

# Automate Data Entry With Computer Vision

New College of Florida - Nate Wagner

A dark blue diagonal gradient bar that starts from the bottom left corner and extends towards the top right corner, covering the lower half of the slide.

# Survey Data

- Sent to 20,000+ Sarasota Businesses
- Received about 2,000 surveys
- Scanned as PDFs
- **Goal:** Build a model to read each survey and translate to CSV using computer vision techniques



## BUSINESS SURVEY 2019

1. HOW MANY EMPLOYEES DO YOU HAVE AT YOUR SARASOTA COUNTY BUSINESS LOCATION? 0

2. DO YOU HAVE ANY INTENTION TO HIRE ADDITIONAL EMPLOYEES IN THE COMING YEAR?  
☐ Yes ☒ No  
IF YES, HOW MANY? \_\_\_\_\_

3. THE EDC AND ITS PARTNERS PROVIDE GROWTH, SUPPORT, AND OTHER BUSINESS ASSISTANCE FREE OF CHARGE TO LOCAL COMPANIES. DO YOU HAVE AN INTEREST IN BEING CONTACTED BY THE EDC?  
☐ Yes ☒ No

4. IS MOST OF YOUR REVENUE GENERATED BY SALES OUTSIDE OF SARASOTA COUNTY?  
☒ Yes ☐ No

ACCOUNT #: \_\_\_\_\_

5. PLEASE RANK YOUR SATISFACTION WITH THE FOLLOWING COMMUNITY TOPICS THAT MAY IMPACT BUSINESS OWNERS:

	Very Dissatisfied	Neutral	Very Satisfied
Cost of Doing Business	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Access to Customers	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Proximity to Amenities (arts, dining, attractions)	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Transportation (public and highways)	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Safety Services (fire, police)	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Housing Affordability	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
Access to Workforce / Employees	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
City / County Permitting Process	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

6. HOW DO YOU RATE THE ECONOMIC OUTLOOK FOR THIS COMING YEAR?  
1: Poor 2 3 4 5: Average 6 7 8 9 10: Excellent  
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☒

7. PLEASE CHECK ANY OF THE FOLLOWING SERVICES THAT YOU MAY BE INTERESTED IN RECEIVING:  
☐ Consulting Services ☐ Workforce Assistance  
☐ Export Assistance ☐ Industry / Business Relationship Building  
☐ Growth Assistance ☐ Green / Sustainable Business Practices  
☐ Financing ☐ Government / Regulatory Assistance

8. IS YOUR BUSINESS A CERTIFIED GREEN BUSINESS PARTNER IN SARASOTA COUNTY? ☐ Yes ☒ No

9. IF YOU ANSWERED "NO" TO QUESTION #7, ARE YOU INTERESTED IN LEARNING MORE ABOUT CERTIFIED GREEN BUSINESS PARTNERS IN SARASOTA COUNTY? ☐ Yes ☒ No

10. PLEASE SELECT THE FUNCTIONS THAT OCCUR AT YOUR BUSINESS: (check all that apply).  
☐ Accounting / Finance ☐ Call Center ☐ Distribution ☐ Engineering / R&D ☐ Headquarters  
☐ Management ☐ Manufacturing ☐ Services ☐ Warehousing ☐ IT / Technology ☒ Other

IF BELOW INFORMATION IS INCORRECT OR MISSING, PLEASE UPDATE.

Name \_\_\_\_\_  
Company Name \_\_\_\_\_  
Phone Number \_\_\_\_\_  
Email Address \_\_\_\_\_

Thank you for your participation in our survey. We value and appreciate your input.  
For information on programs for businesses, visit: [www.edcsarasotacounty.com](http://www.edcsarasotacounty.com) or call 941.309.1200.

TEAR AT PERFORATION AND RETURN WITH YOUR BUSINESS TAX RENEWAL AND PAYMENT IN ENVELOPE PROVIDED

# First Attempt

- Built training set
  - Hand-entered 300 surveys
- First attempt was to crop each question, then train a CNN to classify as
  - [yes, no, no-answer]
- Test accuracy on “Yes/No” style question was 95%
- Issue was on the other style questions

EDC  
Economic Development Corporation  
SARASOTA COUNTY  
BUSINESS SURVEY  
2019

ACCOUNT #:

5. PLEASE RATE YOUR SATISFACTION WITH THE FOLLOWING COMMUNITY TOPICS THAT MAY IMPACT BUSINESS OWNERS.

	Very Dissatisfied	Neutral	Very Satisfied
Cost of Doing Business	○	○	○
Access to Customers	○	○	○
Proximity to Amenities (arts, dining, attractions)	○	○	○
Transportation (public and highways)	○	○	○
Safety Services (fire, police)	○	○	○
Housing Affordability	○	○	○
Access to Workforce/Employment	○	○	○
City/County Permitting Process	○	○	○

6. HOW DO YOU RATE THE ECONOMIC OUTLOOK FOR THIS COMING YEAR?

1: Poor 2 3 4 5: Average 6 7 8 9 10: Excellent

7. PLEASE CHECK ANY OF THE FOLLOWING SERVICES THAT YOU MAY BE INTERESTED IN RECEIVING.

☐ Consulting Services ☐ Workforce Assistance

☐ Export Assistance ☐ Industry/Business Relationship Building

☐ Growth Assistance ☐ Green/Sustainable Business Practices

☐ Financing ☐ Government/Regulatory Assistance

8. IS YOUR BUSINESS A CERTIFIED GREEN BUSINESS PARTNER IN SARASOTA COUNTY? ☐ Yes ☒ No

9. IF YOU ANSWERED "NO" TO QUESTION #8, ARE YOU INTERESTED IN LEARNING MORE ABOUT CERTIFIED GREEN BUSINESS PARTNERS IN SARASOTA COUNTY? ☐ Yes ☒ No

10. PLEASE SELECT THE FUNCTIONS THAT OCCUR AT YOUR BUSINESS: (check all that apply).

☐ Accounting/Finance ☐ Call Center ☐ Distribution ☐ Engineering/R&D ☐ Headquarters

☐ Management ☐ Manufacturing ☐ Services ☐ Warehousing ☐ IT/Technology ☒ Other

IF BELIEVE INFORMATION IS INCORRECT OR MISSING, PLEASE UPDATE.

Name \_\_\_\_\_

Company Name \_\_\_\_\_

Phone Number \_\_\_\_\_

Email Address \_\_\_\_\_

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TEAR AT PERFORATION AND RETURN WITH YOUR BUSINESS TAX RECEIPT AND PAYMENT IN FULL BY BUSINESS

4. IS MOST OF YOUR REVENUE GENERATED  
BY SALES OUTSIDE OF SARASOTA COUNTY?

☐ Yes ☒ No

Image Processing

☐ Yes ☒ No

# Issues With Scanning / Cropping

- When scanning 100s of surveys at a time, they don't always scan perfectly
- Cropping can be WAY off
- **Solution:** Deskew & Template Matching

EDC  
Economic Development Corporation  
SARASOTA COUNTY  
BUSINESS SURVEY  
2019

1. HOW MANY EMPLOYEES DO YOU HAVE AT YOUR SARASOTA COUNTY BUSINESS LOCATION?

2. DO YOU HAVE ANY INTENTION TO HIRE ADDITIONAL EMPLOYEES IN THE COMING YEAR?

3. IF YES, HOW MANY?

4. THE EDC AND ITS PARTNERS PROVIDE GROWTH, SUPPORT, AND OTHER BUSINESS ASSISTANCE FREE OF CHARGE TO LOCAL COMPANIES. HAVE YOU HAD AN INTEREST IN BEING TACTED BY THE EDC?

5. PLEASE RANK YOUR SATISFACTION WITH THE FOLLOWING:

6. HOW DO YOU RATE THE ECONOMIC OUTLOOK FOR THIS COMING YEAR?

7. PLEASE CHECK ANY OF THE FOLLOWING SERVICES THAT YOU MAY BE INTERESTED IN RECEIVING:

8. IS YOUR BUSINESS A CERTIFIED GREEN BUSINESS PARTNER IN SARASOTA COUNTY?

9. IF YOU ANSWERED "NO" TO QUESTION #7, ARE YOU INTERESTED IN LEARNING MORE ABOUT CERTIFIED GREEN BUSINESS PARTNERS IN SARASOTA COUNTY?

10. PLEASE SELECT THE FUNCTIONS THAT OCCUR AT YOUR BUSINESS (check all that apply):

IF BELOW INFORMATION:

MISSING, PLEASE UPDATE.

COMMUNITY TOPICS THAT MAY IMPACT BUSINESS OWNERS

Very Dissatisfied Neutral Very Satisfied

COMMUNITY TOPICS THAT MAY IMPACT BUSINESS OWNERS

Very Dissatisfied Neutral Very Satisfied

# OpenCV - Template Matching

Source Image

ACCOUNT # \_\_\_\_\_

**EDC**  
Economic Development Corporation  
SARASOTA COUNTY

**BUSINESS SURVEY**  
2019

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1. HOW MANY EMPLOYEES DO YOU HAVE AT YOUR SARASOTA COUNTY BUSINESS LOCATION? \_\_\_\_\_

2. DO YOU HAVE ANY INTENTION TO HIRE ADDITIONAL EMPLOYEES IN THE COMING YEAR?  
☐ Yes ☒ No  
 If Yes, How Many? \_\_\_\_\_

3. THE EDC AND ITS PARTNERS PROVIDE GRANTS, SUPPORT AND BUSINESS ASSISTANCE FREE OF CHARGE TO LEGAL COMPANIES. DO YOU HAVE AN INTEREST IN BEING CONTACTED BY THE EDC?  
☐ Yes ☒ No

4. IS MOST OF YOUR REVENUE GENERATED BY SALES OUTSIDE OF SARASOTA COUNTY?  
☒ Yes ☐ No

5. PLEASE RANK YOUR SATISFACTION WITH THE FOLLOWING COMMUNITY TOPICS THAT MAY IMPACT BUSINESS OPERATIONS:

	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied
Cost of Doing Business					
Access to Customers					
Proximity to Amenities (arts, dining, attractions)					
Transportation (buses and highways)					
Safety Services (Fire, police)					
Housing Affordability					
Access to Workforce / Employees					
City/County Permitting Process					

6. HOW DO YOU RATE THE ECONOMIC OUTLOOK FOR THIS COMING YEAR?  
 1 Dissatisfied 2 3 4 5 Satisfied  
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

7. PLEASE CHECK ANY OF THE FOLLOWING SERVICES THAT YOU MAY BE INTERESTED IN RECEIVING:

<input type="checkbox"/> Consulting Services	<input type="checkbox"/> Workforce Assistance
<input type="checkbox"/> Export Assistance	<input type="checkbox"/> Industry Business Relationship Building
<input type="checkbox"/> Growth Assistance	<input type="checkbox"/> Green/Sustainable Business Practices
<input type="checkbox"/> Financing	<input type="checkbox"/> Government / Regulatory Assistance

8. IS YOUR BUSINESS A CERTIFIED GREEN BUSINESS PARTNER IN SARASOTA COUNTY? ☐ Yes ☒ No

9. IF YOUR ANSWER TO "8" IS QUESTION #9, ARE YOU INTERESTED IN LEARNING MORE ABOUT CERTIFIED GREEN BUSINESS PARTNERSHIP IN SARASOTA COUNTY? ☐ Yes ☒ No

10. PLEASE SELECT THE FUNCTIONS THAT OCCUR ON YOUR BUSINESS' CHECK AT THE RATE:

<input type="checkbox"/> Accounting / Finance	<input type="checkbox"/> Call Center	<input type="checkbox"/> Distribution	<input type="checkbox"/> Engineering/R&D	<input type="checkbox"/> Human Resources
<input type="checkbox"/> Management	<input type="checkbox"/> Manufacturing	<input type="checkbox"/> Services	<input type="checkbox"/> Warehousing	<input type="checkbox"/> Technology

IF BELIEF INFORMATION IS INCORRECT OR MISSING, PLEASE UPDATE.

Name \_\_\_\_\_

Company Name \_\_\_\_\_

Phone Number \_\_\_\_\_

Email Address \_\_\_\_\_


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 For information on programs for businesses, visit: [www.edcsarasota.com](http://www.edcsarasota.com) or call 941.309.1200.  
 Tied at PERFORMANCE and RETURN with YOUR BUSINESS TAX RECEIPT and PAYMENT to PAYEE OR MAILING ADDRESS

## Template Image

Very Dissatisfied	Neutral	Very Satisfied
<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>



ACCOUNT # \_\_\_\_\_



**EDC**  
ENVIRONMENTAL DESIGN CENTER  
SARASOTA COUNTY

## BUSINESS SURVEY

### 2019

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**5. PLEASE RANK YOUR SATISFACTION WITH THE FOLLOWING COMMUNITY TOPICS THAT MAY IMPACT BUSINESS DEVELOPMENT.**

	Very Dissatisfied	Neutral	Very Satisfied
Cost of Doing Business	○	○	○
Access to Customers	○	○	○
Proximity to Amenities (arts, dining, attractions)	○	○	○
Transportation (public and highways)	○	○	○
Safety Services (fire, police)	○	○	○
Housing/Affordability	○	○	○
Access to Workforce/Employees	○	○	○
City/County Permitting Process	○	○	○

**6. HOW MANY DO YOU RATE THE ECONOMIC OUTLOOK FOR THIS COMING YEAR?**

1: Poor	2	3	4	5: Average	6	7	8	9	10: Excellent
○	○	○	○	○	○	○	○	○	○

**7. PLEASE CHECK ANY OF THE FOLLOWING SERVICES THAT YOU MAY BE INTERESTED IN RECEIVING:**

<input type="checkbox"/> Consulting Services	<input type="checkbox"/> Workforce Assistance
<input type="checkbox"/> Export Assistance	<input type="checkbox"/> Industry/ Business Relationship Building
<input type="checkbox"/> Growth Assistance	<input type="checkbox"/> Green/ Sustainable Business Practices
<input type="checkbox"/> Financing	<input type="checkbox"/> Government/Regulatory Assistance

**8. IS YOUR BUSINESS A CERTIFIED GREEN BUSINESS PARTNER IN SARASOTA COUNTY?** ☐ Yes ☒ No

**9. IF YOU ANSWERED "NO" TO QUESTION #7, ARE YOU INTERESTED IN LEARNING HOW ABOUT CERTIFIED GREEN BUSINESS PARTNERS IN SARASOTA COUNTY?** ☐ Yes ☒ No

**10. PLEASE SELECT THE FUNCTIONS THAT OCCUR IN YOUR BUSINESS: (check all that apply).**

<input type="checkbox"/> Accounting/ Finance	<input type="checkbox"/> Call Center	<input type="checkbox"/> Distribution	<input type="checkbox"/> Engineering/R&D	<input type="checkbox"/> Headquarters
<input type="checkbox"/> Management	<input type="checkbox"/> Manufacturing	<input type="checkbox"/> Services	<input type="checkbox"/> Warehousing	<input checked="" type="checkbox"/> IT/Technology
<input checked="" type="checkbox"/> Other _____				

**IF BELIEF INFORMATION IS INCORRECT OR MISSING, PLEASE UPDATE.**

Company Name \_\_\_\_\_

Phone Number \_\_\_\_\_

Email Address \_\_\_\_\_

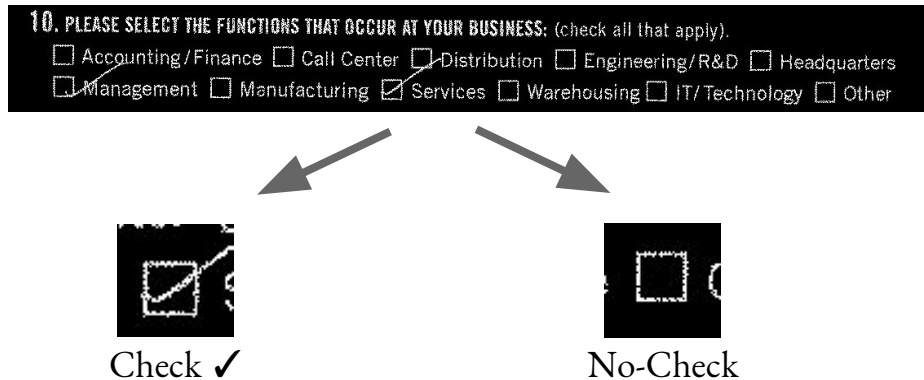
**11. HOW MANY DO YOU HAVE AT YOUR SARASOTA COUNTY BUSINESS LOCATION?** ☐ 0 ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16 ☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23 ☐ 24 ☐ 25 ☐ 26 ☐ 27 ☐ 28 ☐ 29 ☐ 30 ☐ 31 ☐ 32 ☐ 33 ☐ 34 ☐ 35 ☐ 36 ☐ 37 ☐ 38 ☐ 39 ☐ 40 ☐ 41 ☐ 42 ☐ 43 ☐ 44 ☐ 45 ☐ 46 ☐ 47 ☐ 48 ☐ 49 ☐ 50 ☐ 51 ☐ 52 ☐ 53 ☐ 54 ☐ 55 ☐ 56 ☐ 57 ☐ 58 ☐ 59 ☐ 60 ☐ 61 ☐ 62 ☐ 63 ☐ 64 ☐ 65 ☐ 66 ☐ 67 ☐ 68 ☐ 69 ☐ 70 ☐ 71 ☐ 72 ☐ 73 ☐ 74 ☐ 75 ☐ 76 ☐ 77 ☐ 78 ☐ 79 ☐ 80 ☐ 81 ☐ 82 ☐ 83 ☐ 84 ☐ 85 ☐ 86 ☐ 87 ☐ 88 ☐ 89 ☐ 90 ☐ 91 ☐ 92 ☐ 93 ☐ 94 ☐ 95 ☐ 96 ☐ 97 ☐ 98 ☐ 99 ☐ 100 ☐ 101 ☐ 102 ☐ 103 ☐ 104 ☐ 105 ☐ 106 ☐ 107 ☐ 108 ☐ 109 ☐ 110 ☐ 111 ☐ 112 ☐ 113 ☐ 114 ☐ 115 ☐ 116 ☐ 117 ☐ 118 ☐ 119 ☐ 120 ☐ 121 ☐ 122 ☐ 123 ☐ 124 ☐ 125 ☐ 126 ☐ 127 ☐ 128 ☐ 129 ☐ 130 ☐ 131 ☐ 132 ☐ 133 ☐ 134 ☐ 135 ☐ 136 ☐ 137 ☐ 138 ☐ 139 ☐ 140 ☐ 141 ☐ 142 ☐ 143 ☐ 144 ☐ 145 ☐ 146 ☐ 147 ☐ 148 ☐ 149 ☐ 150 ☐ 151 ☐ 152 ☐ 153 ☐ 154 ☐ 155 ☐ 156 ☐ 157 ☐ 158 ☐ 159 ☐ 160 ☐ 161 ☐ 162 ☐ 163 ☐ 164 ☐ 165 ☐ 166 ☐ 167 ☐ 168 ☐ 169 ☐ 170 ☐ 171 ☐ 172 ☐ 173 ☐ 174 ☐ 175 ☐ 176 ☐ 177 ☐ 178 ☐ 179 ☐ 180 ☐ 181 ☐ 182 ☐ 183 ☐ 184 ☐ 185 ☐ 186 ☐ 187 ☐ 188 ☐ 189 ☐ 190 ☐ 191 ☐ 192 ☐ 193 ☐ 194 ☐ 195 ☐ 196 ☐ 197 ☐ 198 ☐ 199 ☐ 200 ☐ 201 ☐ 202 ☐ 203 ☐ 204 ☐ 205 ☐ 206 ☐ 207 ☐ 208 ☐ 209 ☐ 210 ☐ 211 ☐ 212 ☐ 213 ☐ 214 ☐ 215 ☐ 216 ☐ 217 ☐ 218 ☐ 219 ☐ 220 ☐ 221 ☐ 222 ☐ 223 ☐ 224 ☐ 225 ☐ 226 ☐ 227 ☐ 228 ☐ 229 ☐ 230 ☐ 231 ☐ 232 ☐ 233 ☐ 234 ☐ 235 ☐ 236 ☐ 237 ☐ 238 ☐ 239 ☐ 240 ☐ 241 ☐ 242 ☐ 243 ☐ 244 ☐ 245 ☐ 246 ☐ 247 ☐ 248 ☐ 249 ☐ 250 ☐ 251 ☐ 252 ☐ 253 ☐ 254 ☐ 255 ☐ 256 ☐ 257 ☐ 258 ☐

- It slides the template over the source image one pixel at a time and computes a metric that represents how “good” or “bad” the match is
- (R) - Result Matrix
- (x, y) - Each Location
- Then for each location T over I, it computes and stores the result in t

$$R(x, y) = \sum_{x', y'} (T(x', y') - I(x + x', y + y'))^2$$

# Final Attempt

- 1.Deskew
- 2. Template Match Each Question
- 3. Crop
- 4. Trained CNN to classify each bubble as
  - [ check, no-check ]
- Achieved test accuracy of +99% on all questions



# Issues With Reproducibility

- EDC may want to change questions/survey design
- Template matching will no longer work without generating new templates / cropping dimensions
- Solution: **Object Detection**

Template Image



Source Image



## 6. DID YOU RECEIVE COVID-19 RELIEF FUNDS?

☐ Yes ☒ No

EDC SARASOTA COUNTY  
BUSINESS SURVEY  
2019

ACCOUNT # \_\_\_\_\_

5. PLEASE RANK YOUR SATISFACTION WITH THE FOLLOWING COMMUNITY TOPICS THAT MAY IMPACT BUSINESS OWNERS.

	Very Dissatisfied	Neutral	Very Satisfied
Cost of Doing Business	○	○	○
Access to Customers	○	○	○
Proximity to Amenities (arts, dining, attractions)	○	○	○
Transportation (public and highways)	○	○	○
Safety Services (fire, police)	○	○	○
Housing Affordability	○	○	○
Access to Workforce / Employees	○	○	○
City / County Permitting Process	○	○	○

6. HOW DO YOU RATE THE ECONOMIC OUTLOOK FOR THIS COMING YEAR?

1: Poor 2 3 4 5: Average 6 7 8 9 10: Excellent

○ ○ ○ ○ ○ ○ ○ ○ ○ ○

7. PLEASE CHECK ANY OF THE FOLLOWING SERVICES THAT YOU MAY BE INTERESTED IN RECEIVING.

<input type="checkbox"/> Consulting Services	<input type="checkbox"/> Workforce Assistance
<input type="checkbox"/> Export Assistance	<input type="checkbox"/> Industry / Business Relationship Building
<input type="checkbox"/> Growth Assistance	<input type="checkbox"/> Green / Sustainable Business Practices
<input type="checkbox"/> Financing	<input type="checkbox"/> Government / Regulatory Assistance

8. IS YOUR BUSINESS A CERTIFIED GREEN BUSINESS PARTNER IN SARASOTA COUNTY? ☐ Yes ☒ No

9. IF YOU ANSWERED "NO" TO QUESTION #8, ARE YOU INTERESTED IN LEARNING MORE ABOUT CERTIFIED GREEN BUSINESS PARTNERS IN SARASOTA COUNTY? ☐ Yes ☒ No

10. PLEASE SELECT THE FUNCTIONS THAT OCCUR AT YOUR BUSINESS. (check all that apply).

<input type="checkbox"/> Accounting/Finance	<input type="checkbox"/> Call Center	<input type="checkbox"/> Distribution	<input type="checkbox"/> Engineering/R&D	<input type="checkbox"/> Headquarters
<input type="checkbox"/> Management	<input type="checkbox"/> Manufacturing	<input type="checkbox"/> Services	<input type="checkbox"/> Warehousing	<input checked="" type="checkbox"/> Other

IF BELOW INFORMATION IS INCORRECT OR MISSING, PLEASE UPDATE.

Name \_\_\_\_\_

Company Name \_\_\_\_\_

Phone Number \_\_\_\_\_

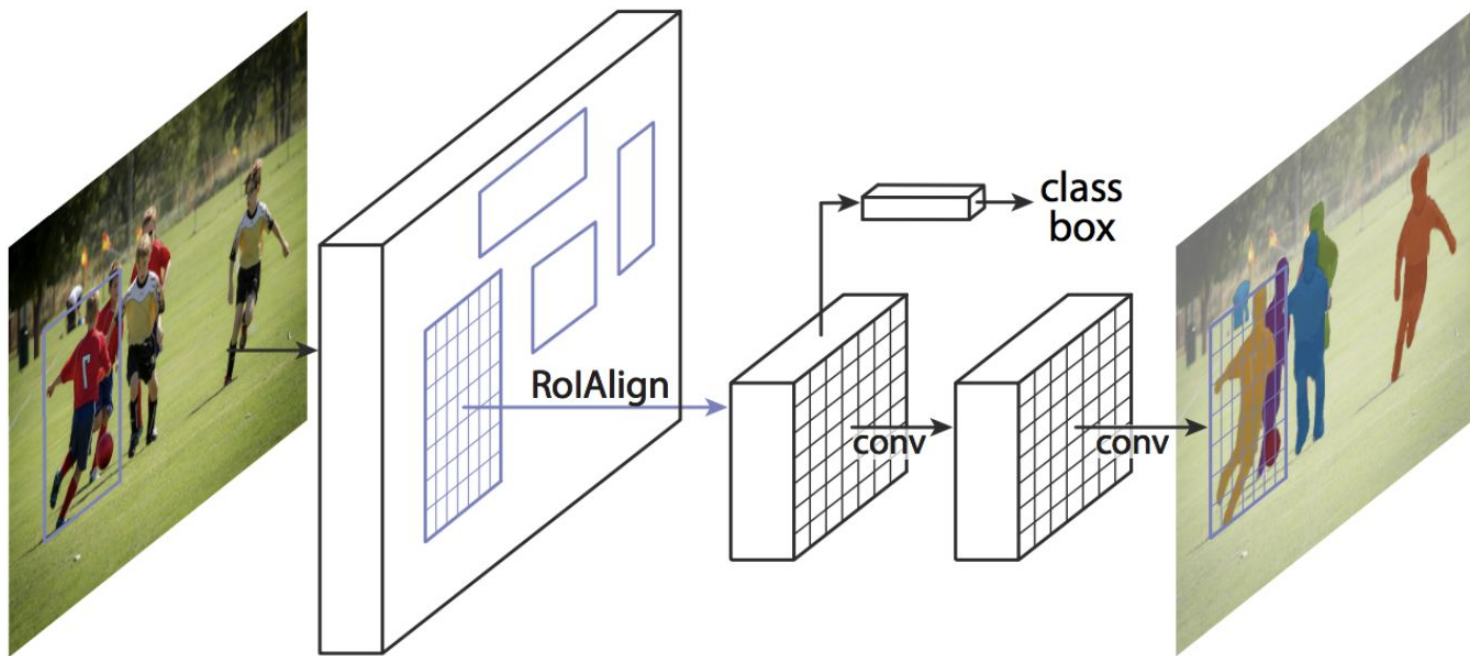
Email Address \_\_\_\_\_

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TEAR AT PERFORATION AND RETURN WITH YOUR BUSINESS TAX RENEWAL AND FORM AT 15 FORT MEADE BOULEVARD





# Architecture - Mask R CNN



Mask R-CNN

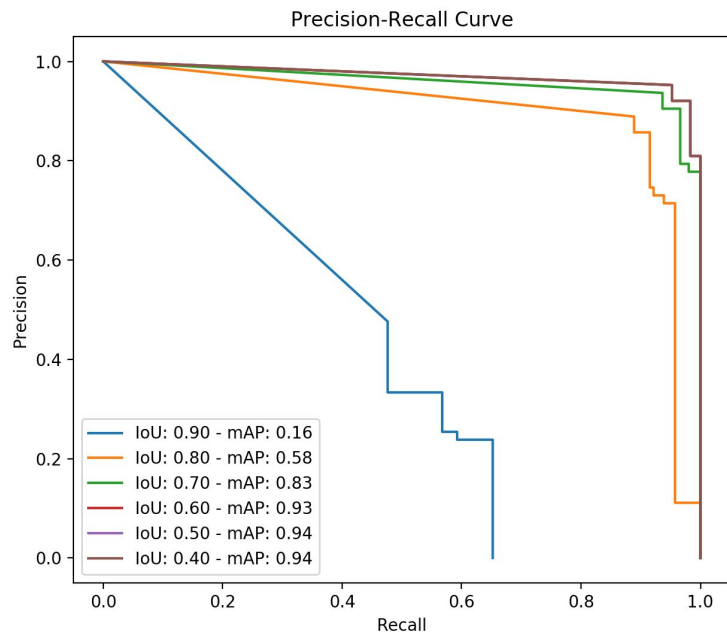
# Evaluate Model - mAP (Mean Average Precision)

- Precision =  $TP / TP + FP$
- Recall =  $TP / TP + FN$
- IoU (intersection over union) is used to determine if a predicted bounding box is TP, FP or FN
- We define a TP, FP, or FN as
  - TP if IoU > 50%
  - FP if IoU < 50% or duplicated bounding box
  - FN if no detection at all, IoU > 50% but wrong classification
- The mAP is calculated as the area under precision-recall curve averaged over all images

$$IoU = \frac{\text{Area of Overlap}}{\text{Area of Union}}$$



# Results



- IoU: 0.50 - mAP: 0.94

**EDC**  
ECONOMIC DEVELOPMENT CORPORATION  
SARASOTA COUNTY

## BUSINESS SURVEY 2019

1. HOW MANY EMPLOYEES DO YOU HAVE AT YOUR SARASOTA COUNTY BUSINESS LOCATION?

2. DO YOU HAVE ANY INTENTION TO HIRE ADDITIONAL EMPLOYEES IN THE COMING YEAR?  
☒ Yes ☐ No **IoU: 0.986 checked\_box 0.774**  
 IF YES, HOW MANY?

3. THE EDC AND ITS PARTNERS PROVIDE GROWTH, SUPPORT, AND OTHER BUSINESS ASSISTANCE FREE OF CHARGE TO LOCAL COMPANIES. DO YOU HAVE AN INTEREST IN BEING CONTACTED BY THE EDC?  
☒ Yes ☐ No **IoU: 0.906 checked\_box 0.905**

4. IS MOST OF YOUR REVENUE GENERATED BY SALES OUTSIDE OF SARASOTA COUNTY?  
☒ Yes ☐ No **IoU: 0.997 checked\_box 0.796**

6. HOW DO YOU RATE THE ECONOMIC OUTLOOK FOR THIS COMING YEAR?  
 1: Poor 2 3 4 5: Average 6 7 8 9 10: Excellent  
☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 **IoU: 0.995 checked\_box 0.995**

7. PLEASE CHECK ANY OF THE FOLLOWING SERVICES THAT YOU MAY BE INTERESTED IN RECEIVING:  
☒ Consulting Services ☒ Workforce Assistance **IoU: 0.978 checked\_box 0.874**  
☒ Export Assistance ☒ Industry/Business Relationship Building **IoU: 0.928 checked\_box 0.980**  
☒ Financial Assistance ☒ Green/Sustainable Business Practices **IoU: 0.927 checked\_box 0.990**  
☒ Financing ☒ Government/Regulatory Assistance **IoU: 0.990 checked\_box 0.996**

8. IS YOUR BUSINESS A CERTIFIED GREEN BUSINESS PARTNER IN SARASOTA COUNTY?  
☒ Yes ☐ No **IoU: 0.906 checked\_box 0.983**

9. IF YOU ANSWERED "NO" TO QUESTION #7, ARE YOU INTERESTED IN LEARNING MORE ABOUT CERTIFIED GREEN BUSINESS PARTNERS IN SARASOTA COUNTY?  
☒ Yes ☐ No **IoU: 0.944 checked\_box 0.943**

10. PLEASE SELECT THE FUNCTIONS THAT OCCUR AT YOUR BUSINESS: (check all that apply)  
☒ Accounting/Finance ☒ Call Center ☒ Distribution ☒ Engineering/R&D ☒ Manufacturing ☒ Management ☒ Marketing ☒ Services ☒ Warehousing ☒ IT/Technology ☒ Other **IoU: 0.997 checked\_box 0.998**  
**IoU: 0.998 checked\_box 0.996**  
**IoU: 0.997 checked\_box 0.999**  
**IoU: 0.996 checked\_box 0.998**  
**IoU: 0.999 checked\_box 0.999**  
**IoU: 0.993 checked\_box 0.996**  
**IoU: 0.994 checked\_box 0.997**  
**IoU: 0.996 checked\_box 0.997**

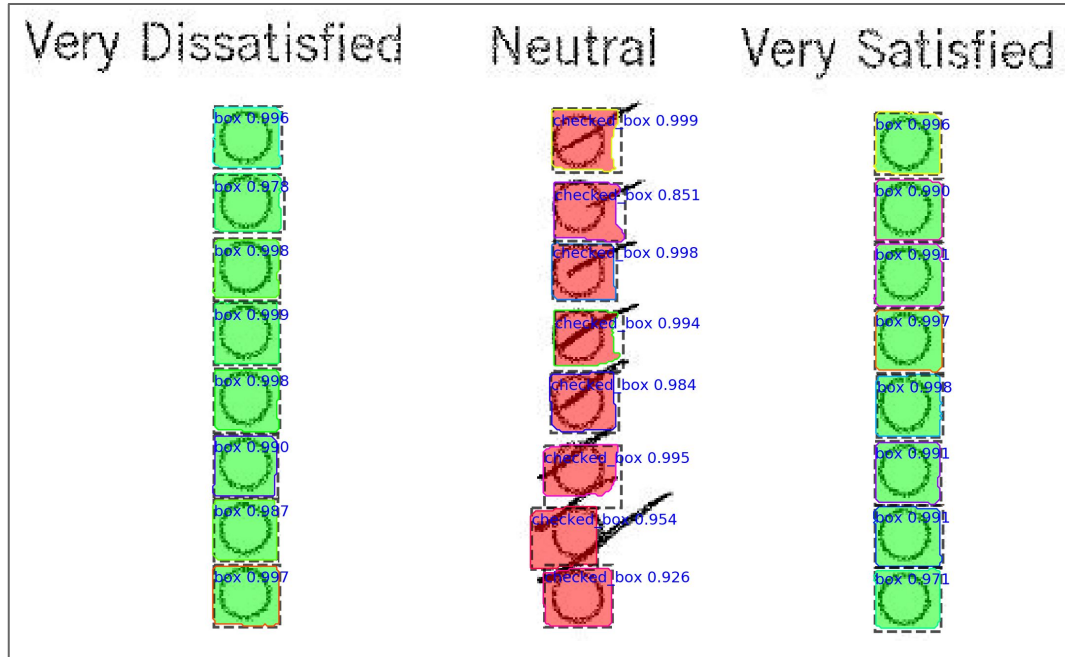
IF BELOW INFORMATION IS INCORRECT OR MISSING, PLEASE UPDATE.

Name

Company Name

Phone Number

# Results



2. DO YOU HAVE ANY INTENTION TO HIRE  
ADDITIONAL EMPLOYEES IN THE  
COMING YEAR?

box 0.995 Yes checked\_box 0.962 No

IF YES, HOW MANY? \_\_\_\_\_

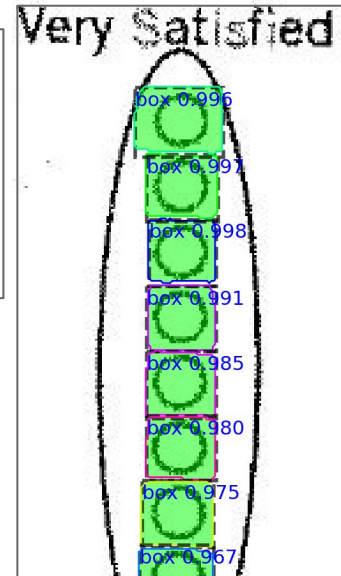
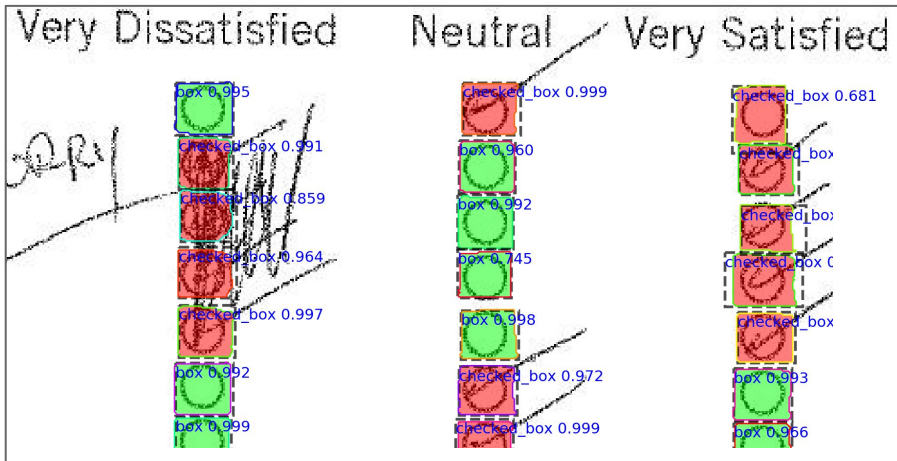
3. THE EDC AND ITS PARTNERS PROVIDE  
GROWTH, SUPPORT, AND OTHER  
BUSINESS ASSISTANCE FREE OF  
CHARGE TO LOCAL COMPANIES.  
DO YOU HAVE AN INTEREST IN BEING  
CONTACTED BY THE EDC?


box 0.998 Yes checked\_box 0.998 No

4. IS MOST OF YOUR REVENUE GENERATED  
BY SALES OUTSIDE OF SARASOTA COUNTY?

box 0.997 Yes checked\_box 0.995 No

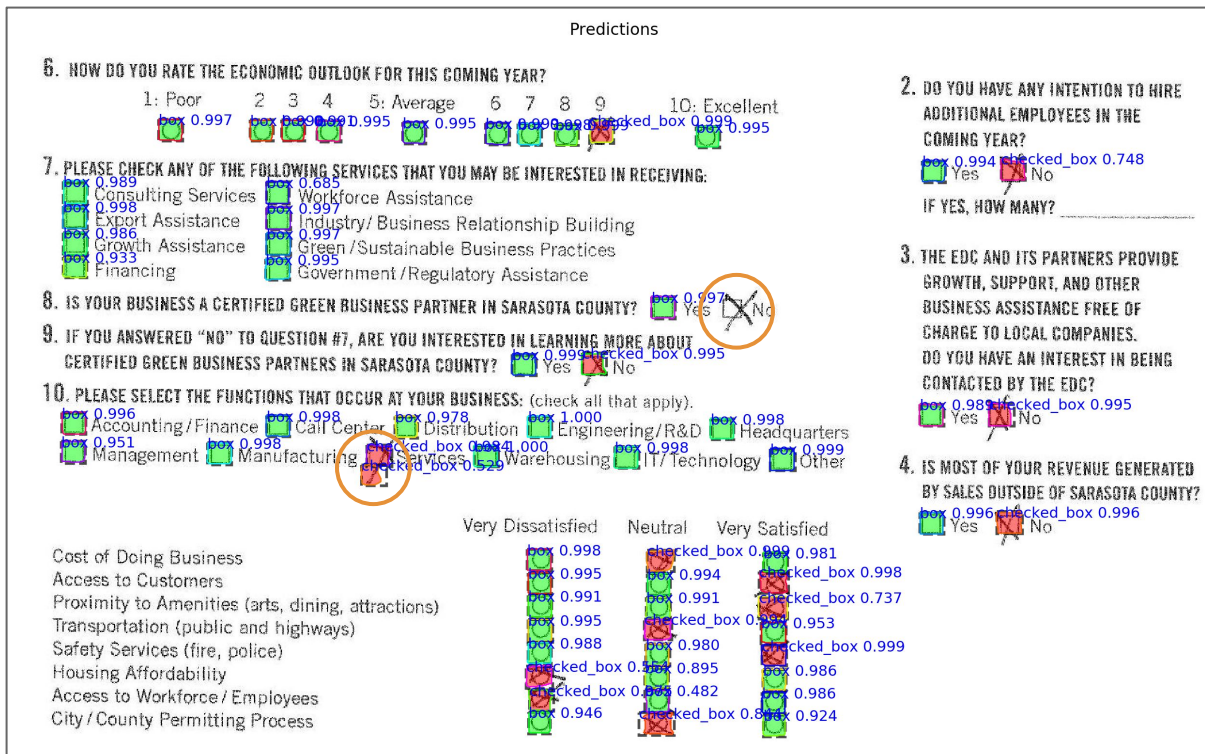
# Results - How Can Data Be Bad?



1. HOW MANY EMPLOYEES DO YOU HAVE AT  
YOUR SARASOTA COUNTY  
BUSINESS LOCATION? 

# What Happens When We Rearrange The Questions?

- Simulate the creation of a new survey
- Didn't do too bad, but still not perfect
- To improve results we would just need more training data (annotated images)





# Model Output

- [illegible]

# Extracting Data - Still In Progress

- Sort the bounding boxes from top to bottom, and maintain order of predicted classes
- Then take the first three bounding boxes and sort them from left to right
- Now we have an ordering, and can figure out which box the person checked
- Continue this procedure with the subsequent groups of boxes

**EDC**  
ECONOMIC DEVELOPMENT CORPORATION  
SARASOTA COUNTY

## BUSINESS SURVEY 2019

1. HOW MANY EMPLOYEES DO YOU HAVE AT YOUR SARASOTA COUNTY BUSINESS LOCATION?

2. DO YOU HAVE ANY INTENTION TO HIRE ADDITIONAL EMPLOYEES IN THE COMING YEAR?  
☒ Yes ☐ No boxed\_box 0.774  
 IF YES, HOW MANY?

3. THE EDC AND ITS PARTNERS PROVIDE GROWTH, SUPPORT, AND OTHER BUSINESS ASSISTANCE FREE OF CHARGE TO LOCAL COMPANIES. DO YOU HAVE AN INTEREST IN BEING CONTACTED BY THE EDC?  
☒ Yes ☐ No boxed\_box 0.905

4. IS MOST OF YOUR REVENUE GENERATED BY SALES OUTSIDE OF SARASOTA COUNTY?  
☒ Yes ☐ No boxed\_box 0.796

**Predictions**

HOW DO YOU RATE THE FOLLOWING COMMUNITIES' FACTORS THAT IMPACT BUSINESS OWNER?

	Very Dissatisfied	Neutral	Very Satisfied
Cost of Doing Business	<input checked="" type="checkbox"/> <span>boxed_box 0.998</span>	<input type="checkbox"/> <span>boxed_box 0.985</span>	<input type="checkbox"/> <span>boxed_box 0.992</span>
Access to Customers	<input checked="" type="checkbox"/> <span>boxed_box 0.997</span>	<input type="checkbox"/> <span>boxed_box 0.999</span>	<input type="checkbox"/> <span>boxed_box 0.999</span>
Proximity to Amenities (arts, dining, attractions)	<input checked="" type="checkbox"/> <span>boxed_box 0.996</span>	<input type="checkbox"/> <span>boxed_box 0.999</span>	<input type="checkbox"/> <span>boxed_box 0.999</span>
Transportation (public and highways)	<input checked="" type="checkbox"/> <span>boxed_box 0.998</span>	<input type="checkbox"/> <span>boxed_box 0.998</span>	<input type="checkbox"/> <span>boxed_box 0.998</span>
Safety Services (fire, police)	<input checked="" type="checkbox"/> <span>boxed_box 0.999</span>	<input type="checkbox"/> <span>boxed_box 0.998</span>	<input type="checkbox"/> <span>boxed_box 0.998</span>
Housing Affordability	<input checked="" type="checkbox"/> <span>boxed_box 0.993</span>	<input type="checkbox"/> <span>boxed_box 0.996</span>	<input type="checkbox"/> <span>boxed_box 0.996</span>
Access to Workforce / Employees	<input checked="" type="checkbox"/> <span>boxed_box 0.994</span>	<input type="checkbox"/> <span>boxed_box 0.997</span>	<input type="checkbox"/> <span>boxed_box 0.997</span>
City/County Permitting Process	<input checked="" type="checkbox"/> <span>boxed_box 0.996</span>	<input type="checkbox"/> <span>boxed_box 0.997</span>	<input type="checkbox"/> <span>boxed_box 0.997</span>

6. HOW DO YOU RATE THE ECONOMIC OUTLOOK FOR THIS COMING YEAR?  
 1: Poor ☒ boxed\_box 0.995 2: ☐ boxed\_box 0.988 3: ☐ boxed\_box 0.995 4: ☐ boxed\_box 0.995 5: Average ☒ boxed\_box 0.995 6: ☐ boxed\_box 0.995 7: ☐ boxed\_box 0.995 8: ☐ boxed\_box 0.995 9: ☐ boxed\_box 0.995 10: Excellent ☐ boxed\_box 0.998

7. PLEASE CHECK ANY OF THE FOLLOWING SERVICES THAT YOU MAY BE INTERESTED IN RECEIVING:  
☒ Consulting Services ☒ Workforce Assistance boxed\_box 0.978  
☒ Export Assistance ☒ Industry / Business Relationship Building boxed\_box 0.928  
☒ Financial Assistance ☒ Green / Sustainable Business Practices boxed\_box 0.927  
☒ Financing ☒ Government / Regulatory Assistance boxed\_box 0.990

8. IS YOUR BUSINESS A CERTIFIED GREEN BUSINESS PARTNER IN SARASOTA COUNTY? ☒ Yes ☐ No boxed\_box 0.980

9. IF YOU ANSWERED "NO" TO QUESTION #7, ARE YOU INTERESTED IN LEARNING MORE ABOUT CERTIFIED GREEN BUSINESS PARTNERS IN SARASOTA COUNTY? ☒ Yes ☐ No boxed\_box 0.943

10. PLEASE SELECT THE FUNCTIONS THAT OCCUR AT YOUR BUSINESS: (check all that apply)  
☒ Accounting / Finance ☒ Call Center ☒ Distribution ☒ Engineering / R&D ☒ Manufacturing ☒ Management ☒ Marketing ☒ Services ☒ Warehousing ☒ IT / Technology ☒ Other boxed\_box 0.997

IF BELOW INFORMATION IS INCORRECT OR MISSING, PLEASE UPDATE.

Name

Company Name

Phone Number



Questions ?