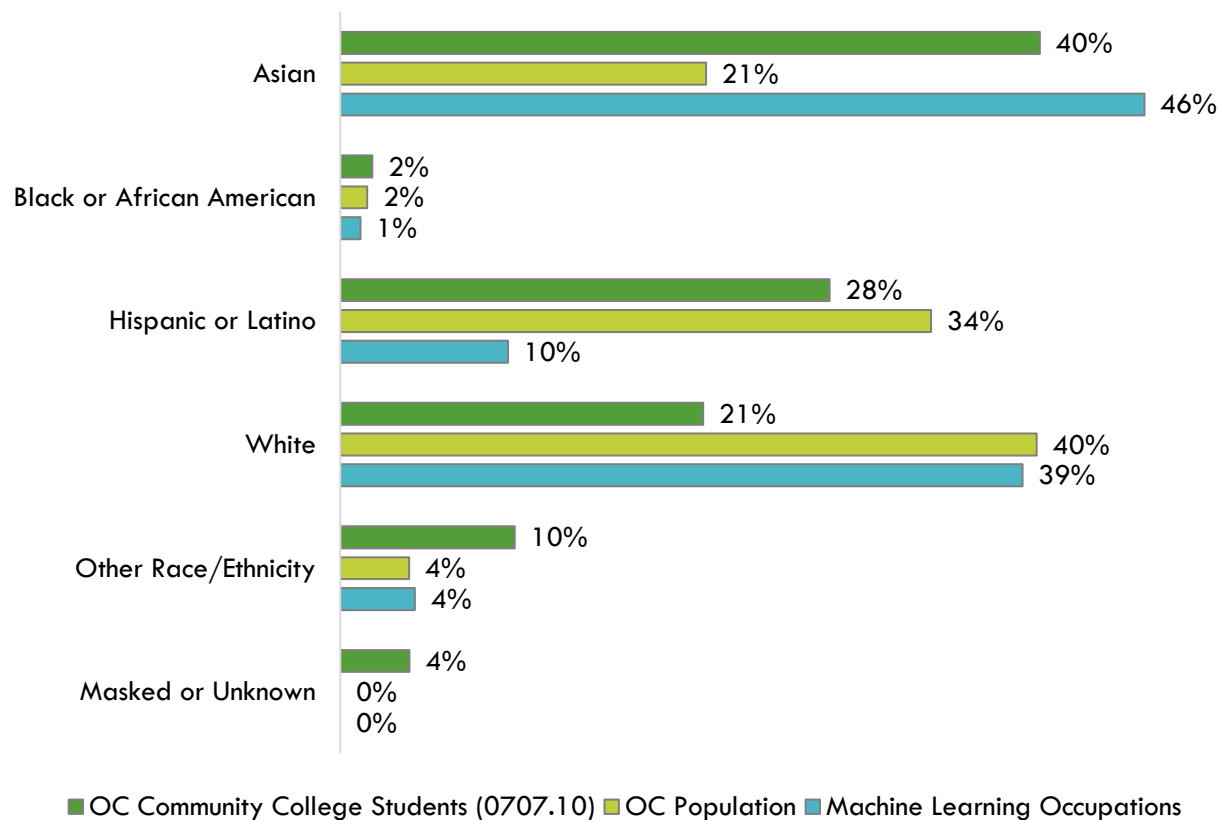
Regional Demographics

This section analyzes demographic data for Orange County community college students enrolled in computer programming programs compared to the OC population, as well occupational data, for the purpose of identifying potential diversity and equity issues that can be addressed by community college programs.

Ethnicity:

Exhibit 14 shows the ethnicity of community college computer program students compared to the overall Orange County population, as well as the three machine learning occupations included in this report. Notably, 46% of workers employed in these machine learning occupations are Asian, which is similar to community college computer programming students (40%), but significantly higher than the population (21%). Additionally, 39% of workers in these occupations are white, which is nearly identical to the population (40%), but significantly higher than community college computer programming students (21%). Only 10% of workers in these occupations are Hispanic or Latino, which is significantly lower than the population (34%) and community college computer programming students (28%).

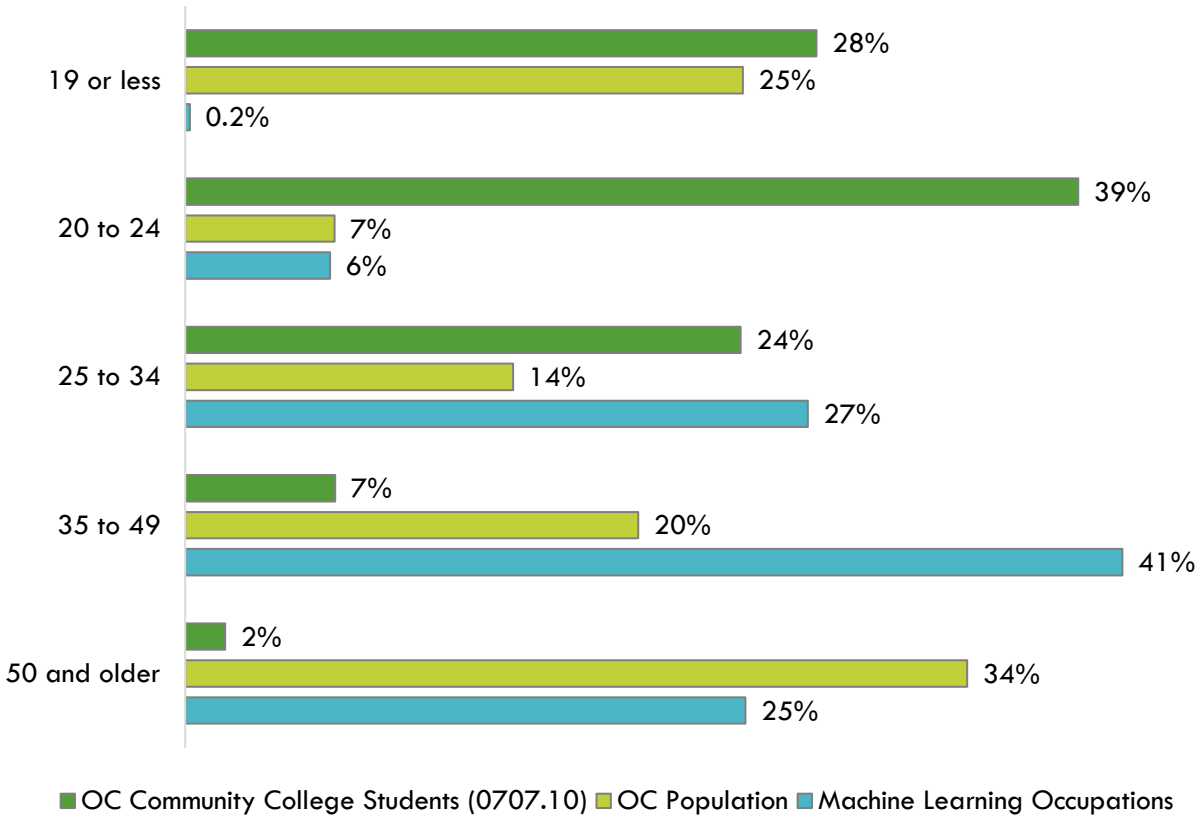
Exhibit 14: Program and County Demographics by Ethnicity



Age:

Exhibit 14 shows the age of community college computer program students compared to the age of the overall Orange County population, as well as the three machine learning occupations included in this report. The plurality (41%) of workers in these machine learning occupations are 35 to 49, which is double the population (20%) and nearly six-times the number of community college computer programming students (7%). Over 60% of community college computer programming students are 19 to 24.

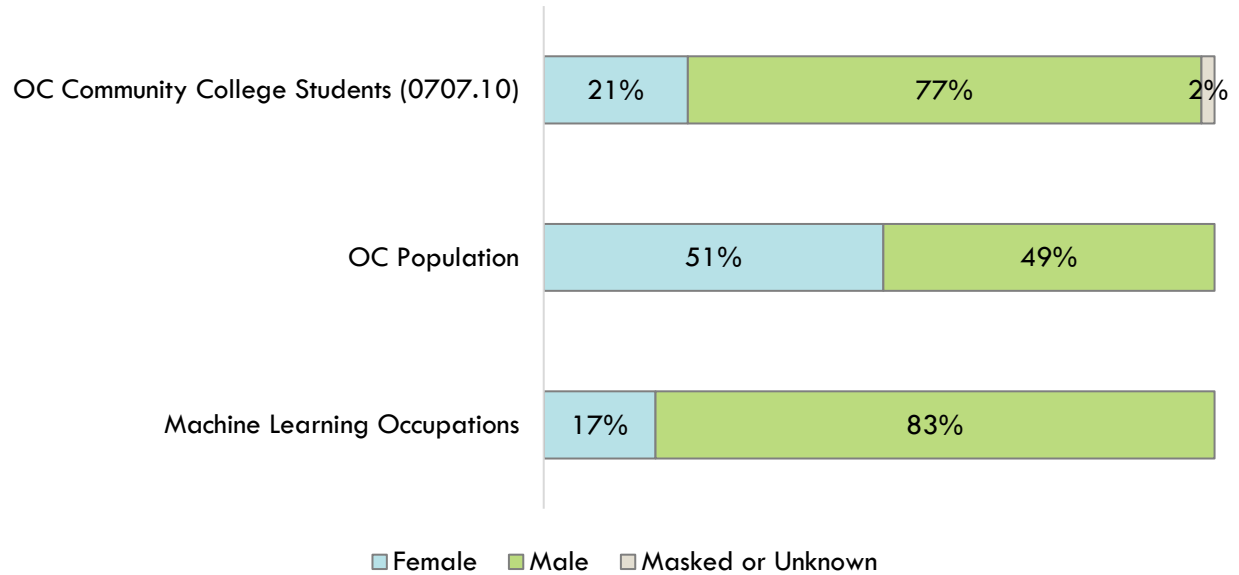
Exhibit 14: Program and County Demographics by Age



Sex:

Exhibit 15 shows the sex of the overall Orange County population as well as these machine learning occupations. Though the population is split nearly evenly, 83% of workers in these machine learning occupations and 77% of community college computer programming students are men.

Exhibit 15: Program and County Demographics by Sex



Appendix A: Methodology

The OC COE prepared this report by analyzing data from occupations and education programs. Occupational data is derived from Lightcast, a labor market analytics firm that consolidates data from the California Employment Development Department (EDD), U.S. Bureau of Labor Statistics (BLS) and other government agencies. Program supply data is drawn from two systems: Taxonomy of Programs (TOP) and Classification of Instructional Programs (CIP).

Using a TOP-SOC crosswalk, the OC COE identified middle-skill jobs for which programs within these TOP codes train. Middle-skill jobs include:

- 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.

The OC COE determined labor market supply for an occupation or SOC code by analyzing the number of program completers or awards in a related TOP or CIP code. The COE developed a "supply table" with this information, which is the source of the program supply data for this report. TOP code data comes from the California Community Colleges Chancellor's Office MIS Data Mart (datamart.cccco.edu) and CIP code data comes from the Integrated Postsecondary Education Data System (nces.ed.gov/ipeds/use-the-data), also known as IPEDS. TOP is a system of numerical codes used at the state level to collect and report information on California community college programs and courses throughout the state that have similar outcomes. CIP codes are a taxonomy of academic disciplines at institutions of higher education in the United States and Canada. Institutions outside of the California Community College system do not use TOP codes in their reporting systems.

Data included in this analysis represent the labor market demand for relevant positions most closely related to the proposed program as expressed by the requesting college in consultation with the OC COE. Traditional labor market information was used to show current and projected employment based on data trends, as well as annual average awards granted by regional community colleges. Real-time labor market information captures job post advertisements for occupations relevant to the field of study which can signal demand and show what employers are looking for in potential employees, but is not a perfect measure of the quantity of open positions.

All representations have been produced from primary research and/or secondary review of publicly and/or privately available data and/or research reports. The most recent data available at the time of the analysis was examined; however, data sets are updated regularly and may not be consistent with previous reports. Efforts have been made to qualify and validate the accuracy of the data and findings; however, neither the Centers of Excellence for Labor Market Research (COE), COE host district, nor California Community Colleges Chancellor's Office are responsible for the applications or decisions made by individuals and/or organizations based on this study or its recommendations.

Appendix B: Data Sources

Data Type	Source
Occupational Projections, Wages, and Job Postings	<p>Traditional labor market information data is sourced from Lightcast, a labor market analytics firm. Lightcast occupational employment data are based on final Lightcast industry data and final Lightcast staffing patterns. Wage estimates are based on Occupational Employment Statistics and the American Community Survey. For more information, see https://lightcast.io/</p>
Living Wage	<p>The living wage is derived from the Insight Center’s California Family Needs Calculator, which measures the income necessary for an individual of family to afford basic expenses. The data assesses the cost of housing, food, child care, health care, transportation, and taxes. For more information, see: https://insightccd.org/family-needs-calculator/</p> <p>The living wage for one adult in Orange County is \$20.63 per hour (\$42,910.40 annually). This figure is used by the CCCCCO to calculate the percentage of students that attained the regional living wage.</p>
Typical Education and Training Requirements, and Educational Attainment	<p>The Bureau of Labor Statistics (BLS) provides information about education and training requirements for hundreds of occupations. BLS uses a system to assign categories for entry-level education, work experience in a related occupation, and typical on-the-job training to each occupation for which BLS publishes projections data. For more information, see https://www.bls.gov/emp/documentation/education/tech.htm</p>
Emerging Occupation Descriptions, Additional Education Requirements, and Employer Preferences	<p>The O*NET database includes information on skills, abilities, knowledges, work activities, and interests associated with occupations. For more information, see https://www.onetonline.org/help/online/</p>
Educational Supply	<p>The CCCCCO Data Mart provides information about students, courses, student services, outcomes and faculty and staff. For more information, see: https://datamart.cccco.edu</p> <p>The National Center for Education Statistics (NCES) Integrated Postsecondary Integrated Data System (IPEDS) collects data on the number of postsecondary awards earned (completions). For more information, see https://nces.ed.gov/ipeds/use-the-data/survey-components/7/completions</p>
Student Metrics and Demographics	<p>LaunchBoard, a statewide data system supported by the California Community Colleges Chancellor's Office and hosted by Cal-PASS Plus, provides data on progress, success, employment, and earnings outcomes for California community college students. For more information, see: https://www.calpassplus.org/LaunchBoard/Home.aspx</p>

Data Type	Source
Population and Occupation Demographics	<p>The Census Bureau's American Community Survey (ACS) is the premier source for detailed population and housing information. For more information, see: https://www.census.gov/programs-surveys/acs</p> <p>Data is sourced from IPUMS USA, a database providing access to ACS and other Census Bureau data products. For more information, see: https://usa.ipums.org/usa/about.shtml</p>

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For more information, please contact the Orange County Center of Excellence:

Jesse Crete, Ed. D., Director
 crete_jesse@rscdd.edu

Jacob Poore, Assistant Director
 poore_jacob@rscdd.edu

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