

Skilled Technical Workforce: Supply, Demand, and Pathways

Data Science for the Public Good

Summer 2019

Alyssa Fowers, Sarah McDonald, and Calvin Isch

Vicki Lancaster, Ph.D., Sam Cohen, Ph.D.



UNIVERSITY
of VIRGINIA

Biocomplexity Institute & Initiative

Data Science for the Public Good

Skilled Technical Workforce Team

NCSES	John Finamore	Program Director, Human Resources Statistics Program
UVA	Alyssa Fowers	Data Science for the Public Good Fellow
UVA	Calvin Isch	Data Science for the Public Good Intern
UVA	Sarah McDonald	Data Science for the Public Good Intern
UVA	Vicki Lancaster	Principal Scientist
UVA	Samantha Cohen	Postdoctoral Research Associate
UVA	Devika Nair	Research Scientist
UVA	Nathaniel Ratcliff	Assistant Research Professor

What is the Skilled Technical Work (STW)?

A job in the STW requires*:

1. A high level of knowledge in a technical domain; but
2. Does not require a bachelor's degree for entry.

Skilled Technical Work:

- Is critical to the nation's ability to innovate and compete in the global economy; and
- Can be a pathway for the individual to the middle class.

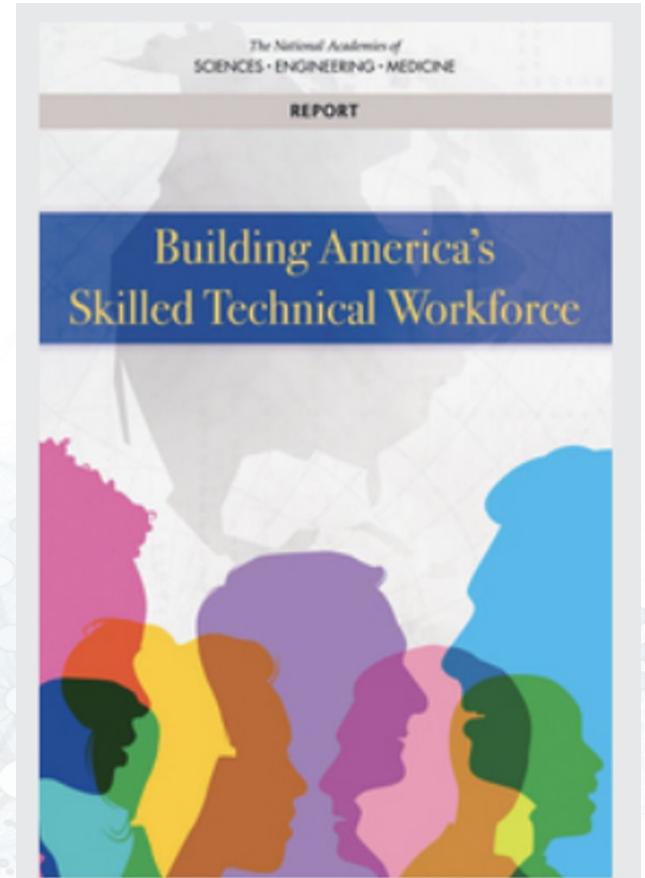
*Rothwell JT, (September 1, 2015) Skilled Technical Work (September 1, 2015). Available at SSRN: <https://ssrn.com/abstract=2709141> or <http://dx.doi.org/10.2139/ssrn.2709141>

Why study the STW?

More precisely understanding can lead to policy reforms that enhance the economic well-being of both the nation and individual.

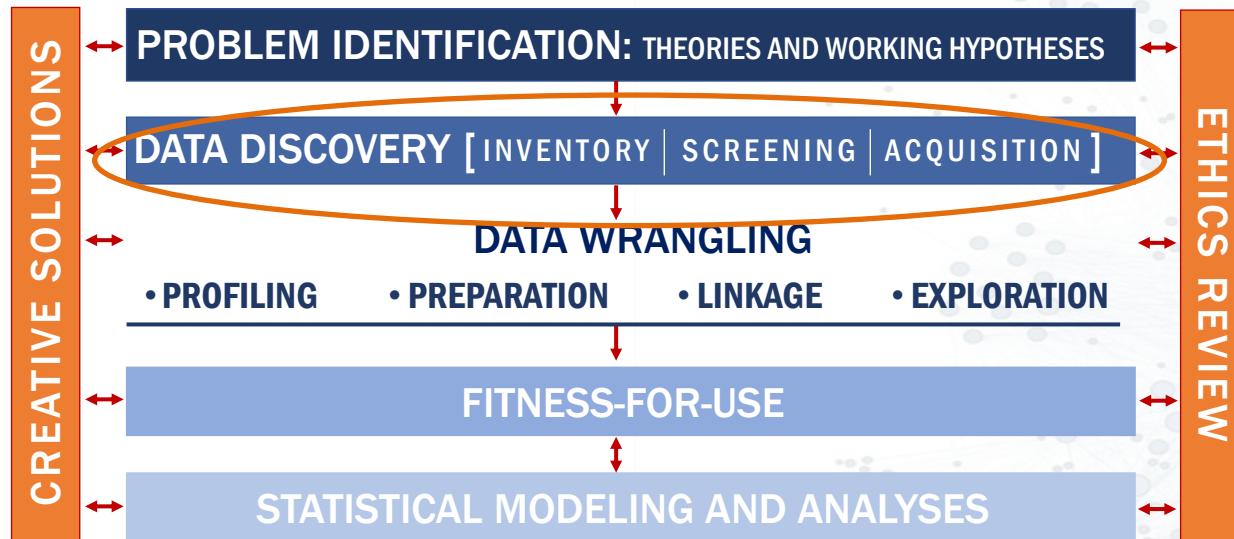
“Better data and better analyses of data are needed to make progress in understanding and addressing the challenges of skilled technical workforce development.”

National Academies report, Building America's Skilled Technical Workforce (2017)



Why study the STW?

Currently there are no federal surveys that measure the prevalence and pathways to non-degree credentials.



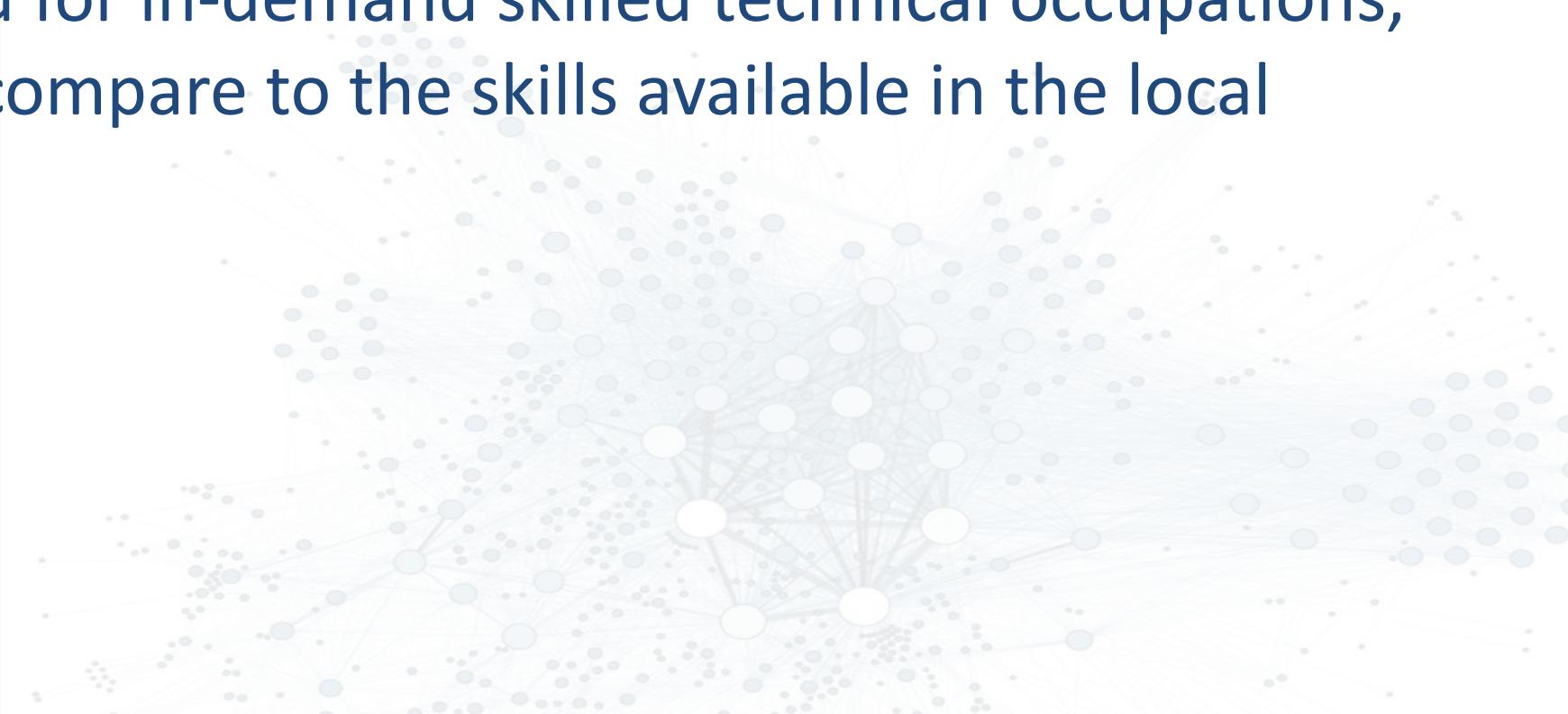
Our data discovery process led to the decision to purchase Burning Glass Technology (BGT) job-ad and resume data.

Research Questions

- What are the most in-demand skilled technical occupations in Virginia?
- Can we evaluate the match between demand and supply for skills in the STW?
- What pathways besides a 4-year degree will provide the skills necessary to secure a job in the STW?

Proof of Concept

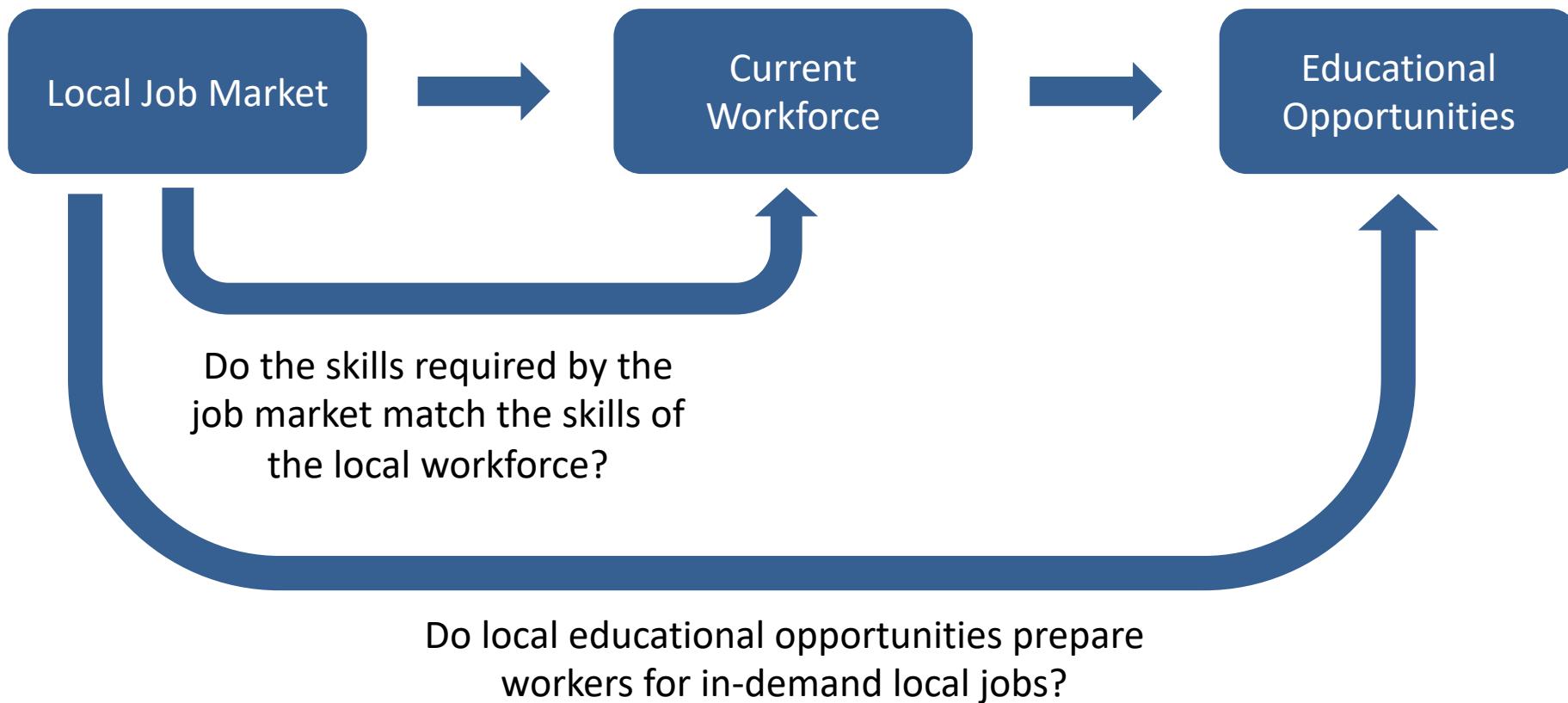
Can we use the BGT job-ad and resume data to understand the skills needed for in-demand skilled technical occupations, and how those compare to the skills available in the local labor force?



What skilled technical positions are available?
What skills are required for those jobs?

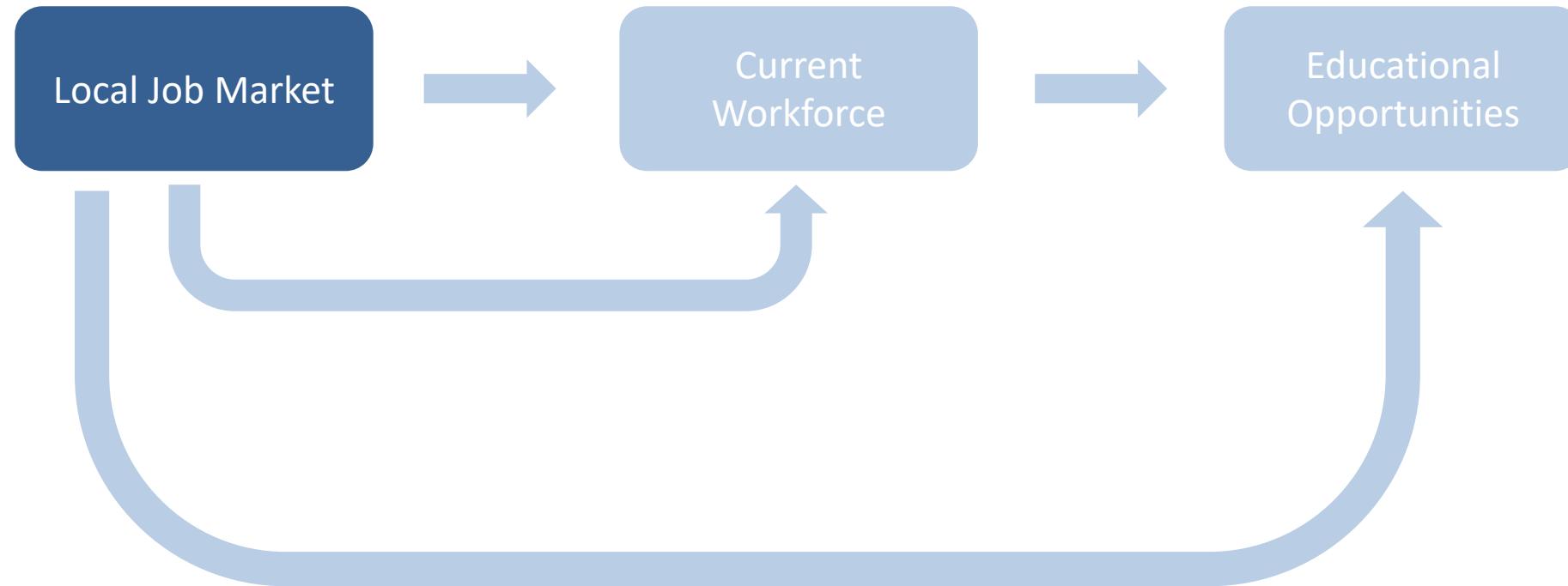
What skills do local workers already have?

Where can residents train for skilled technical positions?



Describing the Local Job Market With Online Job-Ads

What skilled technical positions are available?
What skills are required for those jobs?





* <https://www.burning-glass.com/about/>



burningglass[®]
TECHNOLOGIES

50,000
sites daily

70
variables

2007,
2010-19

* <https://www.burning-glass.com/about/>



50,000
sites daily

70
variables

2007,
2010-19



* <https://www.burning-glass.com/about/>



50,000
sites daily

70
variables

2007,
2010-19

Known Data Biases

1. Does not scrape government websites
2. Skewed toward jobs with higher levels of education

* <https://www.burning-glass.com/about/>

Augmentations of Job-Ad Data



Augmentations of Job-Ad Data

1. STW Jobs

Rothwell STW Parameters



O*NET OnLine



Augmentations of Job-Ad Data

1. STW Jobs

Rothwell STW Parameters



2. Hard/Soft Skills

Define Hard/Soft Skills

STW Jobs of Interest



Augmentations of Job-Ad Data

- A "**soft skill**" is personality-based, primarily used to interact with coworkers, or a general way of approaching a problem.
 - "Teamwork"
 - "Creativity"
- A "**hard skill**" requires domain-specific knowledge or can be easily measured and evaluated.
 - "Microsoft Excel"
 - "Bayesian Statistics"

Augmentations of Job-Ad Data

1. STW Jobs

Rothwell STW Parameters



O*NET OnLine



2. Hard/Soft Skills

Define Hard/Soft Skills

STW Jobs of Interest



3. Skill Changes

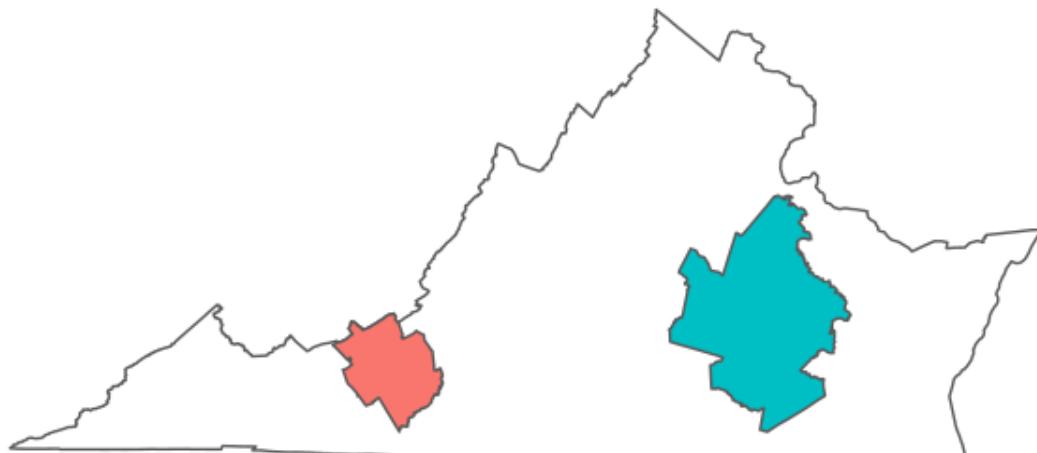
Identify
'near-duplicate'
skills



Group together

Focus on Richmond and Blacksburg

Job-ads and MSAs Used for Analysis



Selected two metropolitan statistical areas (MSAs) in 2016-17:

- Richmond
(Population 1,292,911)
- Blacksburg-Christiansburg-Radford
(Population 182,692)

<https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk>

Common STW in our MSAs

Blacksburg (2,119 STW)

1. 11.6% Critical Care Nurses
2. 9.4% Computer User Support Specialists
3. 6.9% Maintenance and Repair Workers, General
4. 2.1% Emergency Medical Technicians and Paramedics
5. 2.0% Automotive Specialty Technicians

Richmond (18,598 STW)

1. 8.7% Critical Care Nurses
2. 7.5% Maintenance and Repair Workers, General
3. 5.6% Computer User Support Specialists
4. 3.2% Automotive Specialty Technicians
5. 2.7% Web Developers

Common STW in our MSAs

Blacksburg (2,119 STW)

1. 11.6% Critical Care Nurses
2. 9.4% Computer User Support Specialists
3. 6.9% Maintenance and Repair Workers, General
4. 2.1% Emergency Medical Technicians and Paramedics
5. 2.0% Automotive Specialty Technicians

Richmond (18,598 STW)

1. 8.7% Critical Care Nurses
2. 7.5% Maintenance and Repair Workers, General
3. 5.6% Computer User Support Specialists
4. 3.2% Automotive Specialty Technicians
5. 2.7% Web Developers

Selected Critical Care Nurses (CCN) for a case study

Ads for Critical Care Nurses in Richmond and Blacksburg

All Virginia job ads, 2016-2017: 1,486,697

Filter By MSA

All Richmond job ads:
205,285

Filter By MSA

All Blacksburg job ads:
24,358

*Filter via O*NET
and Bachelor's
Requirement*

STW Richmond job ads:
18,598

*Filter via O*NET
and Bachelor's
Requirement*

*Filter By
O*NET Again*

Critical Care Nurse ads in
Richmond:
1,609

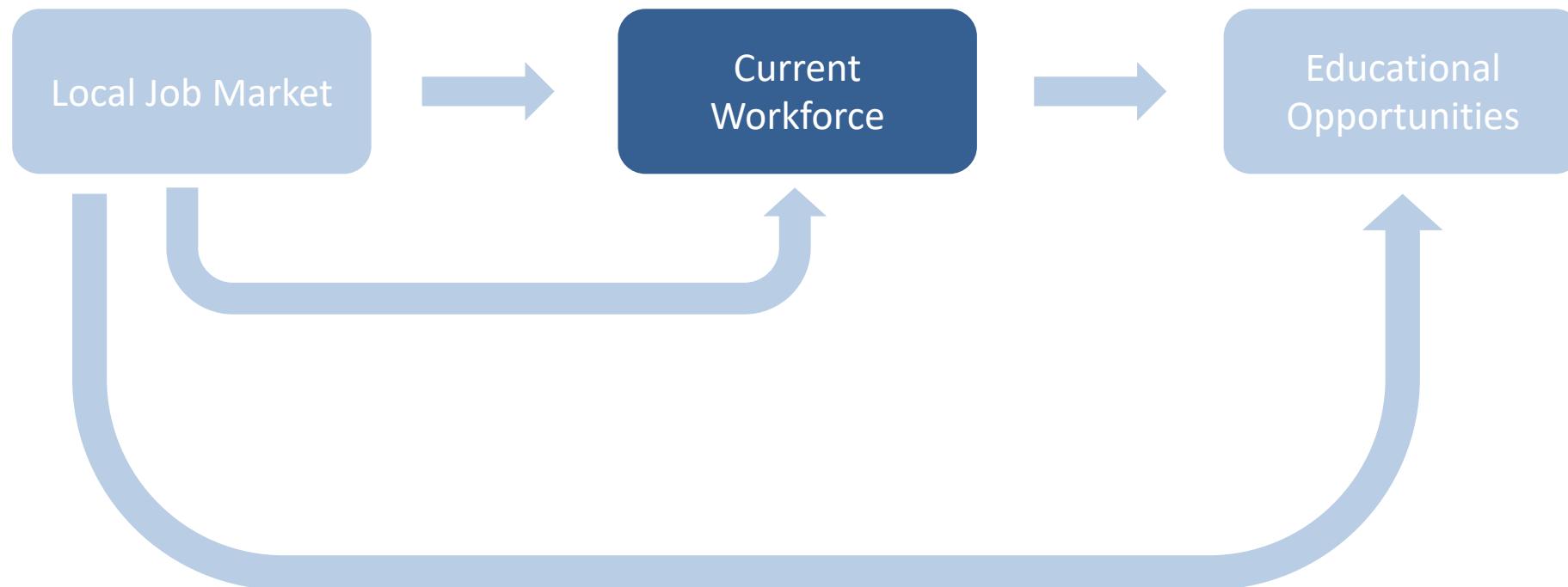
*Filter By
O*NET Again*

Critical Care Nurse ads in
Blacksburg:
245

Describing the Current Workforce with Online Resumes

What skilled technical positions are available?
What skills are required for those jobs?

What skills do local workers already have?



BGT Resume Data

- BGT proprietary dataset, sourced from Burning Glass partners.
 - 2016 to 2018
 - No way to validate



BGT Resume Data

- BGT proprietary dataset, sourced from Burning Glass partners.
 - 2016 to 2018
 - No way to validate
- Originally 2200 zipped files; merged into 5 unique data-tables:
 - Personal information, skills, education, certifications, and job history
 - Same MSA, Education, Skills

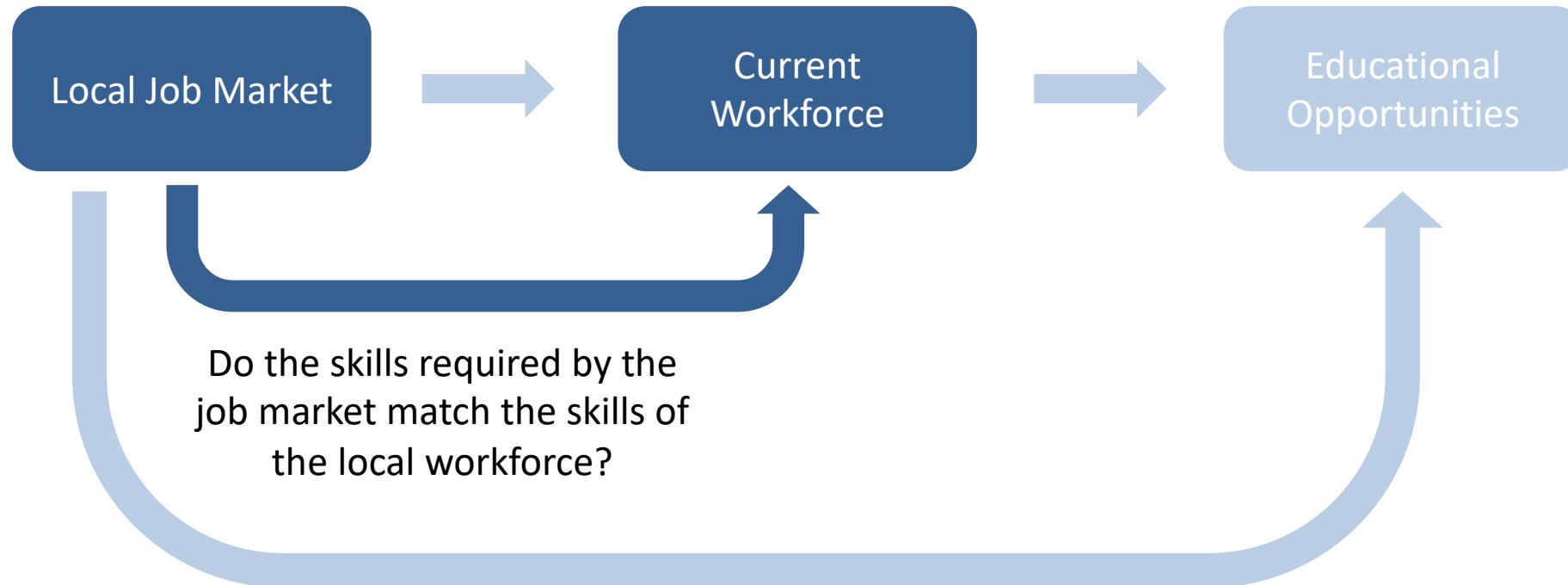
BGT Resume Data

- BGT proprietary dataset, sourced from Burning Glass partners.
 - 2016 to 2018
 - No way to validate
- Originally 2200 zipped files; merged into 5 unique data tables:
 - Personal information, skills, education, certifications, and job history
 - Same MSA, Education, Skills
- Limited analysis to two MSAs in 2016-17, but not 2018:

Blacksburg:
10,428

Richmond:
91,916

Connecting Ads to Resumes With Burning Glass Skills Data



Finding A Probable STW: Education Level

Education

- Non-homogenous data
- Multiple degrees per entry,
skewed distribution
- "Some college"

Finding A Probable STW: Education Level

Cleaning

- Institution:
 - High schools and military schools
 - Virginia community colleges
 - Technical and vocational schools
- Degree type:
 - GED
 - Associates of multiple kinds
- Major or degree type:
 - "Some college"
 - "Coursework"

Finding A Probable STW: Education Level

Cleaning

- Institution:
 - High schools and military schools
 - Virginia community colleges
 - Technical and vocational schools
- Degree type:
 - GED
 - Associates of multiple kinds
- Major or degree type:
 - "Some college"
 - "Coursework"

Increased maximum education level by 11% to 79%

Finding A Probable STW: Education Level

- Education threshold:
 - Less than an Associate's
 - No education listed
 - Some college excluded
- New variable: "Has Bachelors"

Identifying Plausible Candidates for STW: Critical Skills

1. Identify *critical skills*: hard skills in over 25% of job ads
 - Excluding extremely common hard skills, e.g. "Teaching"
2. Select resumes with at least one critical skill

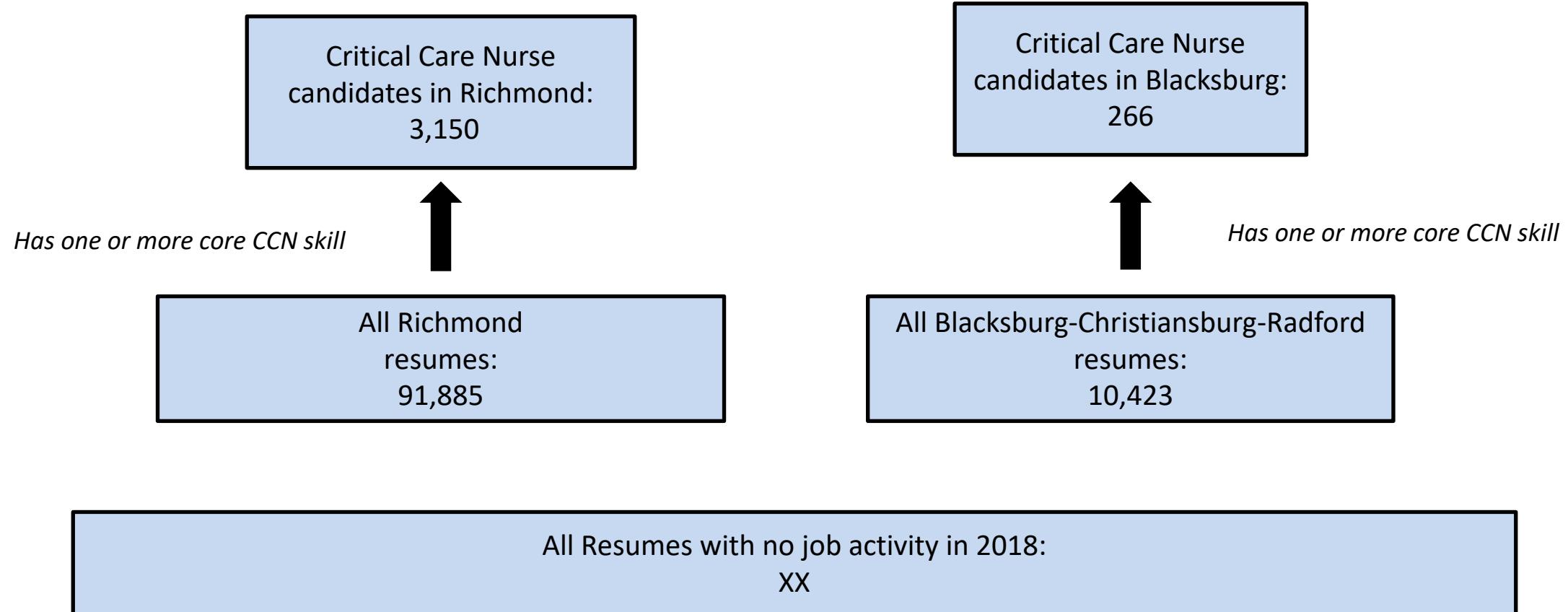
Identifying Plausible Candidates for STW: Critical Skills

1. Identify *critical skills*: hard skills in over 25% of job ads
 - Excluding extremely common hard skills, e.g. "Teaching"
2. Select resumes with at least one critical skill

Critical Skills:

- Richmond: Critical Care, Advanced Cardiac Life Support, Patient Care, and Neonatal Intensive Care Unit
- Blacksburg: Critical Care, Advanced Cardiac Life Support, Patient Care

Ads for Critical Care Nurses in Richmond and Blacksburg



All Virginia job ads, 2016-2017: 1,486,697



Critical Care Nurse ads in
Richmond:
1,609

Critical Care Nurse ads in
Blacksburg:
245

Critical Care Nurse
candidates in Richmond:
3,150

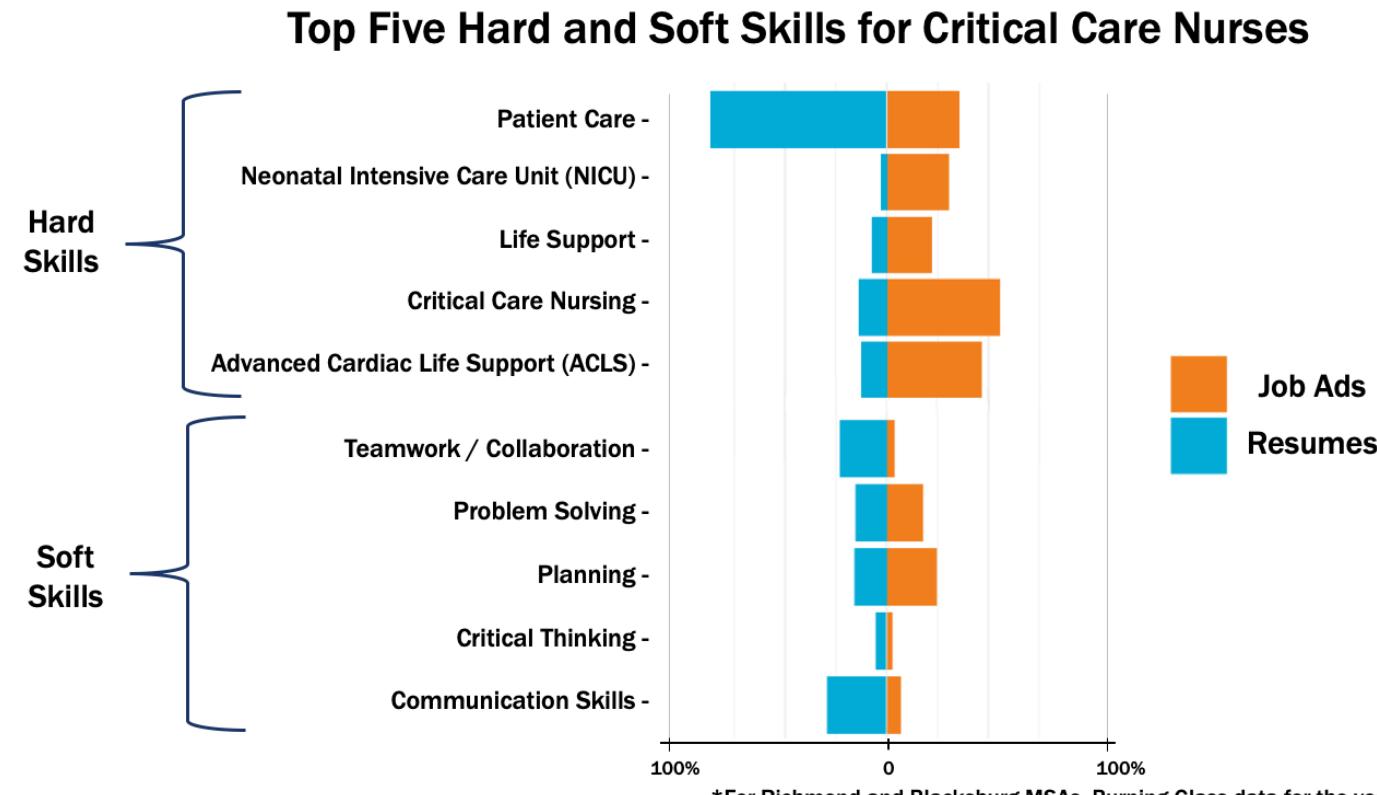
Critical Care Nurse
candidates in Blacksburg:
266



All Resumes with no job activity in 2018:
XX

Skill Differences Between Job-Ads and Resumes

- Most hard skills are undersupplied
- Most soft skills are oversupplied.
- Some skills appear to be extremely undersupplied (NICU)



Determining Match Between Ads and Resumes

Sample Resume

Life Support	Trauma	NICU	Patient Care
✓	✓		✓

Match With Ad

	Life Support	Trauma	NICU	Patient Care	Matching Skills	# of Skills Requested	Match Score
Job 1	✓	✓	✗	✓	1	2	0.5
Job 2	✓	✓	✓	✓	3	3	1
Job 3	✓	✓	✗	✓	0	1	0
Job 4	✓	✓	✗	✓	3	4	0.75

Proportion of requested skills fulfilled by resume

Determining Match Between Ads and Resumes

Sample Resume

Life Support	Trauma	NICU	Patient Care
1	1	0	1

Match With Ad

	Life Support	Trauma	NICU	Patient Care	Matching Skills	# of Skills Requested	Match Score
Job 1	1	0	1	0	1	2	0.5
Job 2	1	1	0	1	3	3	1
Job 3	0	0	1	0	0	1	0
Job 4	1	1	1	1	3	4	.75

Determining Match Between Ads and Resumes

The skills requested in each ad were compared to the skills listed on each resume, resulting in a match score for each resume and each job.

	Job 1	Job 2	Job 3	Job 4
Resume 1	0.5	1	0	.75
Resume 2	0	.33	0	.25
Resume 3	1	.67	1	.75
Resume 4	.5	0	1	0

Match scores between job ads and candidates: Critical Care Nurses

1,609 job ads matched to 3,150 candidates in Richmond, VA

How to Read

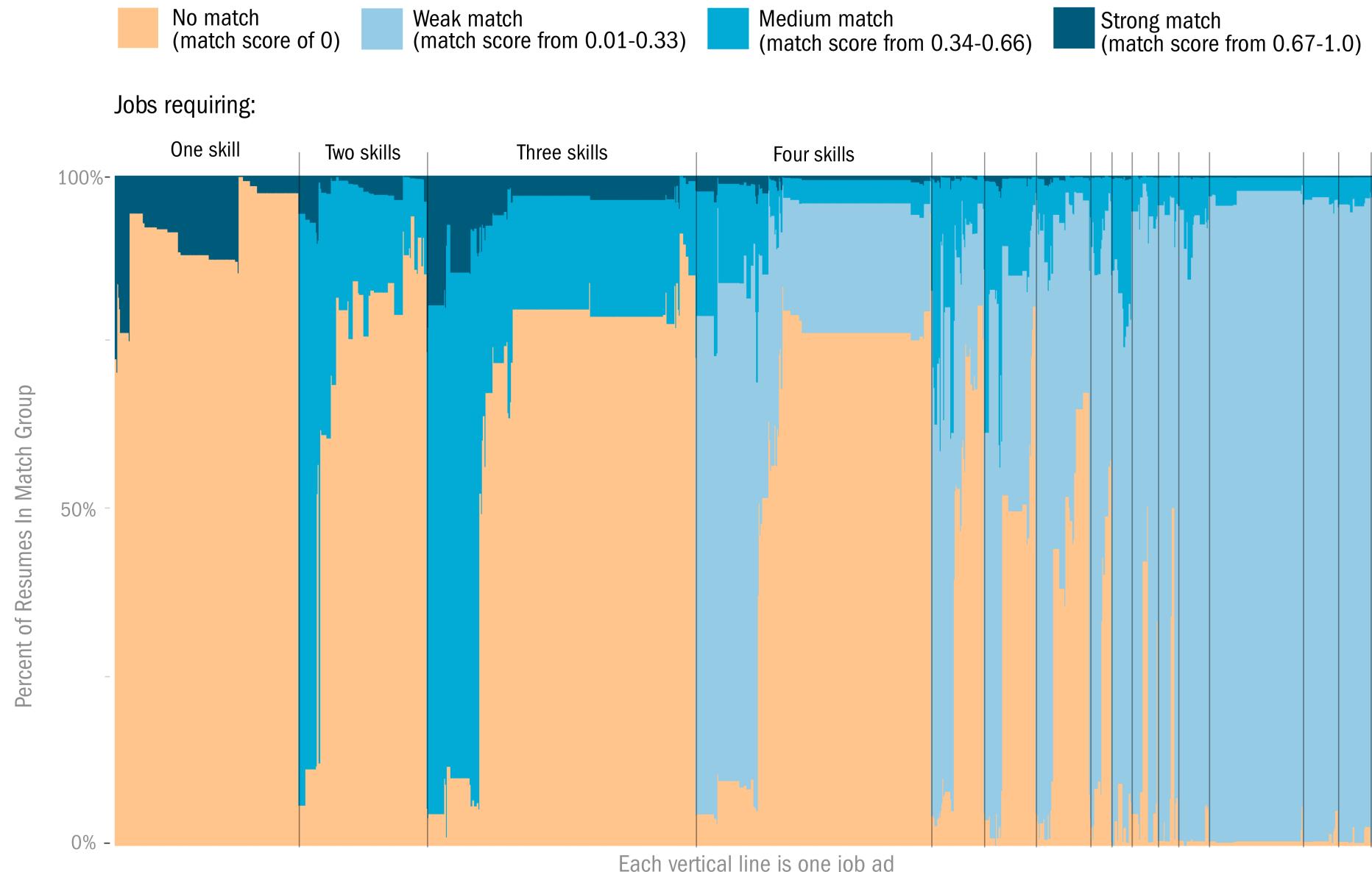
Each vertical line is one job. The colored segments within each line show how many candidates matched to that job at a certain level.

10% of candidates had a strong match to this job (67-100% of requested skills)

20% of candidates had a medium match to this job (34-66% of requested skills)

45% of candidates had a weak match to this job (1-33% of requested skills)

25% of candidates no match to this job (none of the requested skills)



Match scores between job ads and candidates: Critical Care Nurses

245 job ads matched to 266 candidates in Blacksburg, VA

How to Read

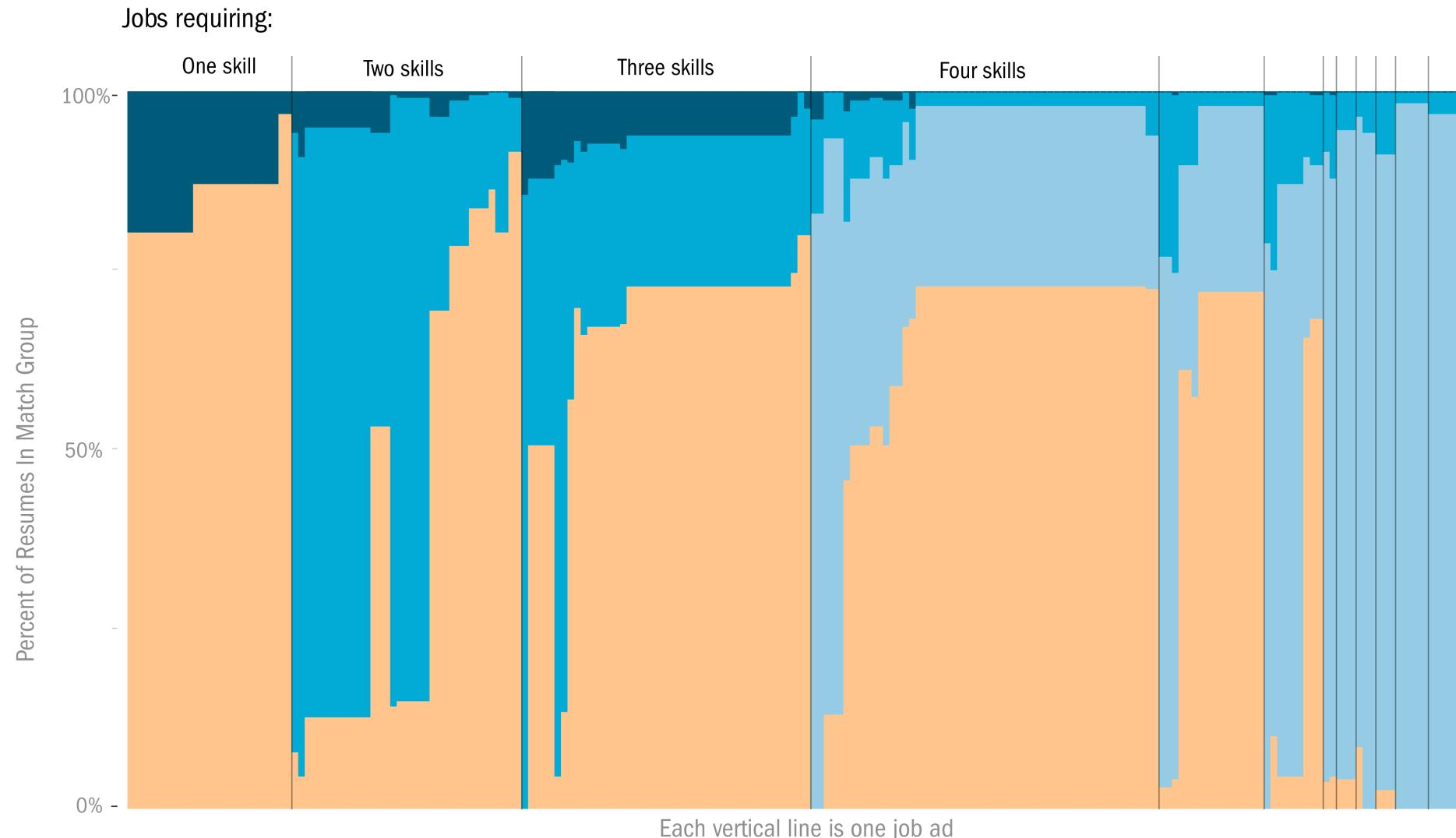
Each vertical line is one job. The colored segments within each line show how many candidates matched to that job at a certain level.

10% of candidates had a strong match to this job (67-100% of requested skills)

20% of candidates had a medium match to this job (34-66% of requested skills)

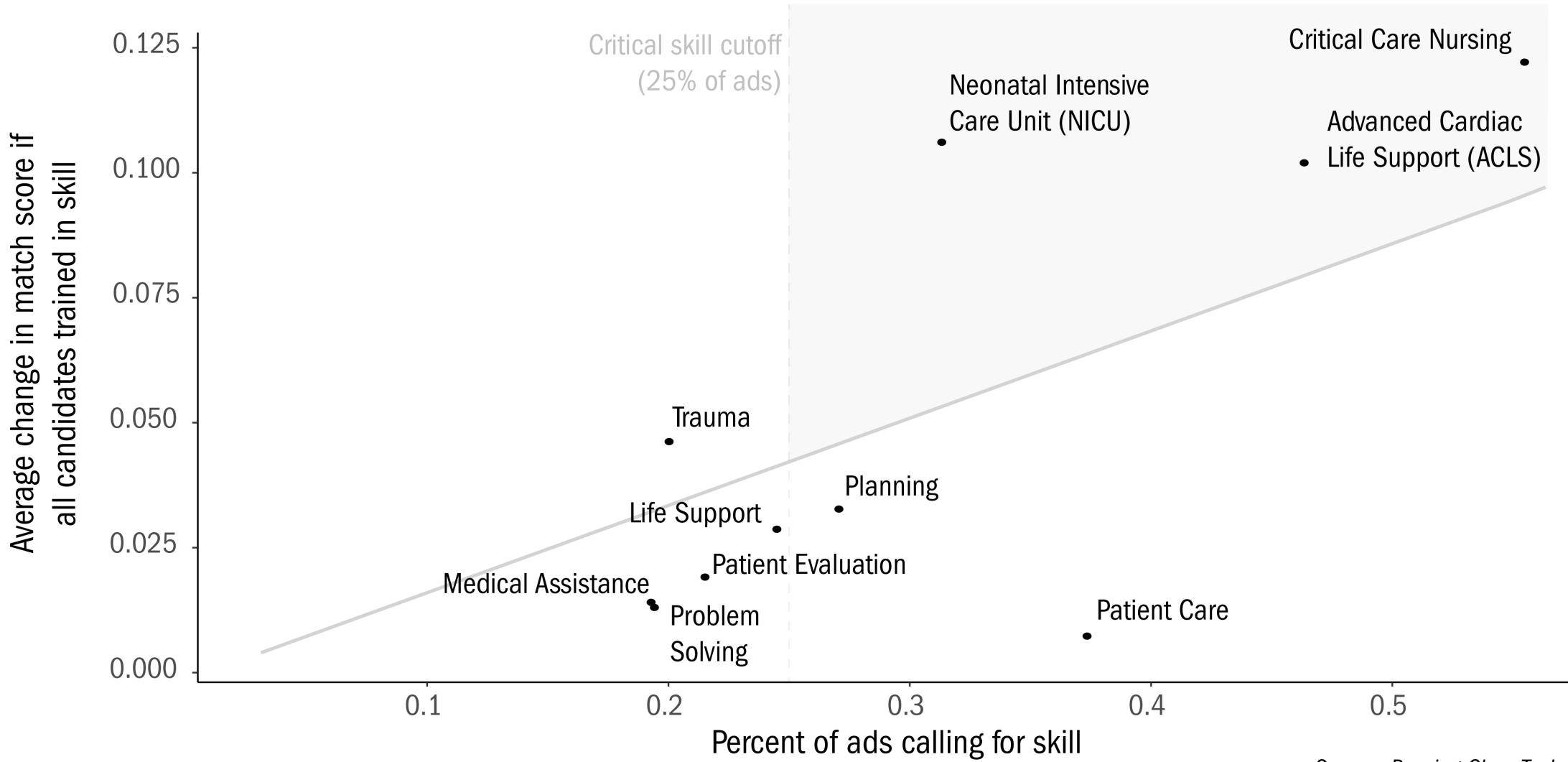
45% of candidates had a weak match to this job (1-33% of requested skills)

25% of candidates no match to this job (none of the requested skills)



Potential Impact of Skill Training on Match Scores

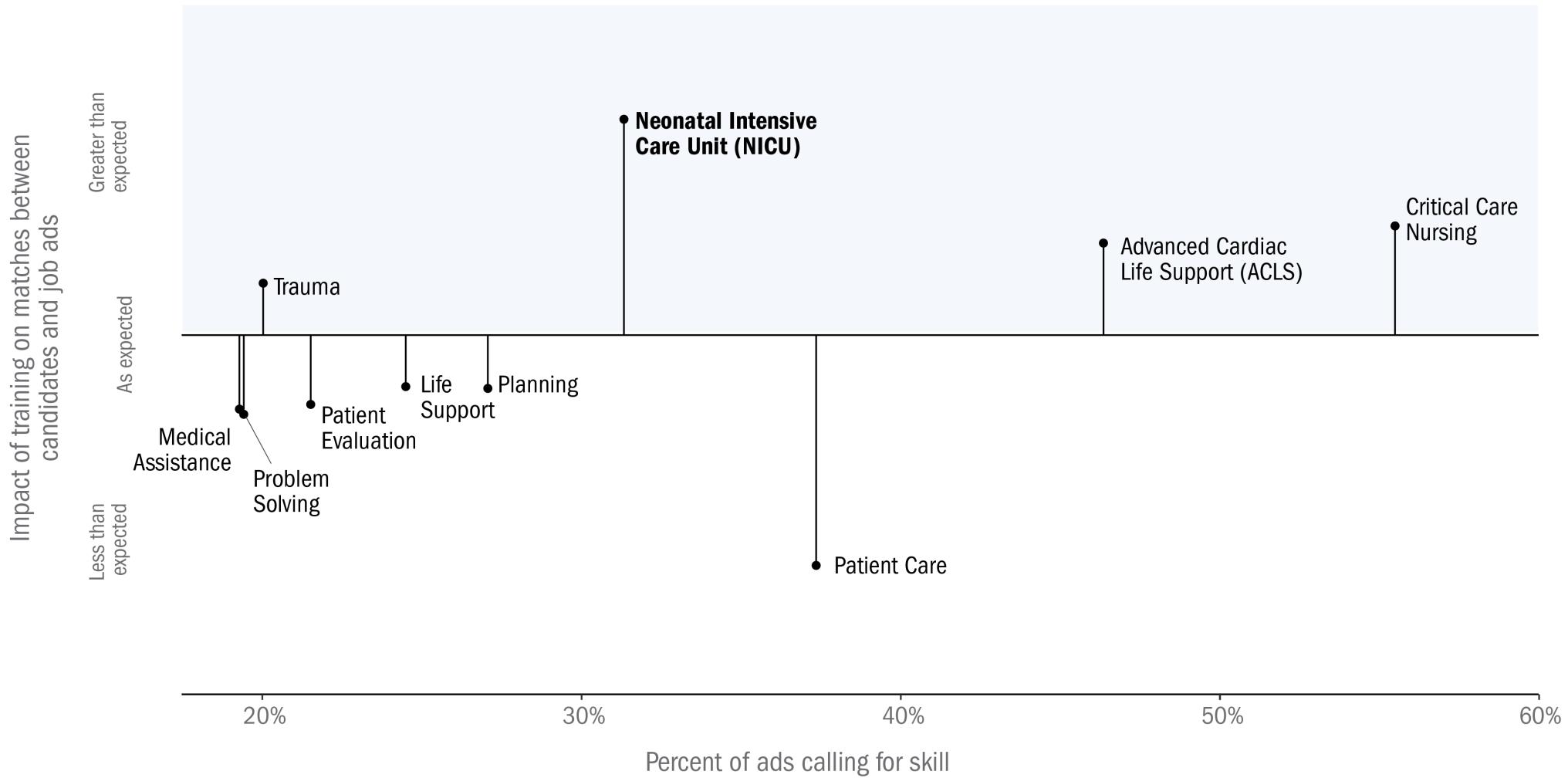
Critical Care Nurses in Richmond, VA



Source: Burning Glass Technologies

Impact of additional skill training on matches to Critical Care Nursing jobs

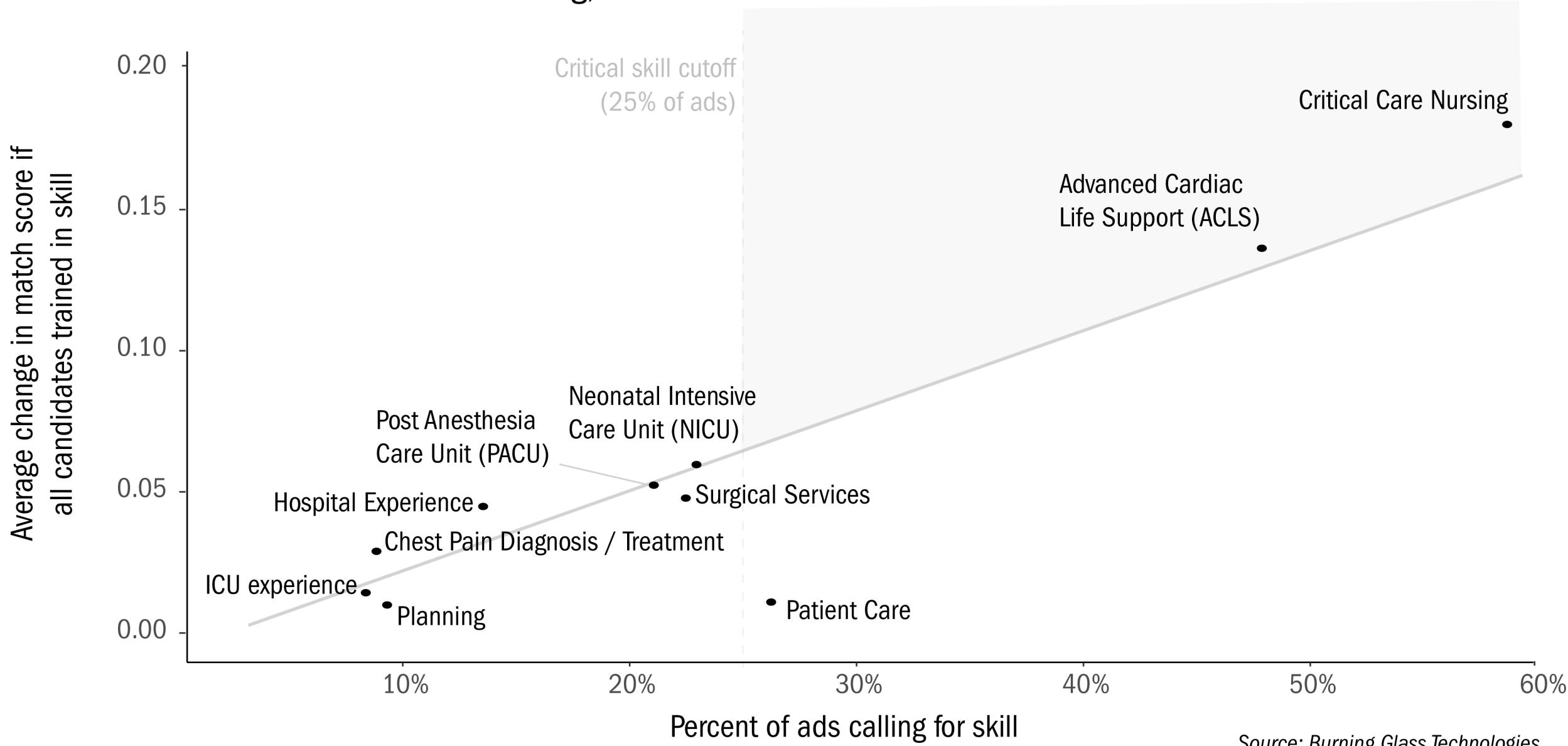
Richmond, VA, 2016-2017



Source: Burning Glass Technologies

Potential Impact of Skill Training on Match Scores

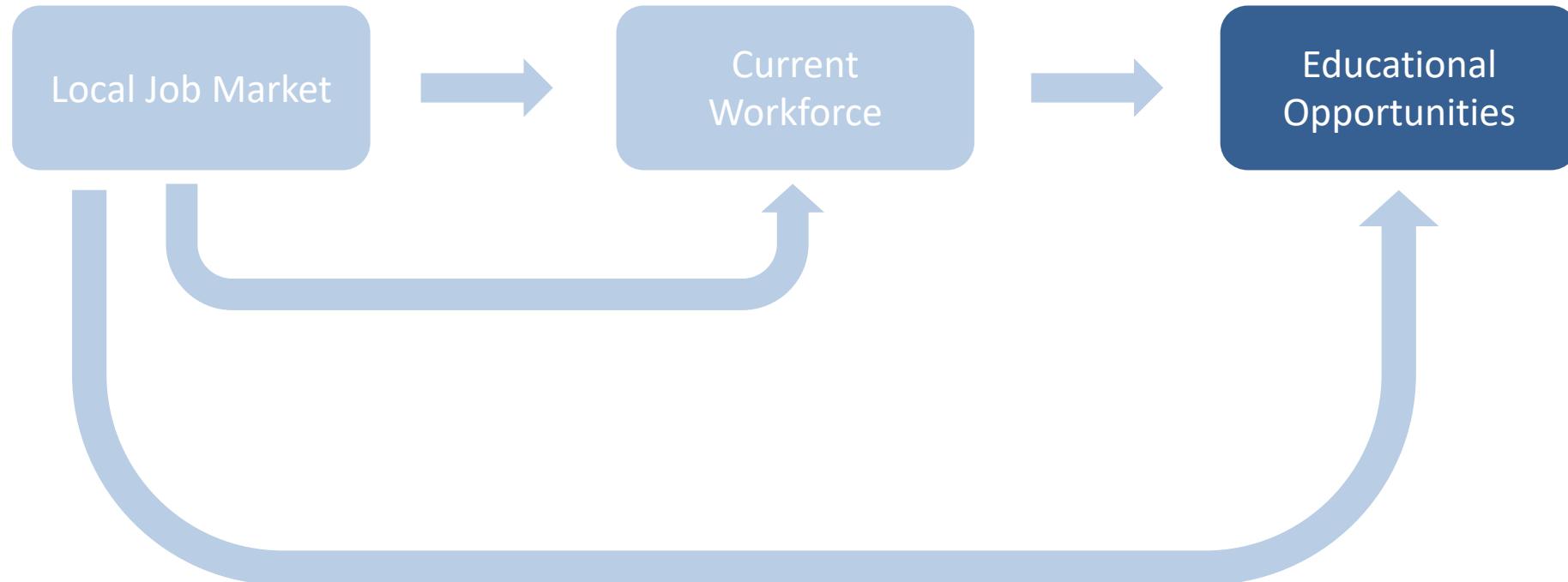
Critical Care Nurses in Blacksburg, VA



Source: Burning Glass Technologies

Next Steps: Investigating Local Educational Opportunities

Where can residents train
for skilled technical
positions?



Next Steps: Investigating Local Educational Opportunities



Critical Care Nurse Certifications

Critical Care Nurse Certification (CCRN)

- American Association of Critical-Care Nurses
- Must be a Registered Nurse (RN)
- Must be in direct care of acutely/critically ill patients for designated years and hours
- Take exam (Adult, Pediatric, Neonatal)
- Cost: \$239, \$344

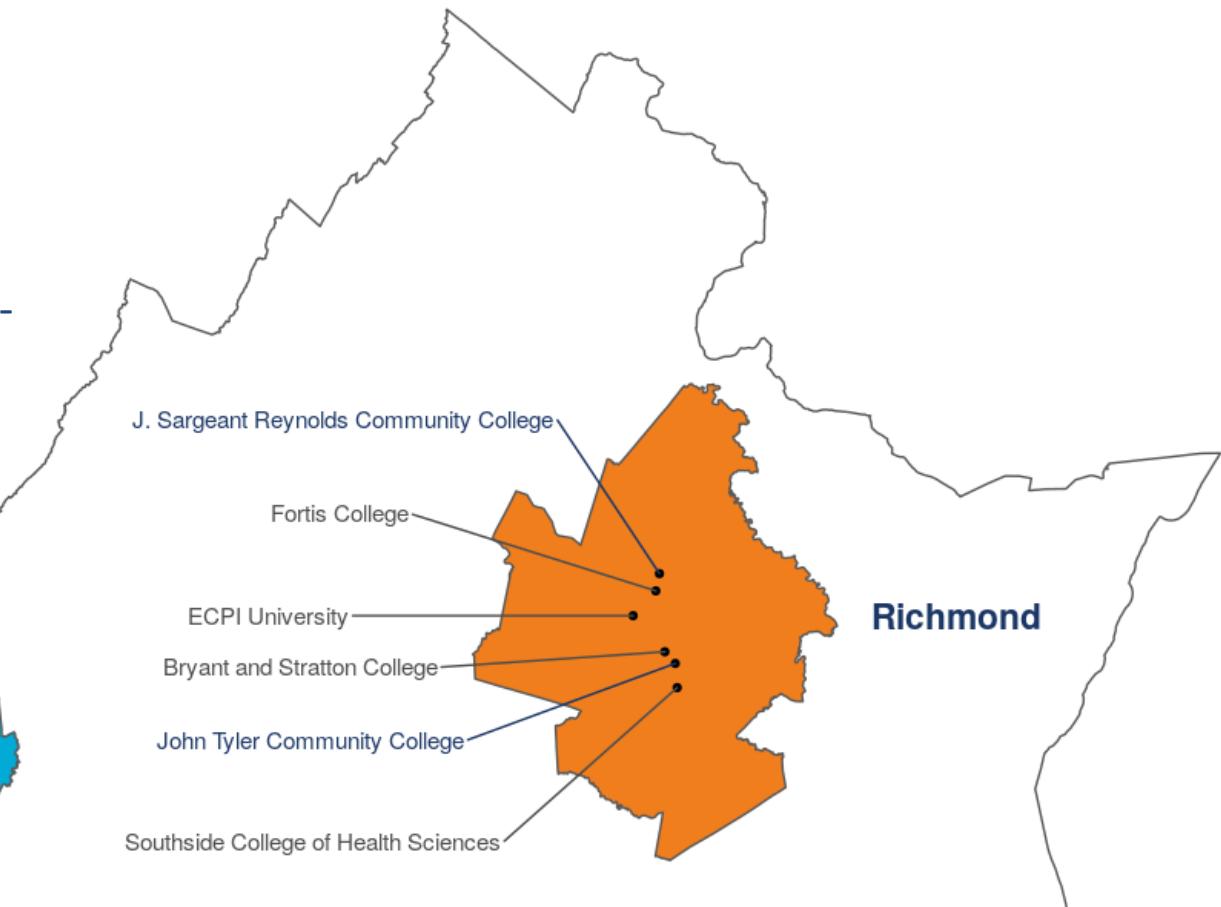
Neonatal Intensive Care Nursing (RNC-NIC)

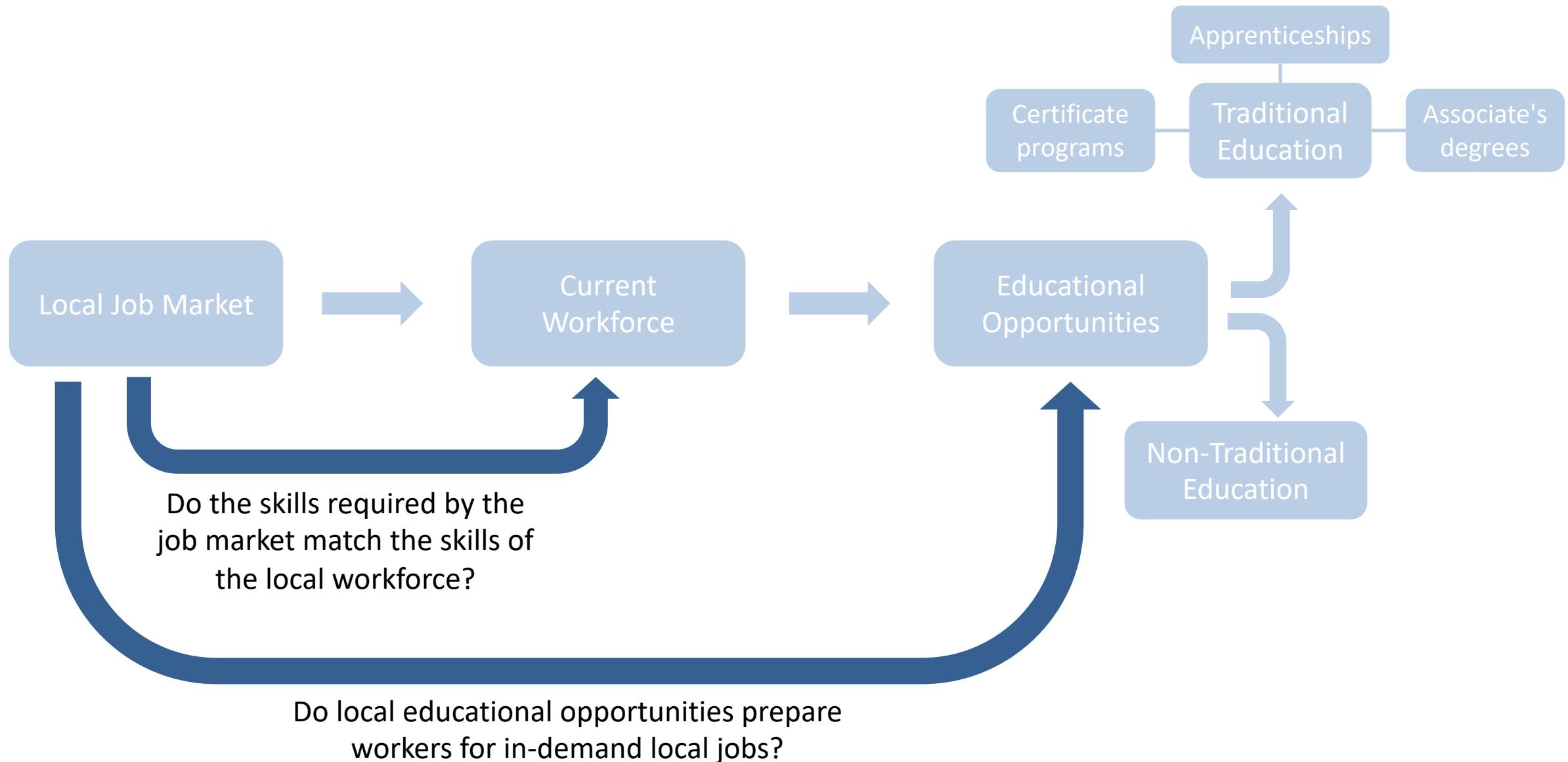
- National Certification Corporation
- Must be a Registered Nurse (RN)
- Must have Neonatal Intensive experience (direct patient care, education, administration, or research) for designated years and hours
- Take exam
- Cost: \$325

Associate's Degree in Nursing Programs

State Council of Higher Education for Virginia (SCHEV)

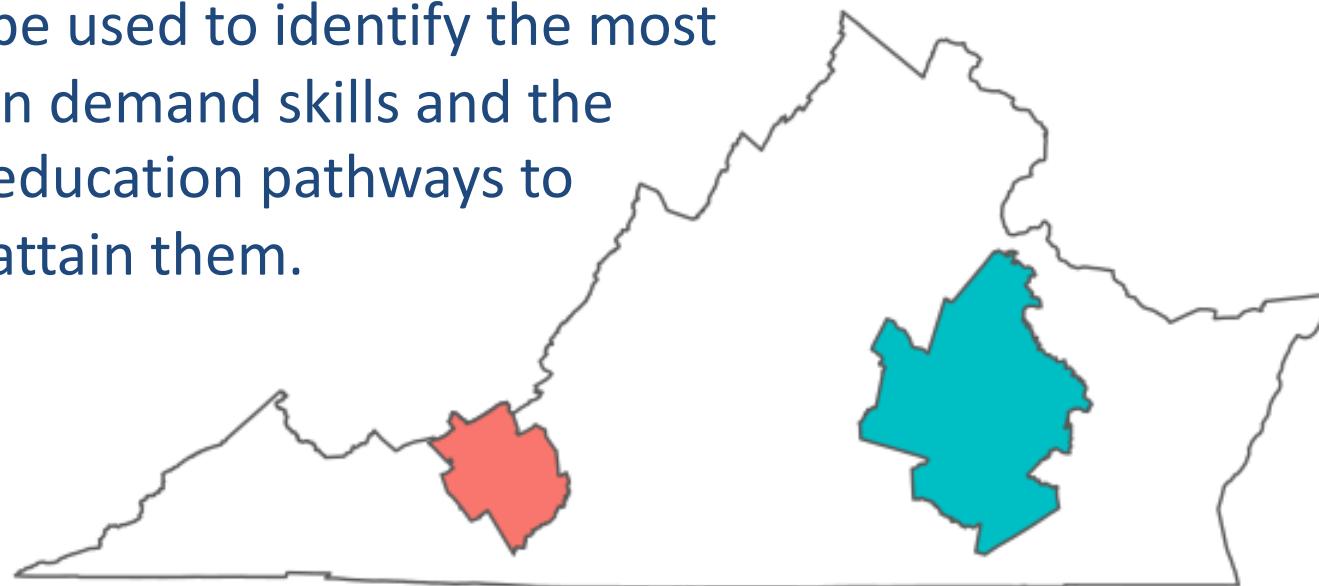
- Degree Inventory for public and private non-profit Institutions
- For-profit degree offerings manually searched





Results and Conclusions

Result: We have developed a match metric for skill supply and demand that can be used to identify the most in demand skills and the education pathways to attain them.



Conclusions: The demand for Critical Care Nursing in both MSAs is not being met.

There are differences in the skill demands between the two MSAs.

Both MSAs areas have educational opportunities to become a Registered Nurse.

Next Steps



- Complete the analysis for entire state of Virginia with additional STW jobs
- Link those resumes with match scores of 1 to their education and credential data to identify the education pathways for acquiring those skills
- Find a repeatable method for identifying the non-degree credential* pathways to a STW job
- Explore ways to calculate the rate of decline of a skill demand

*A non-degree credential includes work experience programs (i.e., apprenticeships), licenses & certifications, and certificates (i.e., nanodegrees, microcredentials, etc.) that do not result in a college (bachelor's, master's or doctoral) or professional degree.

Features of the Job Ad Dataset



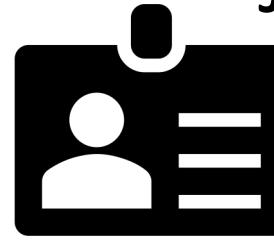
Desired Credentials

- Degree, Min & Max
- Experience, Min & Max



Desired Skills

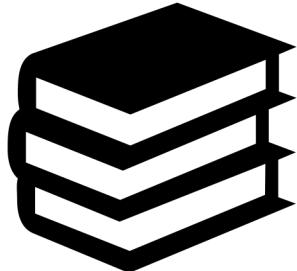
- BGT skill hierarchy, Clusters & Cluster Families
- Highly Cleaned
- BGT Indicators for Baseline, Specialized, Software skills



Job Details:

- MSA
- O*NET code
- Date posted
- Salary
- Employer
- Career and Job Type
- Hours

Features of the Resume Dataset



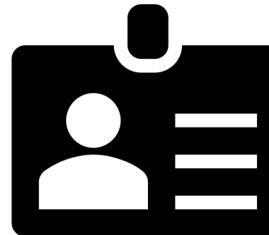
Education/
Certifications:

- Institution
- Degree Level
- Date
- Major



Skills:

- Clusters
- Cluster Families
- Highly Cleaned



Job History:

- Employer
- Dates
- Position title



Personal Information:

- Number of degrees
- Candidate Location:
city, state, county,
zip-code, MSA

Thank You!



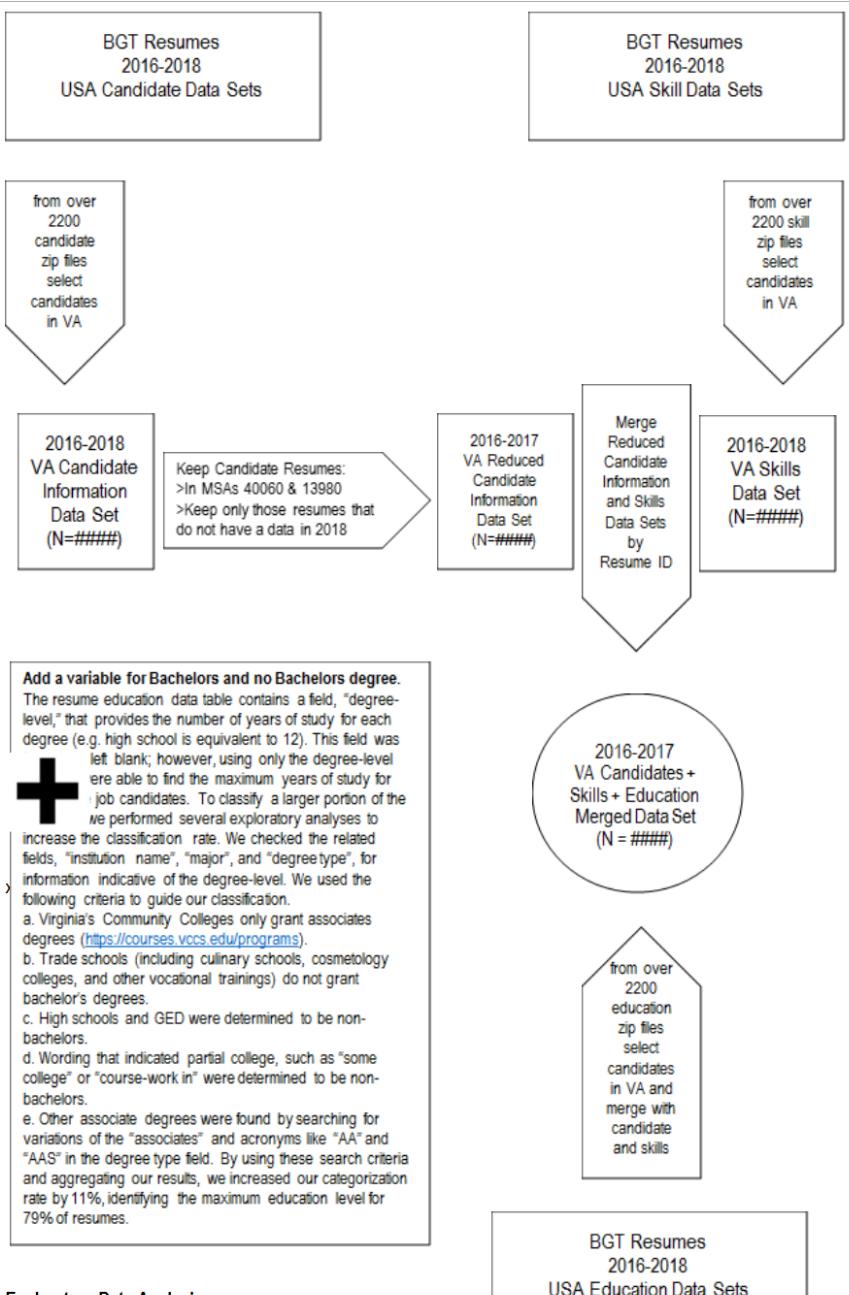
UNIVERSITY
of VIRGINIA

Biocomplexity Institute & Initiative

Extra Slides

Summary: Resume Data Pipeline

Candidate Information (Resume) Data Set



Job Information Data Set

Summary: Job-Ads Data Pipeline

BGT Job-ads
2016-2017
USA Job Information Data Sets

BGT Job-ads
2016-2017
USA Skill Data Sets

from 24 job information data sets select ads in VA

2016-2017 VA Job Information Data Set (N=#####)

Keep Jobs Ads:
>in MSAs 40060 & 13980
>with an education requirement of ≤ 14 years or no education
>with O*NET codes 29-1141.03 and 49-9071.00

2016-2017 VA Reduced Job Information Data Set (N=#####)

from 24 skills data sets select ads in VA

2016-2017 VA Skills Data Set (N=#####)

Add a variable for hard and soft skills. A "soft skill" is either personality-based, primarily used to interact with coworkers, or a general way of approaching a problem. Oral communication, teamwork, and creativity are soft skills. A "skill" requires domain-specific knowledge or can be measured and evaluated. Typing, Microsoft Excel, and financial accounting are hard skills. Five researchers manually identified each skill based on the above definition. Their results were then aggregated and used to create a skill type variable.



2016-2017 VA Job Information + Skills Merged Data Set (N = #####)

Ads for Critical Care Nurses in Richmond and Blacksburg

All Virginia job ads, 2016-2017: 1,486,697

Filter By MSA

All Richmond job ads:
205,285

Filter By MSA

All Blacksburg job ads:
24,358

*Filter via O*NET
and Bachelor's
Requirement*

STW Richmond job ads:
18,598

*Filter via O*NET
and Bachelor's
Requirement*

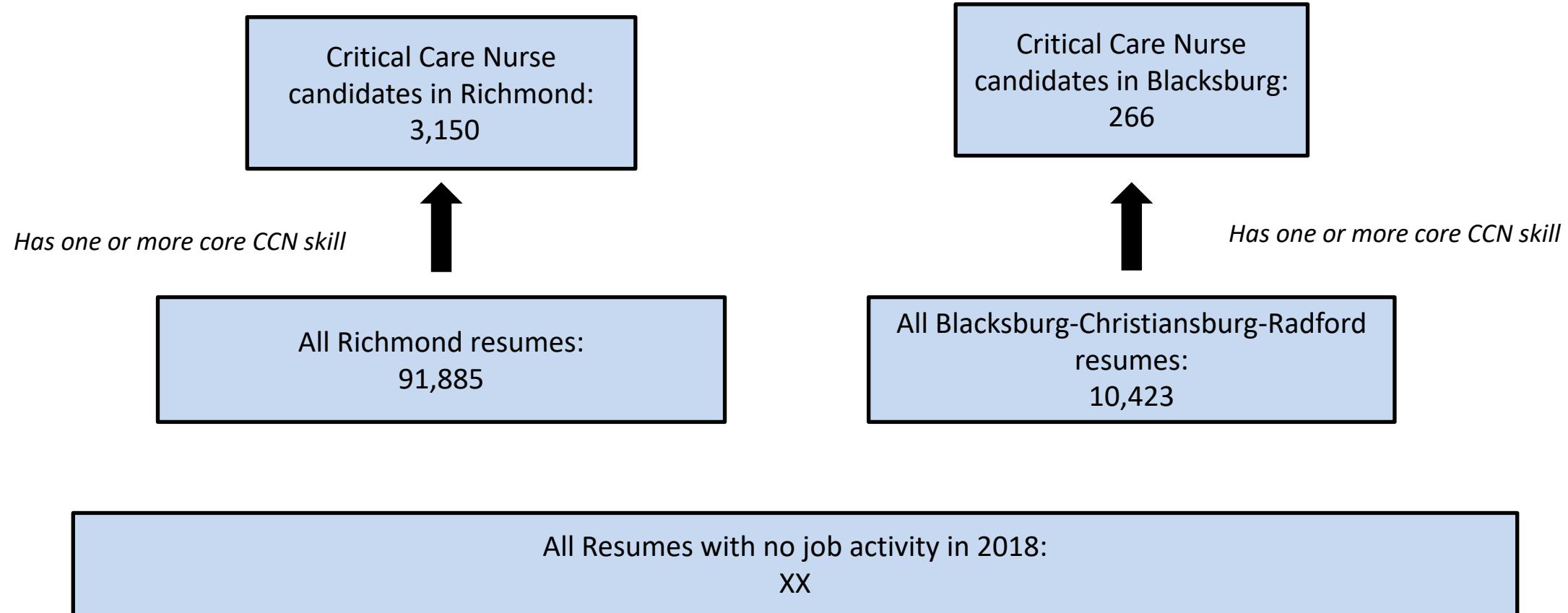
*Filter By
O*NET Again*

Critical Care Nurse ads in
Richmond:
1,609

*Filter By
O*NET Again*

Critical Care Nurse ads in
Blacksburg:
245

Ads for Critical Care Nurses in Richmond and Blacksburg



All Virginia job ads, 2016-2017: 1,486,697



Critical Care Nurse ads in
Richmond:
1,609

Critical Care Nurse ads in
Blacksburg:
245

Critical Care Nurse
candidates in Richmond:
3,150

Critical Care Nurse
candidates in Blacksburg:
266



All Resumes with no job activity in 2018:
XX