🎓 Hackaton (Tech Challenge) - Pós-Tech - IA For Devs - FIAP

📹 Fase 5 - Modelagem de ameaças utilizando IA

👥 Alunos

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📋 Evidências do projeto TODO

- Link para o repositório:Repositorio Git
- Link para o vídeo de apresentação: Video Apresentação

📚 Bibliotecas utilizadas

- Principais bibliotecas:
  - **OpenCV (cv2)**: Biblioteca utilizada para manipulação de imagens.
  - **ultralytics**: Biblioteca utilizada para treinamento e manipulação do modelo Yolo11.
  - **Markdown**: Biblioteca para geração de relatórios básicos em formato Markdown e HTML.
  - **N8N**: Biblioteca utilizada para criação de workflows de automação.
  - **Flask**: Biblioteca utilizada para criação de API.

- Bibliotecas/ferramentas de suporte:
    - **Pytorch**: Biblioteca base para manipulação do modelo: [https://pytorch.org/get-started/locally/]
    - **Yolo**: Modelo utilizado pelo ultralytics na detecção de ícones AWS: yolov11s.pt.
    - **Ollama**: Biblioteca para uso dos modelos de LLM do Ollama [https://ollama.com/download/windows]
    - **Telegram**: Plataforma de mensagens instantâneas, utilizada para interação com o usuário.
    - **Digital Ocean**: Plataforma de hospedagem de aplicações, utilizada para hospedar a API.
    - **N8N**: Plataforma de automação de workflows, utilizada para orquestrar as etapas do agente.

Preparação do Modelo de IA

Para realizar a detecção de diagramas de arquitetura, precisamos preparar um modelo para isto. A primeira etapa foi encontrar um dataset que nos ajudasse a treinar o modelo. Nossa busca levou ao dataset AWS Icon Detector, que parecia promissor, mas necessitava de alguns ajustes.

O principal problema com este dataset é não possuir nenhum exemplo para validação. Outro grande problema é a disparidade entre os exemplos. Algumas classes possuem poucos exemplos como:

- `ACM`, com 3 para treinar e 1 para teste,

contrastando com

- `Lambda`, com 316 para treino e 10 para teste

ou

- `EC2`, com 213 para treino e 40 para teste.

Temos muitos casos, como - `Analytics Services`, que possui apenas 1 exemplo para treino e mais nenhum para teste.

Você pode verificar como o dataset original se distribui pelos diretórios de treino e teste, executando o seguinte script:

```
py dataset_report_samples_per_split.py
```

A execução do script, no dataset **original**, mostra os seguintes valores por classe:

Classe	id	Train	Valid	Test
ACM	0	3	0	1
ALB	1	32	0	5
AMI	2	4	0	0
API-Gateway	3	163	0	0
Active Directory Service	4	1	0	1
Airflow_	5	2	0	0
Amplify	6	8	0	0
Analytics Services	7	1	0	0
AppFlow	8	1	0	0
Appsync	9	5	0	0
Athena	10	10	0	1
Aurora	11	14	0	7
Auto Scaling	12	34	0	8
Auto Scaling Group	13	8	0	0
Automated Tests	14	6	0	0
Availability Zone	15	4	0	0
Backup	16	2	0	0
Build Environment	17	3	0	0
CDN	18	2	0	1
CUR	19	3	0	0
Call Metrics	20	1	0	0
Call Recordings	21	1	0	0
Certificate Manager	22	7	0	1
Client	23	7	0	0
Cloud Connector	24	2	0	0
Cloud Map	25	1	0	0
Cloud Search	26	3	0	1
Cloud Trail	27	16	0	3
Cloud Watch	28	70	0	7
CloudFormation Stack	29	15	0	1
CloudHSM	30	1	0	1
CloudWatch Alarm	31	11	0	0
Cloudfront	32	52	0	9
CodeBuild	33	21	0	1
CodeCommit	34	8	0	1
CodeDeploy	35	1	0	1
CodePipeline	36	20	0	0
Cognito	37	51	0	1
Comprehend	38	5	0	0
Config	39	6	0	6
Connect	40	1	0	0
Connect Contact Lens	41	1	0	0
Container	42	68	0	1
Control Tower	43	1	0	0
Customer Gateway	44	7	0	0
DSI	45	4	0	0
Data Pipeline	46	2	0	0
DataSync	47	2	0	0
Deploy Stage	48	2	0	0
Direct Connect	50	14	0	11
Docker Image	52	13	0	2
Dynamo DB	53	144	0	19
EBS	54	8	0	4
EC2	55	213	0	40
EFS	56	9	0	5
EFS Mount Target	57	8	0	9
EKS	58	15	0	0
ELB	59	77	0	13
Edge Location	61	4	0	3
ElastiCache	62	21	0	5

Elastic Container Registry	63	25	0	0
Elastic Container Service	64	38	0	2
Elastic Search	65	12	0	1
Elemental MediaConvert	66	3	0	1
Email	68	3	0	1
Endpoint	69	2	0	0
Event Bus	70	1	0	0
EventBridge	71	3	0	5
Experiment Duration	72	1	0	0
Experiments	73	1	0	0
Fargate	74	41	0	0
Fault Injection Simulator	75	3	0	0
Flask	77	3	0	0
GameLift	79	2	0	0
Git	80	1	0	0
Github	81	11	0	0
Glue	83	10	0	2
Glue DataBrew	84	2	0	0
Grafana	85	1	0	0
GuardDuty	86	4	0	5
IAM	87	27	0	9
IAM Role	88	16	0	7
IOT Core	89	7	0	1
Image	90	6	0	0
Image Builder	91	1	0	0
Ingress	92	1	0	0
Instances	94	2	0	0
Internet	95	41	0	8
Internet Gateway	96	19	0	4
Jenkins	97	2	0	0
Key Management Service	98	13	0	3
Kibana	99	1	0	0
Kinesis Data Streams	100	21	0	4
Kubernetes	101	1	0	0
Lambda	102	316	0	10
Lex	103	1	0	0
MQ	104	9	0	0
Machine Learning	105	4	0	0
Macie	106	5	0	4
Marketplace	107	2	0	0
Memcached	108	2	0	2
Mobile Client	109	28	0	4
Mongo DB	110	6	0	0
MySQL	111	1	0	0
NAT Gateway	112	36	0	8
Neptune	113	3	0	0
Network Adapter	114	1	0	0
Notebook	116	1	0	0
Order Controller	117	1	0	0
Organization Trail	118	1	0	4
Parameter Store	119	2	0	0
Pinpoint	120	1	0	0
PostgreSQL	121	1	0	0
Private Link	122	7	0	0
Private Subnet	123	101	0	10
Prometheus	124	1	0	0
Public Subnet	125	82	0	18
Quarkus	126	1	0	0
Quicksight	127	4	0	0
RDS	128	70	0	14
React	129	1	0	0
Redis	130	11	0	1

Redshift	131	6	0	1
Region	132	28	0	2
Rekognition	133	2	0	0
Results	134	1	0	0
Route 53	135	2	0	1
Route53	136	65	0	9
S3	137	225	0	24
SAR	138	1	0	0
SDK	139	31	0	1
SES	140	12	0	2
SNS	141	30	0	3
SQS	142	21	0	2
Sagemaker	144	27	0	0
Secret Manager	145	4	0	1
Security Group	146	1	0	1
Security Hub	147	1	0	5
Server	148	19	0	12
Service Catalog	149	6	0	0
Shield	150	3	0	1
Slack	152	2	0	0
Stack	154	2	0	0
Step Function	155	3	0	3
SwaggerHub	157	1	0	0
Systems Manager	158	3	0	2
TV	159	1	0	0
Table	160	19	0	0
Task Runner	161	1	0	0
Terraform	162	3	0	0
Text File	163	9	0	0
Textract	164	1	0	0
Transcribe	165	1	0	0
Transfer Family	166	6	0	0
Transit Gateway	167	2	0	0
Translate	168	3	0	0
Trusted Advisor	169	2	0	0
Twilio	170	1	0	0
Users	171	95	0	13
VDA	172	1	0	0
VP Gateway	173	4	0	1
VPC Router	174	11	0	6
VPN Connection	175	5	0	1
WAF	176	14	0	1
Web Clients	177	36	0	7
Websites	178	4	0	0
X-Ray	179	12	0	0
aws	180	136	0	13
cache Worker	181	2	0	0

Como pode ser notado, muitas classes não possuem testes e outras apenas 1 ou dois exemplos para treinamento.
Mas será que estes são os únicos problemas do dataset? O script abaixo faz algumas análises úteis:

```
py dataset_validation.py
```

Verificamos que o `nc` corresponde ao total de classes declaradas. No momento, temos 210 imagens e 210 labels. Não há nomes de classes duplicados, `nc`, imagens sem labels ou mesmo labels sem imagens. O resultado do script pode ser visto abaixo:

```
── Passo 1: contagens ─────────────────────────────────────────────────────
nc declarado:        182
len(names):          182
total imagens:       210
total labels:        210
✅ nc == len(names)
✅ #imagens == #labels

── Passo 2: duplicatas em names ───────────────────────────────────────────
✅ Nenhuma duplicata em names

── Passo 3: consistência labels x names x imagens ─────────────────────────
✅ Todos os class_id em labels têm names associados

✅ Todas as imagens têm .txt correspondente
✅ Todos os labels têm imagem correspondente

✅ Todas as classes em names têm pelo menos 1 exemplo
```

Se decidirmos treinar o modelo com o dataset incompleto (isto é, com `valid/images` e `valid/labels` vazios), notaremos duas coisas:

```
[1]
WARNING Box and segment counts should be equal, but got len(segments) = 502,
len(boxes) = 3108. To resolve this only boxes will be used and all segments will
be removed. To avoid this please supply either a detect or segment dataset, not
a detect-segment mixed dataset.
albumentations: Blur(p=0.01, blur_limit=(3, 7)), MedianBlur(p=0.01,
blur_limit=(3, 7)), ToGray(p=0.01, method='weighted_average',
num_output_channels=3), CLAHE(p=0.01, clip_limit=(1.0, 4.0), tile_grid_size=(8, 8))
[2]
Traceback (most recent call last):
  File "D:\ia4devs\module_05\05_hackaton\.venv\Lib\site-
        packages\ultralytics\data\base.py",
  line 178, in get_img_files
    assert im_files, f"{self.prefix}No images found in {img_path}.
        {FORMATS_HELP_MSG}"
           ^^^^^^^^
AssertionError: val: No images found in D:
        \ia4devs\module_05\05_hackaton\data\dataset\aws\valid\images.
Supported formats are:
images: {'heic', 'jpg', 'pfm', 'dng', 'mpo', 'bmp', 'jpeg', 'png', 'tiff', 'webp',
        'tif'}
videos: {'mov', 'mkv', 'gif', 'asf', 'ts', 'm4v', 'mpeg', 'webm', 'wmv', 'mpg', 'mp4',
        'avi'}
```

[1] - Temos um aviso de que alguns rótulos nos arquivos de `label` estão inadequados. O formato de segmentação foi encontrado e o yolo vai descartar estas marcações.

[2] - O diretório `valid` deve conter imagens e labels.

Para corrigir [1], precisamos rodar o script:

```
py dataset_fix_labels.py
```

Para que ele detecte e corrija os rótulos inadequados. O resultado final será visto a seguir:

```
Fixed segments in: index101_jpg.rf.86ebe1a7bcfdd3fa92ef93ba5bfd2d19.txt
Fixed segments in: index108_png.rf.c04ccc21c4ad1c3f1ca51903606f7f0c.txt
Fixed segments in: index121_png.rf.71f9a36ddec18e197b04cc9cfc9e33c0.txt
Fixed segments in: index126_png.rf.a27b004ecd3aaae4b1d3a4747b69d613.txt
Fixed segments in: index136_png.rf.fd69f2a7634f5d83d4b09ace2ed4e8cd.txt
Fixed segments in: index137_jpg.rf.4a31794a0730be847e886f42f0fb7c94.txt
Fixed segments in: index154_jpg.rf.77cf8cc45b8a14d6fe9ea46e7f476f96.txt
Fixed segments in: index156_png.rf.b5d9270f67fd558d8e9036f3dfd575c0.txt
Fixed segments in: index161_png.rf.6c17459407b2e312e7adcc5649873ef9.txt
Fixed segments in: index177_png.rf.0cbfadbf1c1f8a322c3fcc7dd55e46a2.txt
Fixed segments in: index190_png.rf.ff2f24ed46424003930919 5bf0a73958.txt
Fixed segments in: index200_png.rf.3e34f6ab90231de27051ce831507656f.txt
Fixed segments in: index60_png.rf.1e092d82c19763160ffbb6b2fdbf68fe.txt
Fixed segments in: index62_png.rf.a1dc5d4beaf0dce66f55b97b7218aa5a.txt
Fixed segments in: index67_png.rf.6101eff034895460da133f0a0c7bb7e9.txt
Fixed segments in: index69_png.rf.f31ae1094002aac0abf4942427ce17c3.txt
Fixed segments in: index72_png.rf.946082aea49f9d39dbfc714ab9a7becf.txt
Fixed segments in: index76_jpg.rf.acd014a7447bfd032a059df9a3c42ed2.txt
Fixed segments in: index78_jpg.rf.41ff895dc95a8301b653232b1f6076f7.txt
Fixed segments in: index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af.txt
Fixed segments in: index80_jpg.rf.ff8325243baab715ecc57e8b2816b32c.txt
Fixed segments in: index82_png.rf.59d98bc77a90b37701036d534176c12b.txt
Fixed segments in: index86_png.rf.1f930ebaa16216d58c45b42eed1980ff.txt
Fixed segments in: index87_png.rf.340a2720a19109394b7209a44a0a0560.txt
Fixed segments in: index93_png.rf.1b8824bdce863db0c370aa9e08dc6025.txt
Fixed segments in: index96_png.rf.50a8179a165b9e4dfa62dadcb03a7601.txt
Fixed segments in: index97_png.rf.c7f0f49920f42b2c1ff635062a6db557.txt
Total files fixed: 27/189
Fixed segments in: index32_png.rf.1f5e0fbbf9b24e978afe47ad026cd451.txt
Fixed segments in: index40_png.rf.c25d82eaf131a966b05189d26ad5bcba.txt
Fixed segments in: index42_png.rf.fe55375b35dcd8d5acb87b455aefe16a.txt
Fixed segments in: index43_jpg.rf.57e2088b019cbe2301f88be96faa8caf.txt
Fixed segments in: index45_png.rf.b8216c6948f9c7338bbc2d54c154b512.txt
Fixed segments in: index46_png.rf.a43f82f889300675176613a33f4e8168.txt
Fixed segments in: index5_png.rf.88b49ae013835d02145d6c80bce061fd.txt
Fixed segments in: index6_jpg.rf.f5a1f31d53e0577b2a9745e1f9b4f77b.txt
Total files fixed: 8/21
Total files fixed: 0/0
```

Para corrigir [2], precisamos rodar o script:

```
py dataset_rebalance_oversample.py
```

O script faz basicamente três coisas — geração de exemplos via oversampling, realocação para garantir ao menos um número mínimo de amostras em `valid` e em `test`, sempre mantendo sincronizados os arquivos de imagem e os de label. Na fase 1, o script garante, no mínimo, `MIN_TRAIN` instâncias de cada classe em `train`, duplicando (com oversampling de forma round-robin) pelas `bases` disponíveis. A cada nova imagem criada, também incrementa o contador e adiciona o novo `basename` ao conjunto. Na fase 2, garante pelo menos `MIN_VALID` instâncias em `valid`, movendo pares `imagem+label` de `train` (preferência) ou `test`. Na fase 3, assegura pelo menos `MIN_TEST` instâncias em `test`, movendo pares `imagem+label` de `train` (preferência) ou `valid`.

Abaixo, um log de exemplo da execução do script:

```
=== Phase 1: Oversampling → TRAIN ===

Class   0: train has 70, target 70 → need 0
  → OK, não precisa oversample

Class   1: train has 48, target 70 → need 22
  → usando fonte train para oversample

(...)

Class 181: train has 2, target 70 → need 68
  → usando fonte train para oversample

=== Phase 2: Rebalance → VALID ===

Class   0: valid has 0, min 15 → need 15
  → movendo de train para valid
    Moved IMAGE  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_5 from train →
        valid
    Moved LABEL  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_5 from train →
        valid
  → movendo de train para valid
    Moved IMAGE  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_24 from train →
        valid
    Moved LABEL  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_24 from train →
        valid
  → movendo de train para valid
    Moved IMAGE  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_20 from train →
        valid
    Moved LABEL  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_20 from train →
        valid
  → movendo de train para valid
    Moved IMAGE  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_58 from train →
        valid
    Moved LABEL  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_58 from train →
        valid
  → movendo de train para valid
    Moved IMAGE  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_16 from train →
        valid
    Moved LABEL  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_16 from train →
        valid
  → movendo de train para valid
    Moved IMAGE  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_19 from train →
        valid
    Moved LABEL  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_19 from train →
        valid
  → movendo de train para valid
    Moved IMAGE  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_57 from train →
        valid
    Moved LABEL  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_57 from train →
        valid
  → movendo de train para valid
    Moved IMAGE  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_9 from train →
        valid
    Moved LABEL  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_9 from train →
        valid
  → movendo de train para valid
    Moved IMAGE  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_11 from train →
        valid
    Moved LABEL  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_11 from train →
        valid
  → movendo de train para valid
```

```
    Moved IMAGE  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_56 from train →
        valid
    Moved LABEL  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_56 from train →
        valid
  → movendo de train para valid
    Moved IMAGE  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_0 from train →
        valid
    Moved LABEL  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_0 from train →
        valid
  → movendo de train para valid
    Moved IMAGE  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_36 from train →
        valid
    Moved LABEL  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_36 from train →
        valid
  → movendo de train para valid
    Moved IMAGE  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_55 from train →
        valid
    Moved LABEL  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_55 from train →
        valid
  → movendo de train para valid
    Moved IMAGE  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_27 from train →
        valid
    Moved LABEL  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_27 from train →
        valid
  → movendo de train para valid
    Moved IMAGE  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_48 from train →
        valid
    Moved LABEL  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_48 from train →
        valid

(...)

Class 181: valid has 0, min 15 → need 15
  → movendo de train para valid
  → movendo de train para valid
  → movendo de train para valid
  → movendo de train para valid
  → movendo de train para valid
    Moved IMAGE  index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_29 from train →
        valid
    Moved LABEL  index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_29 from train →
        valid
  → movendo de train para valid
  → movendo de train para valid
  → movendo de train para valid
  → movendo de train para valid
  → movendo de train para valid
  → movendo de train para valid
  → movendo de train para valid
    Moved IMAGE  index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_61 from train →
        valid
    Moved LABEL  index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_61 from train →
        valid
  → movendo de train para valid
  → movendo de train para valid
  → movendo de train para valid

=== Phase 3: Rebalance → TEST ===

Class   0: test has 1, min 15 → need 14
  → movendo 'index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_60' de train para
        test
```

```
  Moved IMAGE  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_60 from train →
      test
  Moved LABEL  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_60 from train →
      test
→ movendo 'index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_28' de train para
      test
  Moved IMAGE  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_28 from train →
      test
  Moved LABEL  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_28 from train →
      test
→ movendo 'index93_png.rf.1b8824bdce863db0c370aa9e08dc6025' de train para test
→ movendo 'index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_48' de train para
      test
  Moved IMAGE  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_48 from train →
      test
  Moved LABEL  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_48 from train →
      test
→ movendo 'index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_50' de train para
      test
  Moved IMAGE  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_50 from train →
      test
  Moved LABEL  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_50 from train →
      test
→ movendo 'index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_40' de train para
      test
  Moved IMAGE  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_40 from train →
      test
  Moved LABEL  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_40 from train →
      test
→ movendo 'index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_49' de train para
      test
→ movendo 'index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_37' de train para
      test
  Moved IMAGE  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_37 from train →
      test
  Moved LABEL  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_37 from train →
      test
→ movendo 'index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_4' de train para test
  Moved IMAGE  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_4 from train →
      test
  Moved LABEL  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_4 from train →
      test
→ movendo 'index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_2' de train para
      test
  Moved IMAGE  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_2 from train →
      test
  Moved LABEL  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_2 from train →
      test
→ movendo 'index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_26' de train para
      test
  Moved IMAGE  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_26 from train →
      test
  Moved LABEL  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_26 from train →
      test
→ movendo 'index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_41' de train para
      test
  Moved IMAGE  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_41 from train →
      test
  Moved LABEL  index151_jpg.rf.9e63372d562634afb9a7d4bcef7c59f6_os_41 from train →
      test
→ movendo 'index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_6' de train para test
  Moved IMAGE  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_6 from train →
      test
```

```
    Moved LABEL  index79_jpg.rf.4546d4d5cf54f6ddfb791a379783d3af_os_6 from train →
        test
  → movendo 'index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_19' de train para
        test
    Moved IMAGE  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_19 from train →
        test
    Moved LABEL  index93_png.rf.1b8824bdce863db0c370aa9e08dc6025_os_19 from train →
        test
  → test agora tem 15 para classe 0

(...)

Class 181: test has 0, min 15 → need 15
  → movendo 'index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_39' de train para
        test
  → movendo 'index96_png.rf.50a8179a165b9e4dfa62dadcb03a7601_os_30' de train para
        test
  → movendo 'index96_png.rf.50a8179a165b9e4dfa62dadcb03a7601_os_8' de train para test
  → movendo 'index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_23' de train para
        test
    Moved IMAGE  index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_23 from train →
        test
    Moved LABEL  index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_23 from train →
        test
  → movendo 'index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_31' de train para
        test
  → movendo 'index96_png.rf.50a8179a165b9e4dfa62dadcb03a7601_os_36' de train para
        test
  → movendo 'index96_png.rf.50a8179a165b9e4dfa62dadcb03a7601_os_6' de train para test
  → movendo 'index96_png.rf.50a8179a165b9e4dfa62dadcb03a7601_os_16' de train para
        test
  → movendo 'index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_19' de train para
        test
    Moved IMAGE  index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_19 from train →
        test
    Moved LABEL  index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_19 from train →
        test
  → movendo 'index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_33' de train para
        test
  → movendo 'index96_png.rf.50a8179a165b9e4dfa62dadcb03a7601_os_38' de train para
        test
  → movendo 'index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_67' de train para
        test
    Moved IMAGE  index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_67 from train →
        test
    Moved LABEL  index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_67 from train →
        test
  → movendo 'index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_3' de train para
        test
  → movendo 'index161_png.rf.6c17459407b2e312e7adcc5649873ef9_os_27' de train para
        test
  → movendo 'index96_png.rf.50a8179a165b9e4dfa62dadcb03a7601_os_34' de train para
        test
  → test agora tem 15 para classe 181

=== Summary ===
Oversampled → TRAIN : 10484
Moved to VALID      : 2730
Moved to TEST       : 2345
```

Ao final, podemos verificar como ficou a distribuição de exemplos pelos três diretórios de trabalho. Executando o script abaixo novamente:

```
py dataset_report_samples_per_split.py
```

Podemos ver o trabalho efetuado na geração de um dataset útil para o treinamento do modelo e execução deste trabalho. O resultado pode ser comparado com o que foi obtido anteriormente, antes das mudanças que foram aplicadas, visando melhorar o treinamento:

Classe	id	Train	Valid	Test
ACM	0	120	62	42
ALB	1	746	332	292
AMI	2	109	44	39
API-Gateway	3	2798	1178	1063
Active Directory Service	4	81	31	29
Airflow	5	78	30	30
Amplify	6	198	84	76
Analytics Services	7	40	15	15
AppFlow	8	40	15	15
Appsync	9	120	61	50
Athena	10	328	148	141
Aurora	11	331	126	112
Auto Scaling	12	668	307	211
Auto Scaling Group	13	146	88	58
Automated Tests	14	198	98	89
Availability Zone	15	118	48	46
Backup	16	76	30	32
Build Environment	17	88	44	34
CDN	18	53	20	21
CUR	19	92	42	35
Call Metrics	20	40	15	15
Call Recordings	21	40	15	15
Certificate Manager	22	227	98	103
Client	23	124	61	61
Cloud Connector	24	80	32	28
Cloud Map	25	40	15	15
Cloud Search	26	127	56	48
Cloud Trail	27	434	192	142
Cloud Watch	28	1474	644	566
CloudFormation Stack	29	392	168	138
CloudHSM	30	74	34	33
CloudWatch Alarm	31	260	121	106
Cloudfront	32	943	427	366
CodeBuild	33	610	245	208
CodeCommit	34	192	80	66
CodeDeploy	35	41	17	13
CodePipeline	36	504	220	190
Cognito	37	876	391	354
Comprehend	38	153	72	73
Config	39	447	178	147
Connect	40	40	15	15
Connect Contact Lens	41	40	15	15
Container	42	812	346	403
Control Tower	43	39	17	14
Customer Gateway	44	148	74	62
DSI	45	126	68	62
Data Pipeline	46	61	23	22
DataSync	47	67	32	30
Deploy Stage	48	72	30	27
Detective	49	41	15	15
Direct Connect	50	329	126	112
Distribution	51	42	15	15
Docker Image	52	379	179	174
Dynamo DB	53	2352	979	958
EBS	54	330	147	107
EC2	55	4451	1935	1692
EFS	56	302	133	116
EFS Mount Target	57	349	129	128
EKS	58	413	184	164
ELB	59	1347	583	521

EMR	60	41	15	15
Edge Location	61	113	42	27
ElastiCache	62	299	170	121
Elastic Container Registry	63	502	235	212
Elastic Container Service	64	687	331	302
Elastic Search	65	310	147	117
Elemental MediaConvert	66	147	66	64
Elemental MediaPackage	67	41	15	15
Email	68	64	25	29
Endpoint	69	60	27	22
Event Bus	70	39	16	15
EventBridge	71	306	120	101
Experiment Duration	72	39	17	14
Experiments	73	39	17	14
Fargate	74	899	427	423
Fault Injection Simulator	75	105	49	45
Firewall Manager	76	41	15	15
Flask	77	114	45	51
Flow logs	78	164	60	60
GameLift	79	41	17	15
Git	80	38	15	17
Github	81	186	95	90
Glacier	82	41	15	15
Glue	83	260	116	118
Glue DataBrew	84	57	26	22
Grafana	85	36	20	14
GuardDuty	86	325	132	117
IAM	87	779	334	335
IAM Role	88	531	207	185
IOT Core	89	132	54	52
Image	90	154	74	63
Image Builder	91	40	15	15
Ingress	92	38	15	17
Inspector Agent	93	41	15	15
Instances	94	68	38	32
Internet	95	741	345	272
Internet Gateway	96	517	247	200
Jenkins	97	78	30	30
Key Management Service	98	351	155	139
Kibana	99	37	15	18
Kinesis Data Streams	100	483	198	207
Kubernetes	101	38	15	17
Lambda	102	5851	2489	2220
Lex	103	36	16	18
MQ	104	160	57	86
Machine Learning	105	121	56	47
Macie	106	369	146	119
Marketplace	107	49	21	19
Memcached	108	82	36	22
Mobile Client	109	543	249	196
Mongo DB	110	153	70	62
MySQL	111	40	15	15
NAT Gateway	112	802	375	293
Neptune	113	92	42	35
Network Adapter	114	40	15	15
Network Firewall	115	41	15	15
Notebook	116	37	18	15
Order Controller	117	35	18	17
Organization Trail	118	206	77	71
Parameter Store	119	74	26	27
Pinpoint	120	38	16	16
PostgreSQL	121	40	15	15

Private Link	122	204	89	87
Private Subnet	123	2330	930	936
Prometheus	124	36	20	14
Public Subnet	125	1809	841	715
Quarkus	126	36	20	14
Quicksight	127	107	51	50
RDS	128	1540	685	551
React	129	40	15	15
Redis	130	270	100	98
Redshift	131	200	80	72
Region	132	636	269	243
Rekognition	133	70	33	37
Results	134	39	17	14
Route 53	135	118	53	39
Route53	136	1413	611	532
S3	137	4902	2096	1862
SAR	138	38	18	14
SDK	139	802	403	301
SES	140	218	87	84
SNS	141	653	279	254
SQS	142	482	199	197
SSM Agent	143	41	15	15
Sagemaker	144	602	267	241
Secret Manager	145	123	46	44
Security Group	146	40	15	16
Security Hub	147	249	91	85
Server	148	502	193	165
Service Catalog	149	204	91	72
Shield	150	129	58	52
Sign-On	151	41	15	15
Slack	152	73	37	30
Snowball	153	41	15	15
Stack	154	52	22	14
Step Function	155	231	96	90
Storage Gateway	156	41	15	15
SwaggerHub	157	40	15	15
Systems Manager	158	181	76	68
TV	159	36	22	12
Table	160	478	196	154
Task Runner	161	35	18	17
Terraform	162	75	32	38
Text File	163	279	122	99
Textract	164	39	17	14
Transcribe	165	34	17	19
Transfer Family	166	151	68	67
Transit Gateway	167	74	35	31
Translate	168	108	49	53
Trusted Advisor	169	49	36	13
Twilio	170	37	15	18
Users	171	1858	790	656
VDA	172	40	16	14
VP Gateway	173	98	36	39
VPC Router	174	271	102	80
VPN Connection	175	106	57	48
WAF	176	290	131	109
Web Clients	177	605	248	268
Websites	178	85	31	34
X-Ray	179	232	95	112
aws	180	2810	1219	1067
cache Worker	181	68	36	26

Ainda temos classes com um número pequeno de exemplos, quando comparadas com outras que tem um número bem expressivo. Como comparativo, alguns números prévios, tomados ainda na fase aprimoramento de dataset:

```
🎯 Test Metrics (mean per class):
  Precision:     0.470
  Recall:        0.317
  mAP@0.5:       0.318
  mAP@0.5:0.95:  0.257
```

Já os mesmos números, tomados depois do aprimoramento do dataset, com o mesmo modelo, mostram como é importante dispor de um bom conjunto de exemplos para o treinamento de um modelo:

```
🎯 Test Metrics (mean per class):
  Precision:     0.960
  Recall:        0.996
  mAP@0.5:       0.980
  mAP@0.5:0.95:  0.950
```

Apresentando o contexto, os números iniciais foram obtidos pelo modelo `S`, após 200 épocas de treinamento. Comparativamente, o mesmo modelo, utilizando o dataset aprimorado, precisou de apenas 100 épocas para obter um resultado (precisão) muito superior.

Com isto, demos por encerrado o aprimoramento do dataset. O mesmo dataset também pode ser encontrado em AWS Icon Detector Improved.

Partimos então para o treinamento dos modelos `N`ano, `S`mall e `M`edium.

Treinamento do Yolo 11 - Modelo `N`

Para treinar o modelo, basta ajustar a variável abaixo:

```
yolo: str = 'yolo11n'
```

Depois, execute a chamada a seguir:

```
py model.py
```

Aguardar a conclusão do processo. O treinamento utilizou 100 épocas para treino, gastando 1,622 horas no processo. Um exemplo de log de execução pode ser visto abaixo:

```
 Ultralytics 8.3.162  Python-3.12.6 torch-2.7.1+cu128 CUDA:0 (NVIDIA GeForce RTX 4060
         Laptop GPU, 8188MiB)
engine\trainer: agnostic_nms=False, amp=True, augment=True,
auto_augment=randaugment, batch=8, bgr=0.0, box=7.5, cache=False, cfg=None,
classes=None, close_mosaic=10, cls=0.5, conf=None, copy_paste=0.0,
copy_paste_mode=flip, cos_lr=False, cutmix=0.0, data=./data/dataset/aws/data.yaml,
degrees=0.0, deterministic=True, device=0, dfl=1.5, dnn=False, dropout=0.0,
dynamic=False, embed=None, epochs=100, erasing=0.4, exist_ok=False, fliplr=0.5,
flipud=0.0, format=torchscript, fraction=1.0, freeze=None, half=False,
hsv_h=0.015, hsv_s=0.7, hsv_v=0.4, imgsz=640, int8=False, iou=0.7, keras=False,
kobj=1.0, line_width=None, lr0=0.0005, lrf=0.05, mask_ratio=4, max_det=300,
mixup=0.5, mode=train, model=./data/model/yolo11n.pt, momentum=0.937,
mosaic=1.0, multi_scale=True, name=yolo11n_custom_100, nbs=64, nms=False,
opset=None, optimize=False, optimizer=AdamW, overlap_mask=True, patience=10,
perspective=0.0, plots=True, pose=12.0, pretrained=True, profile=False,
project=None, rect=False, resume=False, retina_masks=False, save=True,
save_conf=False, save_crop=False,
save_dir=C:\acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11n_custom_100,
save_frames=False, save_json=False, save_period=-1, save_txt=False, scale=0.5,
seed=0, shear=0.0, show=False, show_boxes=True, show_conf=True, show_labels=True,
simplify=True, single_cls=False, source=None, split=val, stream_buffer=False,
task=detect, time=None, tracker=botsort.yaml, translate=0.1, val=True,
verbose=True, vid_stride=1, visualize=False, warmup_bias_lr=0.1, warmup_epochs=3,
warmup_momentum=0.8, weight_decay=0.0005, workers=8, workspace=None
Overriding model.yaml nc=80 with nc=182

                   from  n    params  module
        arguments
  0                  -1  1       464  ultralytics.nn.modules.conv.Conv
        [3, 16, 3, 2]
  1                  -1  1      4672  ultralytics.nn.modules.conv.Conv
        [16, 32, 3, 2]
  2                  -1  1      6640  ultralytics.nn.modules.block.C3k2
        [32, 64, 1, False, 0.25]
  3                  -1  1     36992  ultralytics.nn.modules.conv.Conv
        [64, 64, 3, 2]
  4                  -1  1     26080  ultralytics.nn.modules.block.C3k2
        [64, 128, 1, False, 0.25]
  5                  -1  1    147712  ultralytics.nn.modules.conv.Conv
        [128, 128, 3, 2]
  6                  -1  1     87040  ultralytics.nn.modules.block.C3k2
        [128, 128, 1, True]
  7                  -1  1    295424  ultralytics.nn.modules.conv.Conv
        [128, 256, 3, 2]
  8                  -1  1    346112  ultralytics.nn.modules.block.C3k2
        [256, 256, 1, True]
  9                  -1  1    164608  ultralytics.nn.modules.block.SPPF
        [256, 256, 5]
 10                  -1  1    249728  ultralytics.nn.modules.block.C2PSA
        [256, 256, 1]
 11                  -1  1         0  torch.nn.modules.upsampling.Upsample
        [None, 2, 'nearest']
 12             [-1, 6]  1         0  ultralytics.nn.modules.conv.Concat
        [1]
 13                  -1  1    111296  ultralytics.nn.modules.block.C3k2
        [384, 128, 1, False]
 14                  -1  1         0  torch.nn.modules.upsampling.Upsample
        [None, 2, 'nearest']
 15             [-1, 4]  1         0  ultralytics.nn.modules.conv.Concat
        [1]
 16                  -1  1     32096  ultralytics.nn.modules.block.C3k2
        [256, 64, 1, False]
```

```
 17                  -1  1     36992  ultralytics.nn.modules.conv.Conv
        [64, 64, 3, 2]
 18            [-1, 13]  1         0  ultralytics.nn.modules.conv.Concat
        [1]
 19                  -1  1     86720  ultralytics.nn.modules.block.C3k2
        [192, 128, 1, False]
 20                  -1  1    147712  ultralytics.nn.modules.conv.Conv
        [128, 128, 3, 2]
 21            [-1, 10]  1         0  ultralytics.nn.modules.conv.Concat
        [1]
 22                  -1  1    378880  ultralytics.nn.modules.block.C3k2
        [384, 256, 1, True]
 23        [16, 19, 22]  1    521278  ultralytics.nn.modules.head.Detect
        [182, [64, 128, 256]]
YOLO11n summary: 181 layers, 2,680,446 parameters, 2,680,430 gradients, 6.9 GFLOPs

Transferred 448/499 items from pretrained weights
Freezing layer 'model.23.dfl.conv.weight'
AMP: running Automatic Mixed Precision (AMP) checks...
Downloading https://github.com/ultralytics/assets/releases/download/v8.3.0/yolo11n.pt
        to 'yolo11n.pt'...
100%|██████████| 5.35M/5.35M [00:03<00:00, 1.77MB/s]
AMP: checks passed
train: Fast image access  (ping: 0.00.0 ms, read: 2741.9957.6 MB/s, size: 410.9 KB)
train: Scanning D:
        \ia4devs\module_05\05_hackaton\data\dataset\aws\train\labels.cache... 3457
        images, 0 backgrounds, 0 c
val: Fast image access  (ping: 0.00.0 ms, read: 977.6420.3 MB/s, size: 204.4 KB)
val: Scanning D:\ia4devs\module_05\05_hackaton\data\dataset\aws\valid\labels.cache...
        1488 images, 0 backgrounds, 0 cor
Plotting labels to C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11n_custom_100\labels.jpg...

optimizer: AdamW(lr=0.0005, momentum=0.937) with parameter groups 81
        weight(decay=0.0), 88 weight(decay=0.0005), 87 bias(decay=0.0)
Image sizes 640 train, 640 val
Using 8 dataloader workers
Logging results to C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11n_custom_100
Starting training for 100 epochs...

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      1/100      6.44G      1.233      3.756     0.9746         32        864: 100%|
        ██████████| 433/433 [00:54<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:23
                   all       1488      30084      0.385     0.0828     0.0319
        0.0239

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      2/100      6.12G       1.14      2.761     0.9666        125        320: 100%|
        ██████████| 433/433 [00:48<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:09
                   all       1488      30084      0.643      0.138       0.12
        0.0872

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      3/100       4.7G      1.075      2.182     0.9515         24        480: 100%|
        ██████████| 433/433 [00:47<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:09
```

```
                   all       1488      30084      0.609      0.248      0.258
      0.196

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      4/100      4.43G      1.049      1.896     0.9445         98        608: 100%|
      ██████████| 433/433 [00:47<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
      mAP50-95): 100%|██████████| 93/93 [00:08
                   all       1488      30084      0.585      0.324      0.354
      0.269

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      5/100      5.45G      1.005      1.644     0.9351         78        640: 100%|
      ██████████| 433/433 [00:46<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
      mAP50-95): 100%|██████████| 93/93 [00:08
                   all       1488      30084      0.643      0.426      0.461
      0.361

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      6/100      5.35G     0.9933        1.5     0.9282         30        896: 100%|
      ██████████| 433/433 [00:46<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
      mAP50-95): 100%|██████████| 93/93 [00:08
                   all       1488      30084      0.624      0.515       0.57
      0.441

(...)

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     48/100      5.61G     0.7054     0.5857      0.862         23        896: 100%|
      ██████████| 433/433 [00:48<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
      mAP50-95): 100%|██████████| 93/93 [00:08
                   all       1488      30084      0.954      0.982      0.981
      0.871

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     49/100      5.03G     0.7039     0.5761     0.8637         43        928: 100%|
      ██████████| 433/433 [00:50<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
      mAP50-95): 100%|██████████| 93/93 [00:08
                   all       1488      30084      0.951      0.989      0.981
      0.874

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     50/100      3.88G     0.7042     0.5848     0.8582         17        416: 100%|
      ██████████| 433/433 [00:48<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
      mAP50-95): 100%|██████████| 93/93 [00:08
                   all       1488      30084      0.955      0.986       0.98
      0.871

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     51/100      3.89G     0.6942     0.5689      0.863         41        832: 100%|
      ██████████| 433/433 [00:49<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
      mAP50-95): 100%|██████████| 93/93 [00:08
                   all       1488      30084      0.955      0.987       0.98
      0.876

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
     52/100      3.91G     0.6947     0.5699     0.8605         91        960: 100%|
        ██████████| 433/433 [00:48<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:08
                   all       1488      30084      0.959      0.983      0.981
        0.878

(...)

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     98/100      3.61G     0.4652     0.2971     0.8127         18        416: 100%|
        ██████████| 433/433 [00:46<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:08
                   all       1488      30084       0.96      0.995      0.983
        0.911

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     99/100      3.61G     0.4553     0.2923     0.8131         30        896: 100%|
        ██████████| 433/433 [00:46<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:08
                   all       1488      30084      0.961      0.994      0.984
        0.911

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    100/100      3.61G     0.4588     0.2938     0.8114         22        960: 100%|
        ██████████| 433/433 [00:45<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:08
                   all       1488      30084      0.961      0.994      0.983
        0.912

100 epochs completed in 1.622 hours.
Optimizer stripped from C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11n_custom_100\weights\best.pt,
        5.7MB


Validating C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11n_custom_100\weights\best.pt...

Ultralytics 8.3.162  Python-3.12.6 torch-2.7.1+cu128 CUDA:0 (NVIDIA GeForce RTX 4060
        Laptop GPU, 8188MiB)
YOLO11n summary (fused): 100 layers, 2,672,434 parameters, 0 gradients, 6.8 GFLOPs
                 Class     Images Instances      Box(P       R   mAP50mAP50-95): 100%|
        ██████████| 93/93 [00:12
                   all       1488      30084   0.957   0.994   0.984    0.892
                   ACM         62         62   0.989       1   0.995    0.958
                   ALB        228        332   0.992       1   0.994    0.862
                   AMI         29         44   0.982       1   0.995    0.943
           API-Gateway        774       1178   0.997   0.983   0.995    0.909
  Active Directory Service     31         31   0.984       1   0.995    0.954
              Airflow_         15         30   0.983       1   0.995    0.898
               Amplify         84         84    0.99       1   0.995    0.833
    Analytics Services         15         15   0.969       1   0.995    0.897
               AppFlow         15         15   0.969       1   0.995    0.897
               Appsync         61         61   0.989       1   0.995    0.824
                Athena        143        148       1   0.995   0.995     0.91
                Aurora         89        126   0.963       1   0.982    0.935
          Auto Scaling        173        307   0.984   0.993   0.995     0.83
    Auto Scaling Group         35         88   0.992       1   0.995     0.82
       Automated Tests         64         98   0.995       1   0.995    0.917
```

Availability Zone	24	48	0.989	1	0.995	0.898
Backup	15	30	0.984	1	0.995	0.995
Build Environment	44	44	0.848	1	0.995	0.862
CDN	20	20	0.89	1	0.966	0.921
CUR	42	42	0.988	1	0.995	0.751
Call Metrics	15	15	0.97	1	0.995	0.887
Call Recordings	15	15	0.973	1	0.995	0.793
Certificate Manager	98	98	0.994	1	0.995	0.945
Client	16	61	0.671	0.702	0.74	0.649
Cloud Connector	16	32	0.982	1	0.995	0.877
Cloud Map	15	15	0.968	1	0.995	0.995
Cloud Search	56	56	0.801	1	0.995	0.893
Cloud Trail	187	192	0.997	1	0.995	0.903
Cloud Watch	543	644	0.986	1	0.995	0.906
CloudFormation Stack	150	168	0.995	1	0.995	0.929
CloudHSM	34	34	0.983	1	0.995	0.916
CloudWatch Alarm	87	121	0.996	1	0.995	0.882
Cloudfront	401	427	0.997	0.998	0.995	0.9
CodeBuild	157	245	0.997	1	0.995	0.94
CodeCommit	68	80	0.992	1	0.995	0.941
CodeDeploy	17	17	0.971	1	0.995	0.995
CodePipeline	214	220	0.998	1	0.995	0.915
Cognito	346	391	0.971	0.927	0.982	0.898
Comprehend	72	72	0.992	1	0.995	0.959
Config	103	178	0.903	0.993	0.982	0.873
Connect	15	15	0.969	1	0.995	0.962
Connect Contact Lens	15	15	0.964	1	0.995	0.902
Container	79	346	0.964	0.997	0.995	0.834
Control Tower	17	17	0.973	1	0.995	0.986
Customer Gateway	38	74	0.996	1	0.995	0.905
DSI	34	68	0.993	1	0.995	0.858
Data Pipeline	23	23	0.978	1	0.995	0.914
DataSync	32	32	0.985	1	0.995	0.995
Deploy Stage	30	30	0.978	1	0.995	0.848
Detective	15	15	0.967	1	0.995	0.922
Direct Connect	91	126	0.995	1	0.995	0.939
Distribution	15	15	0.603	1	0.947	0.927
Docker Image	56	179	0.953	0.904	0.983	0.744
Dynamo DB	660	979	0.997	1	0.995	0.915
EBS	92	147	0.936	0.993	0.995	0.846
EC2	707	1935	0.982	0.997	0.995	0.892
EFS	100	133	0.995	1	0.995	0.928
EFS Mount Target	99	129	0.995	1	0.995	0.877
EKS	161	184	0.996	1	0.995	0.926
ELB	425	583	0.997	0.966	0.97	0.907
EMR	15	15	0.968	1	0.995	0.922
Edge Location	20	42	0.989	1	0.995	0.978
ElastiCache	138	170	0.989	1	0.995	0.882
Elastic Container Registry	235	235	0.979	0.996	0.995	0.936
Elastic Container Service	258	331	0.998	1	0.995	0.866
Elastic Search	142	147	0.995	1	0.995	0.882
Elemental MediaConvert	49	66	0.898	0.802	0.961	0.951
Elemental MediaPackage	15	15	0.467	1	0.669	0.669
Email	25	25	0.98	1	0.995	0.912
Endpoint	27	27	0.973	1	0.995	0.815
Event Bus	16	16	0.962	1	0.995	0.995
EventBridge	60	120	0.915	1	0.994	0.89
Experiment Duration	17	17	0.565	1	0.772	0.597
Experiments	17	17	0.561	1	0.641	0.585
Fargate	193	427	0.999	1	0.995	0.885
Fault Injection Simulator	49	49	0.99	1	0.995	0.918
Firewall Manager	15	15	0.968	1	0.995	0.922

Flask	15	45	0.977	0.956	0.984	0.726
Flow logs	15	60	0.985	1	0.995	0.745
GameLift	17	17	0.973	1	0.995	0.93
Git	15	15	0.97	1	0.995	0.904
Github	81	95	0.986	1	0.995	0.911
Glacier	15	15	0.967	1	0.995	0.9
Glue	58	116	1	0.979	0.995	0.876
Glue DataBrew	26	26	0.982	1	0.995	0.969
Grafana	20	20	0.977	1	0.995	0.995
GuardDuty	72	132	0.996	1	0.995	0.843
IAM	201	334	0.83	1	0.985	0.844
IAM Role	98	207	0.823	0.965	0.971	0.776
IOT Core	40	54	0.991	1	0.995	0.969
Image	74	74	0.992	1	0.995	0.821
Image Builder	15	15	0.964	1	0.995	0.995
Ingress	15	15	0.97	1	0.995	0.989
Inspector Agent	15	15	0.969	1	0.995	0.834
Instances	19	38	0.554	0.98	0.661	0.587
Internet	240	345	0.949	1	0.994	0.907
Internet Gateway	167	247	0.965	1	0.995	0.836
Jenkins	15	30	0.984	1	0.995	0.97
Key Management Service	127	155	0.997	1	0.995	0.915
Kibana	15	15	0.97	1	0.995	0.845
Kinesis Data Streams	150	198	0.986	1	0.995	0.937
Kubernetes	15	15	0.97	1	0.995	0.918
Lambda	945	2489	0.994	0.997	0.995	0.919
Lex	16	16	0.97	1	0.995	0.995
MQ	25	57	0.991	1	0.995	0.869
Machine Learning	56	56	0.832	1	0.98	0.947
Macie	65	146	0.99	1	0.995	0.832
Marketplace	21	21	0.981	1	0.995	0.662
Memcached	18	36	0.976	1	0.995	0.923
Mobile Client	198	249	0.975	0.984	0.989	0.831
Mongo DB	26	70	0.971	0.957	0.994	0.775
MySQL	15	15	0.973	1	0.995	0.844
NAT Gateway	187	375	0.999	1	0.995	0.913
Neptune	42	42	0.991	1	0.995	0.679
Network Adapter	15	15	0.916	1	0.995	0.995
Network Firewall	15	15	0.968	1	0.995	0.986
Notebook	18	18	0.974	1	0.995	0.982
Order Controller	18	18	0.973	1	0.995	0.91
Organization Trail	32	77	0.992	1	0.995	0.873
Parameter Store	26	26	0.98	1	0.995	0.92
Pinpoint	16	16	0.97	1	0.995	0.973
PostgreSQL	15	15	0.964	1	0.995	0.911
Private Link	89	89	0.994	1	0.995	0.912
Private Subnet	368	930	0.982	0.967	0.986	0.798
Prometheus	20	20	0.976	1	0.995	0.922
Public Subnet	338	841	0.98	0.987	0.993	0.79
Quarkus	20	20	0.976	1	0.995	0.966
Quicksight	41	51	0.972	1	0.995	0.92
RDS	345	685	0.985	0.987	0.994	0.89
React	15	15	0.852	1	0.995	0.815
Redis	49	100	1	0.995	0.995	0.91
Redshift	73	80	0.994	1	0.995	0.868
Region	183	269	0.994	1	0.995	0.828
Rekognition	33	33	0.984	1	0.995	0.973
Results	17	17	0.564	1	0.737	0.681
Route 53	53	53	0.987	1	0.995	0.97
Route53	428	611	0.995	1	0.995	0.918
S3	977	2096	0.995	0.999	0.995	0.894
SAR	18	18	0.974	1	0.995	0.989

```
                    SDK        123        403      0.972      0.995      0.995       0.89
                    SES         72         87      0.994          1      0.995      0.895
                    SNS        258        279      0.994          1      0.995      0.954
                    SQS        189        199      0.997          1      0.995      0.913
              SSM Agent         15         15      0.969          1      0.995      0.967
              Sagemaker         81        267      0.985          1      0.995      0.731
         Secret Manager         46         46      0.987          1      0.995      0.924
         Security Group         15         15      0.967          1      0.995      0.995
           Security Hub         31         91      0.955          1      0.995      0.812
                 Server        101        193      0.989          1      0.995       0.91
        Service Catalog         40         91      0.994          1      0.995      0.885
                 Shield         58         58      0.991          1      0.995      0.966
                Sign-On         15         15      0.969          1      0.995       0.91
                  Slack         37         37      0.984          1      0.995      0.923
               Snowball         15         15      0.969          1      0.995      0.984
                  Stack         22         22      0.977          1      0.995      0.862
          Step Function         32         96      0.994          1      0.995      0.909
        Storage Gateway         15         15      0.966          1      0.995      0.902
             SwaggerHub         15         15      0.966          1      0.995       0.96
        Systems Manager         61         76       0.99          1      0.995      0.949
                     TV         22         22      0.976          1      0.995      0.897
                  Table         88        196          1          1      0.995      0.847
            Task Runner         18         18       0.97          1      0.995      0.905
              Terraform         32         32      0.986          1      0.995      0.874
              Text File         54        122      0.946          1      0.994      0.881
               Textract         17         17      0.971          1      0.995      0.966
             Transcribe         17         17      0.972          1      0.995      0.909
        Transfer Family         68         68      0.993          1      0.995      0.954
        Transit Gateway         35         35      0.964          1      0.995      0.927
              Translate         49         49       0.99          1      0.995       0.96
        Trusted Advisor         36         36      0.987          1      0.995      0.952
                 Twilio         15         15      0.969          1      0.995      0.987
                  Users        574        790      0.994      0.971      0.992       0.87
                    VDA         16         16      0.964          1      0.995      0.895
             VP Gateway         30         36       0.99          1      0.995       0.85
             VPC Router         50        102      0.933          1      0.995      0.894
         VPN Connection         21         57       0.99          1      0.995      0.917
                    WAF        112        131      0.996          1      0.995      0.917
            Web Clients        213        248      0.784          1      0.983      0.826
               Websites         31         31      0.985          1      0.995      0.933
                  X-Ray         83         95      0.995          1      0.995      0.911
                    aws        971       1219      0.981      0.991      0.994      0.841
           cache Worker         36         36      0.982          1      0.995      0.933
Speed: 0.1ms preprocess, 4.4ms inference, 0.0ms loss, 1.1ms postprocess per image
Results saved to C:\acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11n_custom_100
🚀 Save dir: C:\acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11n_custom_100
✅ best.pt:  C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11n_custom_100\weights\best.pt

Ultralytics 8.3.162  Python-3.12.6 torch-2.7.1+cu128 CUDA:0 (NVIDIA GeForce RTX 4060
        Laptop GPU, 8188MiB)
YOLO11n summary (fused): 100 layers, 2,672,434 parameters, 0 gradients, 6.8 GFLOPs
val: Fast image access  (ping: 0.00.0 ms, read: 627.2396.8 MB/s, size: 365.8 KB)
val: Scanning D:\ia4devs\module_05\05_hackaton\data\dataset\aws\test\labels... 1327
        images, 0 backgrounds, 0 corrupt: 1
val: New cache created: D:
        \ia4devs\module_05\05_hackaton\data\dataset\aws\test\labels.cache
                    Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|
        ██████████| 166/166 [00:
                      all       1327      26828      0.957      0.992      0.979      0.911
                      ACM         42         42      0.984          1      0.995       0.99
                      ALB        206        292      0.968      0.983      0.993      0.891
```

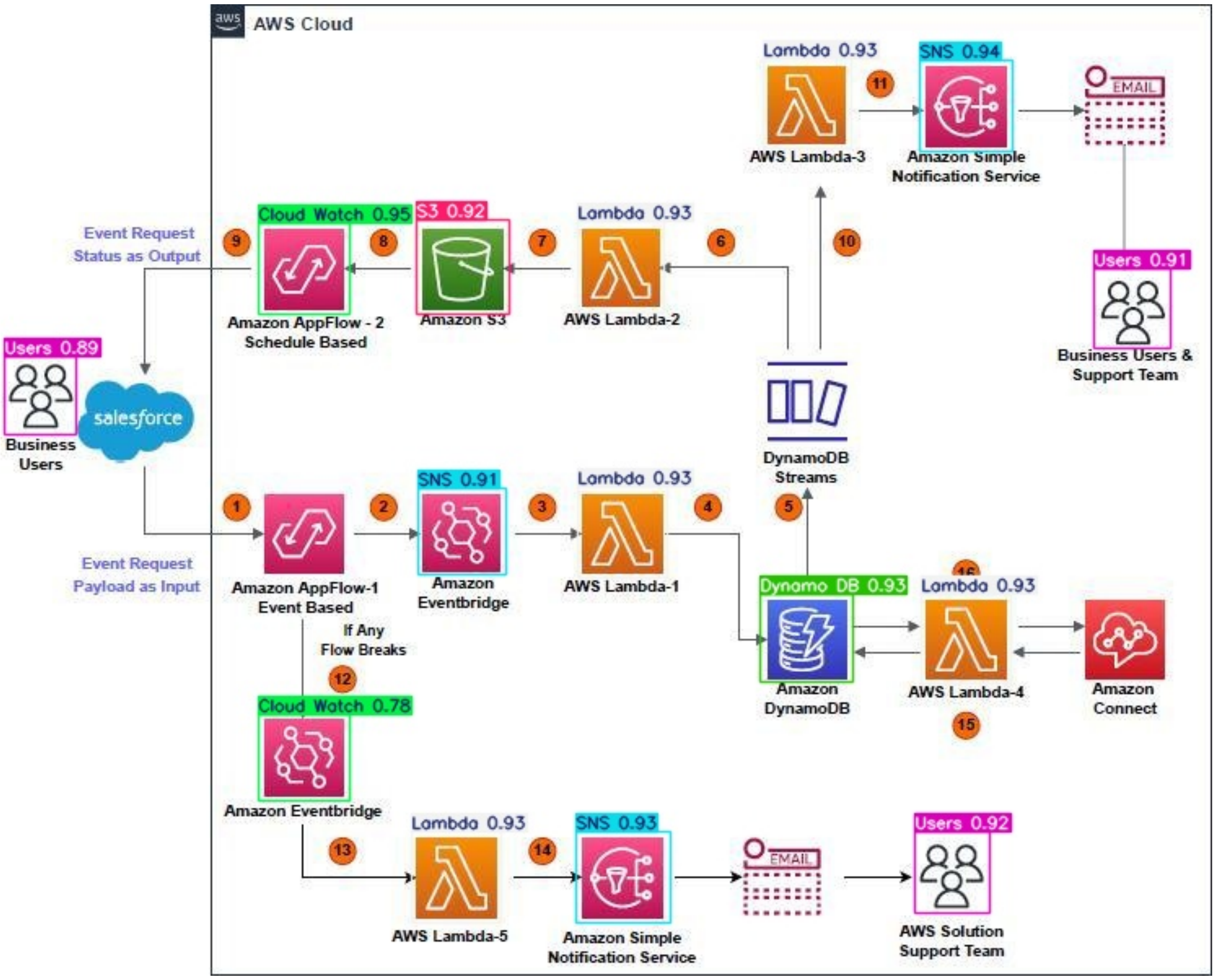
AMI	24	39	0.985	1	0.995	0.956
API-Gateway	707	1063	1	0.981	0.995	0.93
Active Directory Service	29	29	0.982	1	0.995	0.985
Airflow_	15	30	0.983	1	0.995	0.901
Amplify	76	76	0.998	1	0.995	0.894
Analytics Services	15	15	0.967	1	0.995	0.978
AppFlow	15	15	0.968	1	0.995	0.986
Appsync	50	50	0.972	1	0.995	0.817
Athena	133	141	1	0.979	0.995	0.939
Aurora	79	112	0.983	0.964	0.968	0.933
Auto Scaling	126	211	0.996	0.976	0.989	0.826
Auto Scaling Group	25	58	0.988	1	0.995	0.848
Automated Tests	58	89	0.996	1	0.995	0.95
Availability Zone	23	46	0.987	1	0.995	0.935
Backup	16	32	0.983	1	0.995	0.995
Build Environment	34	34	0.89	1	0.995	0.845
CDN	21	21	0.974	1	0.995	0.976
CUR	35	35	0.985	1	0.995	0.79
Call Metrics	15	15	0.965	1	0.995	0.863
Call Recordings	15	15	0.976	1	0.995	0.859
Certificate Manager	103	103	0.995	1	0.995	0.987
Client	16	61	0.559	0.82	0.686	0.612
Cloud Connector	14	28	0.979	1	0.995	0.919
Cloud Map	15	15	0.966	1	0.995	0.995
Cloud Search	48	48	0.761	1	0.995	0.93
Cloud Trail	140	142	0.996	1	0.995	0.944
Cloud Watch	468	566	0.997	1	0.995	0.924
CloudFormation Stack	124	138	0.988	1	0.995	0.981
CloudHSM	33	33	0.981	1	0.995	0.977
CloudWatch Alarm	75	106	0.995	1	0.995	0.886
Cloudfront	346	366	0.996	1	0.995	0.91
CodeBuild	140	208	0.997	1	0.995	0.963
CodeCommit	52	66	0.992	1	0.995	0.983
CodeDeploy	13	13	0.96	1	0.995	0.988
CodePipeline	183	190	0.993	1	0.99	0.916
Cognito	310	354	0.969	0.935	0.975	0.927
Comprehend	73	73	0.993	1	0.995	0.95
Config	72	147	0.912	0.983	0.986	0.889
Connect	15	15	0.967	1	0.995	0.984
Connect Contact Lens	15	15	0.97	1	0.995	0.942
Container	86	403	0.988	1	0.995	0.861
Control Tower	14	14	0.964	1	0.995	0.976
Customer Gateway	35	62	0.996	1	0.995	0.929
DSI	31	62	0.992	1	0.995	0.854
Data Pipeline	22	22	0.975	1	0.995	0.995
DataSync	30	30	0.982	1	0.995	0.995
Deploy Stage	27	27	0.979	1	0.995	0.863
Detective	15	15	0.963	1	0.995	0.922
Direct Connect	77	112	0.995	0.991	0.995	0.914
Distribution	15	15	0.594	1	0.849	0.822
Docker Image	44	174	0.993	0.877	0.984	0.76
Dynamo DB	619	958	0.997	0.993	0.995	0.921
EBS	65	107	0.931	0.963	0.992	0.825
EC2	609	1692	0.982	0.987	0.994	0.904
EFS	90	116	0.986	0.983	0.989	0.931
EFS Mount Target	95	128	1	0.925	0.981	0.905
EKS	147	164	0.996	1	0.995	0.956
ELB	379	521	0.996	0.956	0.97	0.912
EMR	15	15	0.966	1	0.995	0.98
Edge Location	15	27	0.982	1	0.995	0.94
ElastiCache	101	121	0.994	0.967	0.971	0.871
Elastic Container Registry	212	212	0.998	1	0.995	0.957

Elastic Container Service	236	302	0.995	1	0.995	0.9
Elastic Search	116	117	0.984	1	0.995	0.89
Elemental MediaConvert	49	64	0.853	0.938	0.97	0.955
Elemental MediaPackage	15	15	0.498	1	0.563	0.563
Email	29	29	0.98	0.966	0.969	0.871
Endpoint	22	22	0.975	1	0.995	0.846
Event Bus	15	15	0.963	1	0.995	0.995
EventBridge	41	101	0.912	0.99	0.993	0.923
Experiment Duration	14	14	0.552	0.88	0.559	0.489
Experiments	14	14	0.513	1	0.692	0.666
Fargate	180	423	0.999	1	0.995	0.923
Fault Injection Simulator	45	45	0.989	1	0.995	0.931
Firewall Manager	15	15	0.966	1	0.995	0.915
Flask	17	51	0.996	0.98	0.994	0.742
Flow logs	15	60	0.992	1	0.995	0.81
GameLift	15	15	0.966	1	0.995	0.933
Git	17	17	0.974	1	0.995	0.964
Github	73	90	0.995	1	0.995	0.928
Glacier	15	15	0.967	1	0.995	0.989
Glue	59	118	1	0.964	0.995	0.923
Glue DataBrew	22	22	0.976	1	0.995	0.995
Grafana	14	14	0.966	1	0.995	0.995
GuardDuty	57	117	0.998	1	0.995	0.904
IAM	180	335	0.921	0.994	0.991	0.889
IAM Role	78	185	0.843	0.984	0.98	0.816
IOT Core	46	52	1	0.991	0.995	0.988
Image	63	63	0.99	1	0.995	0.843
Image Builder	15	15	0.966	1	0.995	0.984
Ingress	17	17	0.971	1	0.995	0.995
Inspector Agent	15	15	0.968	1	0.995	0.995
Instances	16	32	0.517	1	0.536	0.476
Internet	201	272	0.947	0.993	0.993	0.915
Internet Gateway	133	200	0.996	0.99	0.995	0.836
Jenkins	15	30	0.982	1	0.995	0.969
Key Management Service	111	139	0.997	1	0.995	0.965
Kibana	18	18	0.983	1	0.995	0.899
Kinesis Data Streams	156	207	0.995	0.986	0.995	0.946
Kubernetes	17	17	0.971	1	0.995	0.957
Lambda	830	2220	0.995	0.995	0.995	0.939
Lex	18	18	0.971	1	0.995	0.995
MQ	34	86	0.994	1	0.995	0.899
Machine Learning	47	47	0.805	1	0.981	0.933
Macie	56	119	0.983	0.977	0.994	0.911
Marketplace	19	19	0.979	1	0.995	0.689
Memcached	11	22	0.895	1	0.995	0.943
Mobile Client	150	196	0.987	0.98	0.986	0.848
Mongo DB	26	62	1	0.986	0.995	0.783
MySQL	15	15	0.974	1	0.995	0.9
NAT Gateway	147	293	0.987	0.986	0.988	0.919
Neptune	35	35	0.988	1	0.995	0.708
Network Adapter	15	15	0.949	1	0.995	0.995
Network Firewall	15	15	0.966	1	0.995	0.995
Notebook	15	15	0.965	1	0.995	0.995
Order Controller	17	17	0.97	1	0.995	0.905
Organization Trail	26	71	0.992	1	0.995	0.934
Parameter Store	27	27	0.978	1	0.995	0.94
Pinpoint	16	16	0.969	1	0.995	0.995
PostgreSQL	15	15	0.962	1	0.995	0.919
Private Link	87	87	0.994	1	0.995	0.967
Private Subnet	335	936	0.994	0.966	0.985	0.83
Prometheus	14	14	0.964	1	0.995	0.995
Public Subnet	299	715	0.995	0.976	0.994	0.823

```
             Quarkus     14      14  0.962      1  0.995     0.995
          Quicksight     40      50  0.986      1  0.995     0.966
                 RDS    266     551  0.972  0.975  0.977     0.898
               React     15      15  0.838  0.933  0.973     0.756
               Redis     47      98      1  0.996  0.995     0.975
            Redshift     65      72  0.993      1  0.995     0.945
              Region    161     243      1      1  0.995     0.876
         Rekognition     37      37  0.986      1  0.995     0.981
             Results     14      14  0.517      1  0.555     0.525
            Route 53     39      39  0.957      1  0.993      0.98
             Route53    376     532  0.992  0.991  0.993     0.926
                  S3    867    1862  0.999  0.995  0.995     0.916
                 SAR     14      14  0.964      1  0.995      0.99
                 SDK     98     301  0.974  0.999  0.993     0.887
                 SES     69      84  0.991  0.988  0.995     0.932
                 SNS    232     254  0.998  0.996  0.995     0.967
                 SQS    184     197  0.997      1  0.995     0.956
           SSM Agent     15      15  0.966      1  0.995     0.995
           Sagemaker     76     241  0.999      1  0.995     0.736
      Secret Manager     44      44  0.986      1  0.995     0.957
      Security Group     16      16  0.969      1  0.995     0.966
        Security Hub     25      85  0.994      1  0.995     0.897
              Server     88     165  0.995      1  0.995     0.904
     Service Catalog     30      72  0.994      1  0.995     0.907
              Shield     52      52  0.991      1  0.995     0.963
             Sign-On     15      15  0.966      1  0.995     0.934
               Slack     30      30   0.98      1  0.995     0.983
            Snowball     15      15  0.968      1  0.995     0.995
               Stack     14      14  0.967      1  0.995     0.908
       Step Function     30      90  0.994      1  0.995      0.92
     Storage Gateway     15      15  0.965      1  0.995      0.97
          SwaggerHub     15      15  0.971      1  0.995     0.965
     Systems Manager     53      68  0.987      1  0.995      0.99
                  TV     12      12  0.956      1  0.995     0.912
               Table     72     154  0.991  0.987  0.995      0.88
         Task Runner     17      17   0.97      1  0.995     0.995
           Terraform     38      38  0.989      1  0.995     0.864
           Text File     49      99  0.949  0.899   0.97     0.866
            Textract     14      14  0.965      1  0.995     0.995
          Transcribe     19      19  0.974      1  0.995     0.995
     Transfer Family     67      67  0.993      1  0.995     0.985
     Transit Gateway     31      31  0.962      1  0.995     0.895
           Translate     53      53   0.99      1  0.995     0.959
     Trusted Advisor     13      13  0.958      1  0.995     0.964
              Twilio     18      18  0.971      1  0.995      0.98
               Users    486     656  0.995   0.98  0.987     0.893
                 VDA     14      14  0.966      1  0.995     0.912
          VP Gateway     27      39  0.989  0.974  0.984     0.841
          VPC Router     39      80   0.98      1  0.995     0.879
      VPN Connection     21      48  0.997      1  0.995      0.91
                 WAF     99     109  0.995      1  0.995     0.968
         Web Clients    202     268  0.795      1  0.971      0.84
            Websites     34      34   0.99      1  0.995     0.953
               X-Ray     88     112      1  0.988  0.995     0.953
                 aws    845    1067  0.982  0.986  0.992      0.87
        cache Worker     26      26  0.981      1  0.995     0.995
Speed: 0.2ms preprocess, 2.7ms inference, 0.0ms loss, 1.0ms postprocess per image
Saving C:\acmattos\dev\tools\Python\ia4devs\runs\detect\val\predictions.json...
Results saved to C:\acmattos\dev\tools\Python\ia4devs\runs\detect\val

🎯 Test Metrics (mean per class):
  Precision:    0.957
```

```
  Recall:        0.992
  mAP@0.5:       0.979
  mAP@0.5:0.95: 0.911

image 1/1 D:\ia4devs\module_05\05_hackaton\data\sample\aws_02.png: 576x640
1 ALB, 1 Auto Scaling, 1 Auto Scaling Group, 2 Cloud Watchs, 1 Cloudfront, 4 EC2s,
1 EFS, 1 Key Management Service, 2 NAT Gateways, 3 Private Subnets, 3 Public Subnets,
1 RDS, 1 Region, 1 Users, 2 WAFs, 1 aws, 47.2ms
Speed: 3.3ms preprocess, 47.2ms inference, 5.2ms postprocess per image at shape (1,
        3, 576, 640)
Results saved to C:\acmattos\dev\tools\Python\ia4devs\runs\detect\predict
1 label saved to C:\acmattos\dev\tools\Python\ia4devs\runs\detect\predict\labels
✅ Detailed JSON saved to data\reports\yolo11n_custom_100\results.json
✅ Summary JSON saved to data\reports\yolo11n_custom_100\report.json
[ultralytics.engine.results.Results object with attributes:

boxes: ultralytics.engine.results.Boxes object
keypoints: None
masks: None
(...)
obb: None
(...)
path: 'D:\\ia4devs\\module_05\\05_hackaton\\data\\sample\\aws_02.png'
probs: None
save_dir: 'C:\\acmattos\\dev\\tools\\Python\\ia4devs\\runs\\detect\\predict'
speed: {'preprocess': 3.2868999987840652, 'inference': 47.22200002288446,
        'postprocess': 5.245600012131035}]
```

Predição do Yolo 11 - Modelo `N`



Detecção do Modelo N

Treinamento do Yolo 11 - Modelo `S`

Para treinar o modelo, basta ajustar a variável abaixo:

```
yolo: str = 'yolo11s'
```

Depois, execute a chamada a seguir:

```
py model.py
```

Aguardar a conclusão do processo. O treinamento utilizou 100 épocas para treino, gastando 4.872 horas no processo. Um exemplo de log de execução pode ser visto abaixo:

```
Ultralytics 8.3.162  Python-3.12.6 torch-2.7.1+cu128 CUDA:0 (NVIDIA GeForce RTX 4060
        Laptop GPU, 8188MiB)
engine\trainer: agnostic_nms=False, amp=True, augment=True,
auto_augment=randaugment, batch=8, bgr=0.0, box=7.5, cache=False, cfg=None,
classes=None, close_mosaic=10, cls=0.5, conf=None, copy_paste=0.0,
copy_paste_mode=flip, cos_lr=False, cutmix=0.0, data=./data/dataset/aws/data.yaml,
degrees=0.0, deterministic=True, device=0, dfl=1.5, dnn=False, dropout=0.0,
dynamic=False, embed=None, epochs=100, erasing=0.4, exist_ok=False, fliplr=0.5,
flipud=0.0, format=torchscript, fraction=1.0, freeze=None, half=False,
hsv_h=0.015, hsv_s=0.7, hsv_v=0.4, imgsz=640, int8=False, iou=0.7, keras=False,
kobj=1.0, line_width=None, lr0=0.0005, lrf=0.05, mask_ratio=4, max_det=300,
mixup=0.5, mode=train, model=./data/model/yolo11s.pt, momentum=0.937,
mosaic=1.0, multi_scale=True, name=yolo11s_custom_100, nbs=64, nms=False,
opset=None, optimize=False, optimizer=AdamW, overlap_mask=True, patience=10,
perspective=0.0, plots=True, pose=12.0, pretrained=True, profile=False,
project=None, rect=False, resume=False, retina_masks=False, save=True,
save_conf=False, save_crop=False,
save_dir=C:\acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11s_custom_100,
save_frames=False, save_json=False, save_period=-1, save_txt=False, scale=0.5,
seed=0, shear=0.0, show=False, show_boxes=True, show_conf=True, show_labels=True,
simplify=True, single_cls=False, source=None, split=val, stream_buffer=False,
task=detect, time=None, tracker=botsort.yaml, translate=0.1, val=True,
verbose=True, vid_stride=1, visualize=False, warmup_bias_lr=0.1, warmup_epochs=3,
warmup_momentum=0.8, weight_decay=0.0005, workers=8, workspace=None
Overriding model.yaml nc=80 with nc=182

                   from  n    params  module                                       arguments
  0                  -1  1       928  ultralytics.nn.modules.conv.Conv             [3, 32, 3, 2]
  1                  -1  1     18560  ultralytics.nn.modules.conv.Conv             [32, 64, 3, 2]
  2                  -1  1     26080  ultralytics.nn.modules.block.C3k2            [64, 128, 1,
        False, 0.25]
  3                  -1  1    147712  ultralytics.nn.modules.conv.Conv             [128, 128, 3, 2]
  4                  -1  1    103360  ultralytics.nn.modules.block.C3k2            [128, 256, 1,
        False, 0.25]
  5                  -1  1    590336  ultralytics.nn.modules.conv.Conv             [256, 256, 3, 2]
  6                  -1  1    346112  ultralytics.nn.modules.block.C3k2            [256, 256, 1,
        True]
  7                  -1  1   1180672  ultralytics.nn.modules.conv.Conv             [256, 512, 3, 2]
  8                  -1  1   1380352  ultralytics.nn.modules.block.C3k2            [512, 512, 1,
        True]
  9                  -1  1    656896  ultralytics.nn.modules.block.SPPF            [512, 512, 5]
 10                  -1  1    990976  ultralytics.nn.modules.block.C2PSA           [512, 512, 1]
 11                  -1  1         0  torch.nn.modules.upsampling.Upsample         [None, 2,
        'nearest']
 12             [-1, 6]  1         0  ultralytics.nn.modules.conv.Concat           [1]
 13                  -1  1    443776  ultralytics.nn.modules.block.C3k2            [768, 256, 1,
        False]
 14                  -1  1         0  torch.nn.modules.upsampling.Upsample         [None, 2,
        'nearest']
 15             [-1, 4]  1         0  ultralytics.nn.modules.conv.Concat           [1]
 16                  -1  1    127680  ultralytics.nn.modules.block.C3k2            [512, 128, 1,
        False]
 17                  -1  1    147712  ultralytics.nn.modules.conv.Conv             [128, 128, 3, 2]
 18            [-1, 13]  1         0  ultralytics.nn.modules.conv.Concat           [1]
 19                  -1  1    345472  ultralytics.nn.modules.block.C3k2            [384, 256, 1,
        False]
 20                  -1  1    590336  ultralytics.nn.modules.conv.Conv             [256, 256, 3, 2]
 21            [-1, 10]  1         0  ultralytics.nn.modules.conv.Concat           [1]
 22                  -1  1   1511424  ultralytics.nn.modules.block.C3k2            [768, 512, 1,
        True]
 23        [16, 19, 22]  1    889842  ultralytics.nn.modules.head.Detect           [182, [128, 256,
        512]]
```

```
YOLO11s summary: 181 layers, 9,498,226 parameters, 9,498,210 gradients, 21.9 GFLOPs

Transferred 493/499 items from pretrained weights
Freezing layer 'model.23.dfl.conv.weight'
AMP: running Automatic Mixed Precision (AMP) checks...
AMP: checks passed
train: Fast image access  (ping: 0.10.0 ms, read: 344.2160.3 MB/s, size: 410.9 KB)
train: Scanning D:
        \ia4devs\module_05\05_hackaton\data\dataset\aws\train\labels.cache... 3457
        images, 0 backgrounds, 0 c
val: Fast image access  (ping: 0.00.0 ms, read: 415.3126.7 MB/s, size: 204.4 KB)
val: Scanning D:\ia4devs\module_05\05_hackaton\data\dataset\aws\valid\labels.cache...
        1488 images, 0 backgrounds, 0 cor
Plotting labels to C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11s_custom_100\labels.jpg...

optimizer: AdamW(lr=0.0005, momentum=0.937) with parameter groups 81
        weight(decay=0.0), 88 weight(decay=0.0005), 87 bias(decay=0.0)
Image sizes 640 train, 640 val
Using 8 dataloader workers
Logging results to C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11s_custom_100
Starting training for 100 epochs...

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      1/100      7.99G      1.148      2.744     0.9568         32        864: 100%|
        ██████████| 433/433 [03:05<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:40
                   all       1488      30084      0.546      0.199       0.18
        0.133

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      2/100      8.17G      1.024      1.643     0.9337        125        320: 100%|
        ██████████| 433/433 [03:56<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:32
                   all       1488      30084      0.649      0.431       0.49
        0.363

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      3/100      6.62G     0.9507      1.235     0.9159         24        480: 100%|
        ██████████| 433/433 [02:24<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:31
                   all       1488      30084      0.728      0.611      0.703
        0.535

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      4/100      6.47G     0.9155      1.038     0.9073         98        608: 100%|
        ██████████| 433/433 [02:24<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:31
                   all       1488      30084      0.786      0.758      0.848
        0.686

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      5/100      7.34G     0.8713     0.8872     0.8983         78        640: 100%|
        ██████████| 433/433 [02:24<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:31
                   all       1488      30084       0.87      0.876      0.938
        0.767
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      6/100      7.42G     0.8463     0.8025     0.8909         30        896: 100%|
        ██████████| 433/433 [02:42<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:31
                   all       1488      30084      0.868      0.869      0.938
        0.768

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      7/100      6.64G     0.8276     0.7553     0.8904         35        800: 100%|
        ██████████| 433/433 [02:27<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:31
                   all       1488      30084      0.896      0.928      0.965
        0.801

(...)

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     48/100      7.63G      0.515       0.37      0.818         23        896: 100%|
        ██████████| 433/433 [02:06<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:24
                   all       1488      30084      0.967      0.989      0.983
        0.925

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     49/100      7.17G     0.5161     0.3662     0.8196         43        928: 100%|
        ██████████| 433/433 [02:16<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:19
                   all       1488      30084      0.962       0.99      0.982
        0.92

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     50/100      5.74G     0.5183     0.3713     0.8174         17        416: 100%|
        ██████████| 433/433 [01:59<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:30
                   all       1488      30084      0.966      0.992      0.982
        0.919

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     51/100      6.08G     0.5072     0.3612     0.8181         41        832: 100%|
        ██████████| 433/433 [02:12<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:26
                   all       1488      30084      0.962      0.995      0.984
        0.93

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     52/100      6.55G     0.5098      0.362     0.8175         91        960: 100%|
        ██████████| 433/433 [02:18<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:30
                   all       1488      30084      0.974      0.985      0.983
        0.927

(...)

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
      99/100      5.69G     0.2881     0.1915     0.7826         30        896: 100%|
        ██████████| 433/433 [02:17<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:29
                   all       1488      30084      0.962      0.997      0.981
        0.949

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     100/100      5.57G     0.2896     0.1916      0.781         22        960: 100%|
        ██████████| 433/433 [02:14<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:31
                   all       1488      30084      0.962      0.997      0.982
        0.949

100 epochs completed in 4.872 hours.
Optimizer stripped from C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11s_custom_100\weights\last.pt,
        19.3MB

Optimizer stripped from C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11s_custom_100\weights\best.pt,
        19.3MB


Validating C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11s_custom_100\weights\best.pt...

Ultralytics 8.3.162  Python-3.12.6 torch-2.7.1+cu128 CUDA:0 (NVIDIA GeForce RTX 4060
        Laptop GPU, 8188MiB)
YOLO11s summary (fused): 100 layers, 9,483,234 parameters, 0 gradients, 21.7 GFLOPs
                       Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 93/93 [00:45
                         all       1488      30084      0.962      0.995
        0.982       0.93
                         ACM         62         62      0.992          1
        0.995      0.994
                         ALB        228        332      0.999          1
        0.995      0.938
                         AMI         29         44      0.987          1
        0.995       0.98
                 API-Gateway        774       1178      0.974      0.992
        0.994      0.952
    Active Directory Service         31         31      0.983          1
        0.995      0.975
                    Airflow_         15         30      0.984          1
        0.995      0.969
                     Amplify         84         84      0.982          1
        0.995      0.852
          Analytics Services         15         15      0.969          1
        0.995      0.905
                     AppFlow         15         15      0.969          1
        0.995      0.995
                     Appsync         61         61      0.993          1
        0.995      0.824
                      Athena        143        148      0.819          1
        0.995      0.942
                      Aurora         89        126      0.976          1
        0.995      0.974
                Auto Scaling        173        307      0.998          1
        0.995      0.929
          Auto Scaling Group         35         88      0.995          1
        0.995      0.847
```

Automated Tests	64	98	0.995	1	0.995	0.945
Availability Zone	24	48	0.985	1	0.995	0.979
Backup	15	30	0.984	1	0.995	0.995
Build Environment	44	44	0.989	1	0.995	0.863
CDN	20	20	0.89	1	0.913	0.897
CUR	42	42	0.99	1	0.995	0.814
Call Metrics	15	15	0.969	1	0.995	0.89
Call Recordings	15	15	0.969	1	0.995	0.9
Certificate Manager	98	98	0.995	1	0.995	0.969
Client	16	61	0.709	0.52	0.788	0.682
Cloud Connector	16	32	0.985	1	0.995	0.933
Cloud Map	15	15	0.968	1	0.995	0.995
Cloud Search	56	56	0.991	1	0.995	0.918
Cloud Trail	187	192	0.997	1	0.995	0.979
Cloud Watch	543	644	0.999	1	0.995	0.942
CloudFormation Stack	150	168	0.997	1	0.995	0.968
CloudHSM	34	34	0.985	1	0.995	0.982
CloudWatch Alarm	87	121	0.996	1	0.995	0.933
Cloudfront	401	427	0.985	0.929	0.993	0.947
CodeBuild	157	245	0.998	1	0.995	0.94
CodeCommit	68	80	0.994	1	0.995	0.989
CodeDeploy	17	17	0.972	1	0.995	0.995
CodePipeline	214	220	0.998	1	0.995	0.928
Cognito	346	391	0.964	0.89	0.986	0.939
Comprehend	72	72	0.992	1	0.995	0.995
Config	103	178	0.921	0.978	0.993	0.902
Connect	15	15	0.968	1	0.995	0.98
Connect Contact Lens	15	15	0.965	1	0.995	0.921
Container	79	346	0.997	1	0.995	0.916
Control Tower	17	17	0.972	1	0.995	0.98
Customer Gateway	38	74	0.993	1	0.995	0.967
DSI	34	68	0.993	1	0.995	0.877

Data Pipeline	23	23	0.978	1	0.995	0.882
DataSync	32	32	0.985	1	0.995	0.992
Deploy Stage	30	30	0.985	1	0.995	0.878
Detective	15	15	0.969	1	0.995	0.963
Direct Connect	91	126	0.996	1	0.995	0.95
Distribution	15	15	0.615	1	0.92	0.9
Docker Image	56	179	0.967	1	0.995	0.826
Dynamo DB	660	979	0.963	1	0.995	0.96
EBS	92	147	0.999	1	0.995	0.925
EC2	707	1935	0.985	1	0.995	0.941
EFS	100	133	0.996	1	0.995	0.977
EFS Mount Target	99	129	0.996	1	0.995	0.93
EKS	161	184	0.992	1	0.995	0.975
ELB	425	583	0.999	0.969	0.975	0.944
EMR	15	15	0.968	1	0.995	0.995
Edge Location	20	42	0.988	1	0.995	0.97
ElastiCache	138	170	0.991	1	0.995	0.967
Elastic Container Registry	235	235	0.998	1	0.995	0.951
Elastic Container Service	258	331	0.991	0.993	0.995	0.893
Elastic Search	142	147	0.997	1	0.995	0.935
Elemental MediaConvert	49	66	0.83	0.962	0.963	0.963
Elemental MediaPackage	15	15	0.467	1	0.572	0.572
Email	25	25	0.98	1	0.995	0.969
Endpoint	27	27	0.983	1	0.995	0.98
Event Bus	16	16	0.967	1	0.995	0.995
EventBridge	60	120	0.996	1	0.995	0.9
Experiment Duration	17	17	0.566	1	0.588	0.559
Experiments	17	17	0.563	1	0.803	0.782
Fargate	193	427	0.973	1	0.995	0.932
Fault Injection Simulator	49	49	0.99	1	0.995	0.916
Firewall Manager	15	15	0.969	1	0.995	0.995
Flask	15	45	0.987	1	0.995	0.809

Flow logs	15	60	0.992	1	0.995	0.835
GameLift	17	17	0.973	1	0.995	0.904
Git	15	15	0.969	1	0.995	0.911
Github	81	95	0.995	1	0.995	0.939
Glacier	15	15	0.968	1	0.995	0.987
Glue	58	116	0.995	1	0.995	0.94
Glue DataBrew	26	26	0.981	1	0.995	0.981
Grafana	20	20	0.976	1	0.995	0.995
GuardDuty	72	132	0.996	1	0.995	0.956
IAM	201	334	0.992	0.91	0.99	0.906
IAM Role	98	207	0.868	1	0.983	0.845
IOT Core	40	54	0.991	1	0.995	0.984
Image	74	74	0.994	1	0.995	0.854
Image Builder	15	15	0.968	1	0.995	0.995
Ingress	15	15	0.969	1	0.995	0.899
Inspector Agent	15	15	0.968	1	0.995	0.982
Instances	19	38	0.558	1	0.571	0.479
Internet	240	345	0.953	1	0.994	0.96
Internet Gateway	167	247	0.991	1	0.995	0.907
Jenkins	15	30	0.984	1	0.995	0.97
Key Management Service	127	155	0.997	1	0.995	0.981
Kibana	15	15	0.969	1	0.995	0.995
Kinesis Data Streams	150	198	0.997	1	0.995	0.969
Kubernetes	15	15	0.968	1	0.995	0.985
Lambda	945	2489	0.987	0.991	0.995	0.962
Lex	16	16	0.97	1	0.995	0.995
MQ	25	57	0.992	1	0.995	0.866
Machine Learning	56	56	0.835	1	0.982	0.946
Macie	65	146	0.997	1	0.995	0.917
Marketplace	21	21	0.98	1	0.995	0.695
Memcached	18	36	0.986	1	0.995	0.991
Mobile Client	198	249	0.988	0.997	0.995	0.914

Mongo DB	26	70	0.873	1	0.995	0.874
MySQL	15	15	0.97	1	0.995	0.911
NAT Gateway	187	375	0.999	1	0.995	0.955
Neptune	42	42	0.985	1	0.995	0.7
Network Adapter	15	15	0.968	1	0.995	0.995
Network Firewall	15	15	0.969	1	0.995	0.901
Notebook	18	18	0.973	1	0.995	0.995
Order Controller	18	18	0.974	1	0.995	0.905
Organization Trail	32	77	0.994	1	0.995	0.849
Parameter Store	26	26	0.982	1	0.995	0.987
Pinpoint	16	16	0.97	1	0.995	0.915
PostgreSQL	15	15	0.97	1	0.995	0.948
Private Link	89	89	0.994	1	0.995	0.941
Private Subnet	368	930	0.975	0.981	0.987	0.869
Prometheus	20	20	0.976	1	0.995	0.995
Public Subnet	338	841	0.998	1	0.995	0.869
Quarkus	20	20	0.974	1	0.995	0.982
Quicksight	41	51	0.99	1	0.995	0.963
RDS	345	685	0.998	1	0.995	0.939
React	15	15	0.969	1	0.995	0.867
Redis	49	100	0.997	1	0.995	0.965
Redshift	73	80	0.994	1	0.995	0.966
Region	183	269	0.996	1	0.995	0.902
Rekognition	33	33	0.985	1	0.995	0.995
Results	17	17	0.565	1	0.626	0.611
Route 53	53	53	0.991	1	0.995	0.979
Route53	428	611	0.998	1	0.995	0.959
S3	977	2096	0.979	0.99	0.995	0.943
SAR	18	18	0.974	1	0.995	0.995
SDK	123	403	0.978	0.999	0.995	0.954
SES	72	87	0.994	1	0.995	0.944
SNS	258	279	0.998	1	0.995	0.965

SQS	189	199	0.998	1	0.995	0.969
SSM Agent	15	15	0.968	1	0.995	0.986
Sagemaker	81	267	0.922	0.981	0.987	0.816
Secret Manager	46	46	0.988	1	0.995	0.892
Security Group	15	15	0.969	1	0.995	0.995
Security Hub	31	91	0.995	1	0.995	0.844
Server	101	193	0.997	1	0.995	0.953
Service Catalog	40	91	0.995	1	0.995	0.911
Shield	58	58	0.992	1	0.995	0.993
Sign-On	15	15	0.968	1	0.995	0.979
Slack	37	37	0.987	1	0.995	0.979
Snowball	15	15	0.969	1	0.995	0.995
Stack	22	22	0.978	1	0.995	0.938
Step Function	32	96	0.995	1	0.995	0.935
Storage Gateway	15	15	0.968	1	0.995	0.995
SwaggerHub	15	15	0.968	1	0.995	0.995
Systems Manager	61	76	0.994	1	0.995	0.983
TV	22	22	0.978	1	0.995	0.961
Table	88	196	0.997	1	0.995	0.942
Task Runner	18	18	0.973	1	0.995	0.995
Terraform	32	32	0.985	1	0.995	0.945
Text File	54	122	0.943	1	0.994	0.931
Textract	17	17	0.972	1	0.995	0.995
Transcribe	17	17	0.972	1	0.995	0.995
Transfer Family	68	68	0.993	1	0.995	0.984
Transit Gateway	35	35	0.986	1	0.995	0.953
Translate	49	49	0.99	1	0.995	0.979
Trusted Advisor	36	36	0.986	1	0.995	0.983
Twilio	15	15	0.968	1	0.995	0.972
Users	574	790	0.976	0.989	0.995	0.928
VDA	16	16	0.971	1	0.995	0.962
VP Gateway	30	36	0.987	1	0.995	0.913

```
                  VPC Router         50         102       0.991          1
        0.995       0.95
              VPN Connection         21          57       0.991          1
        0.995      0.946
                         WAF        112         131       0.996          1
        0.995      0.956
                 Web Clients        213         248       0.821          1
        0.984       0.89
                    Websites         31          31       0.984          1
        0.995      0.959
                       X-Ray         83          95       0.995          1
        0.995       0.99
                         aws        971        1219       0.996      0.999
        0.995      0.912
                cache Worker         36          36       0.986          1
        0.995      0.968
Speed: 0.2ms preprocess, 13.9ms inference, 0.0ms loss, 4.2ms postprocess per image
Results saved to C:\acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11s_custom_100
🚀 Save dir: C:\acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11s_custom_100
✅ best.pt:  C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11s_custom_100\weights\best.pt

Ultralytics 8.3.162  Python-3.12.6 torch-2.7.1+cu128 CUDA:0 (NVIDIA GeForce RTX 4060
        Laptop GPU, 8188MiB)
YOLO11s summary (fused): 100 layers, 9,483,234 parameters, 0 gradients, 21.7 GFLOPs
val: Fast image access  (ping: 0.10.0 ms, read: 217.8131.8 MB/s, size: 365.8 KB)
val: Scanning D:\ia4devs\module_05\05_hackaton\data\dataset\aws\test\labels... 1327
        images, 0 backgrounds, 0 corrupt: 1
val: New cache created: D:
        \ia4devs\module_05\05_hackaton\data\dataset\aws\test\labels.cache
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 166/166 [00:
                   all       1327      26828       0.96      0.996
        0.98        0.95
                   ACM         42         42      0.987          1
        0.995      0.995
                   ALB        206        292      0.999          1
        0.995      0.961
                   AMI         24         39      0.986          1
        0.995      0.995
           API-Gateway        707       1063      0.973      0.997
        0.995      0.973
  Active Directory Service         29         29      0.981          1
        0.995      0.995
              Airflow_         15         30      0.983          1
        0.995      0.976
               Amplify         76         76      0.983          1
        0.989      0.868
    Analytics Services         15         15      0.966          1
        0.995      0.979
               AppFlow         15         15      0.965          1
        0.995      0.995
               Appsync         50         50      0.994          1
        0.995      0.842
                Athena        133        141      0.844          1
        0.995      0.956
                Aurora         79        112      0.993      0.964
        0.979      0.976
          Auto Scaling        126        211      0.998          1
        0.995      0.942
    Auto Scaling Group         25         58      0.992          1
        0.995      0.957
```

Automated Tests	58	89	0.994	1	0.995	0.962
Availability Zone	23	46	0.989	1	0.995	0.993
Backup	16	32	0.983	1	0.995	0.995
Build Environment	34	34	0.986	1	0.995	0.84
CDN	21	21	0.975	1	0.995	0.983
CUR	35	35	0.987	1	0.995	0.779
Call Metrics	15	15	0.966	1	0.995	0.995
Call Recordings	15	15	0.966	1	0.995	0.862
Certificate Manager	103	103	0.995	1	0.995	0.995
Client	16	61	0.534	0.984	0.663	0.587
Cloud Connector	14	28	0.982	1	0.995	0.993
Cloud Map	15	15	0.965	1	0.995	0.995
Cloud Search	48	48	0.989	1	0.995	0.984
Cloud Trail	140	142	0.995	1	0.995	0.991
Cloud Watch	468	566	0.999	1	0.995	0.97
CloudFormation Stack	124	138	0.996	1	0.995	0.994
CloudHSM	33	33	0.984	1	0.995	0.995
CloudWatch Alarm	75	106	0.995	1	0.995	0.951
Cloudfront	346	366	0.988	0.929	0.992	0.964
CodeBuild	140	208	0.997	1	0.995	0.965
CodeCommit	52	66	0.992	1	0.995	0.994
CodeDeploy	13	13	0.959	1	0.995	0.983
CodePipeline	183	190	0.993	1	0.992	0.955
Cognito	310	354	0.935	0.887	0.984	0.962
Comprehend	73	73	0.992	1	0.995	0.995
Config	72	147	0.946	0.98	0.993	0.957
Connect	15	15	0.965	1	0.995	0.995
Connect Contact Lens	15	15	0.965	1	0.995	0.99
Container	86	403	0.999	1	0.995	0.944
Control Tower	14	14	0.963	1	0.995	0.995
Customer Gateway	35	62	0.991	1	0.995	0.977
DSI	31	62	0.992	1	0.995	0.872

Data Pipeline	22	22	0.976	1	0.995	0.995
DataSync	30	30	1	1	0.995	0.995
Deploy Stage	27	27	0.981	1	0.995	0.873
Detective	15	15	0.965	1	0.995	0.995
Direct Connect	77	112	0.995	0.991	0.995	0.959
Distribution	15	15	0.619	1	0.816	0.816
Docker Image	44	174	0.99	0.989	0.99	0.838
Dynamo DB	619	958	0.967	0.992	0.995	0.969
EBS	65	107	1	0.996	0.995	0.938
EC2	609	1692	0.983	0.991	0.994	0.965
EFS	90	116	0.987	0.983	0.986	0.977
EFS Mount Target	95	128	0.998	0.977	0.982	0.964
EKS	147	164	0.996	1	0.995	0.98
ELB	379	521	0.994	0.964	0.975	0.958
EMR	15	15	0.965	1	0.995	0.995
Edge Location	15	27	0.982	1	0.995	0.928
ElastiCache	101	121	0.995	0.967	0.985	0.968
Elastic Container Registry	212	212	0.998	1	0.995	0.972
Elastic Container Service	236	302	0.976	0.937	0.992	0.923
Elastic Search	116	117	0.996	1	0.995	0.943
Elemental MediaConvert	49	64	0.816	1	0.98	0.978
Elemental MediaPackage	15	15	0.497	1	0.53	0.53
Email	29	29	1	0.966	0.982	0.976
Endpoint	22	22	0.978	1	0.995	0.982
Event Bus	15	15	0.964	1	0.995	0.995
EventBridge	41	101	0.995	1	0.995	0.984
Experiment Duration	14	14	0.516	1	0.572	0.553
Experiments	14	14	0.515	1	0.621	0.621
Fargate	180	423	0.935	1	0.994	0.958
Fault Injection Simulator	45	45	0.988	1	0.995	0.963
Firewall Manager	15	15	0.965	1	0.995	0.995
Flask	17	51	0.989	1	0.995	0.791

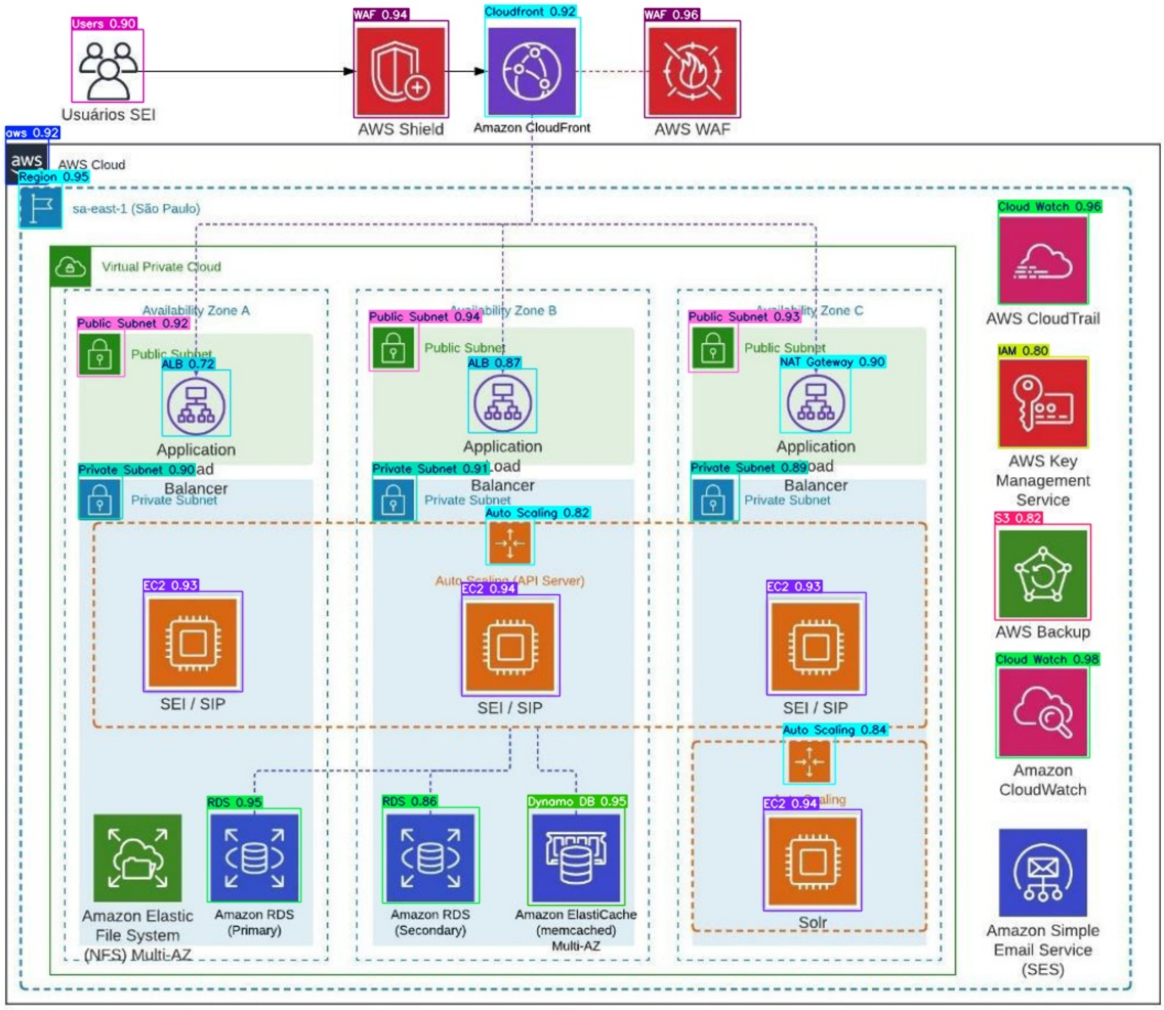
Flow logs	15	60	0.995	1	0.995	0.915
GameLift	15	15	0.967	1	0.995	0.939
Git	17	17	0.969	1	0.995	0.96
Github	73	90	0.994	1	0.995	0.96
Glacier	15	15	0.965	1	0.995	0.995
Glue	59	118	0.995	1	0.995	0.965
Glue DataBrew	22	22	0.975	1	0.995	0.995
Grafana	14	14	0.96	1	0.995	0.995
GuardDuty	57	117	0.995	1	0.995	0.978
IAM	180	335	0.96	0.934	0.99	0.951
IAM Role	78	185	0.855	0.989	0.978	0.895
IOT Core	46	52	0.994	1	0.995	0.992
Image	63	63	0.992	1	0.995	0.89
Image Builder	15	15	0.962	1	0.995	0.995
Ingress	17	17	0.969	1	0.995	0.995
Inspector Agent	15	15	0.965	1	0.995	0.995
Instances	16	32	0.515	1	0.637	0.622
Internet	201	272	0.951	0.994	0.994	0.98
Internet Gateway	133	200	1	0.999	0.995	0.926
Jenkins	15	30	0.982	1	0.995	0.995
Key Management Service	111	139	0.996	1	0.995	0.995
Kibana	18	18	0.971	1	0.995	0.983
Kinesis Data Streams	156	207	1	0.988	0.995	0.991
Kubernetes	17	17	0.971	1	0.995	0.995
Lambda	830	2220	0.988	0.996	0.995	0.978
Lex	18	18	0.97	1	0.995	0.995
MQ	34	86	0.994	1	0.995	0.963
Machine Learning	47	47	0.809	1	0.974	0.969
Macie	56	119	0.994	1	0.995	0.966
Marketplace	19	19	0.981	1	0.995	0.726
Memcached	11	22	0.976	1	0.995	0.983
Mobile Client	150	196	1	0.989	0.995	0.921

Mongo DB	26	62	0.992	1	0.995	0.92
MySQL	15	15	0.967	1	0.995	0.911
NAT Gateway	147	293	0.993	0.989	0.995	0.985
Neptune	35	35	0.982	1	0.995	0.7
Network Adapter	15	15	0.965	1	0.995	0.995
Network Firewall	15	15	0.967	1	0.995	0.995
Notebook	15	15	0.965	1	0.995	0.995
Order Controller	17	17	0.969	1	0.995	0.889
Organization Trail	26	71	0.994	1	0.995	0.981
Parameter Store	27	27	0.98	1	0.995	0.985
Pinpoint	16	16	0.967	1	0.995	0.995
PostgreSQL	15	15	0.967	1	0.995	0.987
Private Link	87	87	0.994	1	0.995	0.989
Private Subnet	335	936	0.994	0.981	0.987	0.927
Prometheus	14	14	0.963	1	0.995	0.995
Public Subnet	299	715	0.997	0.992	0.995	0.918
Quarkus	14	14	0.962	1	0.995	0.995
Quicksight	40	50	0.989	1	0.995	0.995
RDS	266	551	0.982	0.982	0.982	0.961
React	15	15	0.968	1	0.995	0.911
Redis	47	98	0.98	1	0.995	0.987
Redshift	65	72	0.993	1	0.995	0.993
Region	161	243	0.997	1	0.995	0.928
Rekognition	37	37	0.985	1	0.995	0.988
Results	14	14	0.523	1	0.685	0.685
Route 53	39	39	0.962	1	0.989	0.989
Route53	376	532	0.995	0.996	0.995	0.974
S3	867	1862	0.969	0.982	0.994	0.963
SAR	14	14	0.964	1	0.995	0.995
SDK	98	301	0.971	1	0.992	0.969
SES	69	84	0.994	1	0.995	0.978
SNS	232	254	0.998	1	0.995	0.988

SQS	184	197	0.997	1	0.995	0.979
SSM Agent	15	15	0.965	1	0.995	0.995
Sagemaker	76	241	0.991	0.992	0.993	0.823
Secret Manager	44	44	0.983	1	0.995	0.995
Security Group	16	16	0.967	1	0.995	0.97
Security Hub	25	85	0.995	1	0.995	0.953
Server	88	165	0.996	1	0.995	0.95
Service Catalog	30	72	0.992	1	0.995	0.965
Shield	52	52	0.99	1	0.995	0.995
Sign-On	15	15	0.965	1	0.995	0.995
Slack	30	30	0.982	1	0.995	0.973
Snowball	15	15	0.963	1	0.995	0.995
Stack	14	14	0.964	1	0.995	0.973
Step Function	30	90	0.994	1	0.995	0.922
Storage Gateway	15	15	0.965	1	0.995	0.995
SwaggerHub	15	15	0.965	1	0.995	0.995
Systems Manager	53	68	0.992	1	0.995	0.995
TV	12	12	0.959	1	0.995	0.967
Table	72	154	0.99	1	0.995	0.954
Task Runner	17	17	0.969	1	0.995	0.99
Terraform	38	38	0.986	1	0.995	0.97
Text File	49	99	0.914	1	0.98	0.955
Textract	14	14	0.962	1	0.995	0.995
Transcribe	19	19	0.972	1	0.995	0.995
Transfer Family	67	67	0.992	1	0.995	0.989
Transit Gateway	31	31	0.983	1	0.995	0.962
Translate	53	53	0.99	1	0.995	0.995
Trusted Advisor	13	13	0.96	1	0.995	0.986
Twilio	18	18	0.971	1	0.995	0.995
Users	486	656	0.999	0.985	0.995	0.959
VDA	14	14	0.964	1	0.995	0.983
VP Gateway	27	39	0.987	0.974	0.979	0.934

```
              VPC Router        39         80          1      0.994
        0.995      0.938
          VPN Connection        21         48      0.992          1
        0.995      0.989
                     WAF        99        109      0.995          1
        0.995       0.99
             Web Clients       202        268      0.831      0.994
        0.971      0.909
                Websites        34         34      0.985          1
        0.995      0.993
                   X-Ray        88        112      0.996          1
        0.995      0.991
                     aws       845       1067      0.993      0.993
        0.995      0.945
            cache Worker        26         26      0.979          1
        0.995      0.995
Speed: 0.4ms preprocess, 10.0ms inference, 0.0ms loss, 4.4ms postprocess per image
Saving C:\acmattos\dev\tools\Python\ia4devs\runs\detect\val\predictions.json...
Results saved to C:\acmattos\dev\tools\Python\ia4devs\runs\detect\val

🎯 Test Metrics (mean per class):
  Precision:     0.960
  Recall:        0.996
  mAP@0.5:       0.980
  mAP@0.5:0.95:  0.950

image 1/1 D:\ia4devs\module_05\05_hackaton\data\sample\aws_02.png: 576x640 2 ALBs,
2 Auto Scalings, 2 Cloud Watchs, 1 Cloudfront, 1 Dynamo DB, 4 EC2s, 1 IAM, 1 NAT
        Gateway,
3 Private Subnets, 3 Public Subnets, 2 RDSs, 1 Region, 1 S3, 1 Users, 2 WAFs, 1 aws,
        209.5ms
Speed: 8.4ms preprocess, 209.5ms inference, 4.7ms postprocess per image at shape (1,
        3, 576, 640)
Results saved to C:\acmattos\dev\tools\Python\ia4devs\runs\detect\predict
1 label saved to C:\acmattos\dev\tools\Python\ia4devs\runs\detect\predict\labels
✅ Detailed JSON saved to data\reports\yolo11s_custom_100\results.json
✅ Summary JSON saved to data\reports\yolo11s_custom_100\report.json
[ultralytics.engine.results.Results object with attributes:

boxes: ultralytics.engine.results.Boxes object
keypoints: None
masks: None
(...)
obb: None
(...)
orig_shape: (993, 1167)
path: 'D:\\ia4devs\\module_05\\05_hackaton\\data\\sample\\aws_02.png'
probs: None
save_dir: 'C:\\acmattos\\dev\\tools\\Python\\ia4devs\\runs\\detect\\predict'
speed: {'preprocess': 8.365600020624697, 'inference': 209.4717000145465,
        'postprocess': 4.683099978137761}]
```

Predição do Modelo do Yolo 11 - `S`



Detecção do Modelo S

Treinamento do Yolo 11 - Modelo `M`

Para treinar o modelo, basta ajustar a variável abaixo:

```
yolo: str = 'yolo11m'
```

Depois, execute a chamada a seguir:

```
py model.py
```

Aguardar a conclusão do processo. O treinamento utilizou 82 épocas para treino, gastando 5.280 horas no processo. O mecanismo de `Early Stop` foi acionado após 10 épocas que passarem sem nenhum progresso no treinamento do modelo. Um exemplo de log de execução pode ser visto abaixo:

```
New https://pypi.org/project/ultralytics/8.3.162 available  Update with 'pip install
        -U ultralytics'
Ultralytics 8.3.161  Python-3.12.6 torch-2.7.1+cu128 CUDA:0 (NVIDIA GeForce RTX 4060
        Laptop GPU, 8188MiB)
engine\trainer: agnostic_nms=False, amp=True, augment=True, auto_augment=randaugment,
        batch=6,
bgr=0.0, box=7.5, cache=False, cfg=None, classes=None, close_mosaic=10, cls=0.5,
        conf=None,
copy_paste=0.0, copy_paste_mode=flip, cos_lr=False, cutmix=0.0, data=./data/dataset/
        aws/data.yaml,
degrees=0.0, deterministic=True, device=0, dfl=1.5, dnn=False, dropout=0.0, dynamic=False,
embed=None, epochs=100, erasing=0.4, exist_ok=False, fliplr=0.5, flipud=0.0, format=torchscript,
fraction=1.0, freeze=None, half=False, hsv_h=0.015, hsv_s=0.7, hsv_v=0.4, imgsz=640,
        int8=False,
iou=0.7, keras=False, kobj=1.0, line_width=None, lr0=0.0005, lrf=0.05, mask_ratio=4,
        max_det=300,
mixup=0.5, mode=train, model=./data/model/yolo11m.pt, momentum=0.937, mosaic=1.0,
        multi_scale=True,
name=yolo11m_custom_100, nbs=64, nms=False, opset=None, optimize=False, optimizer=AdamW,
overlap_mask=True, patience=10, perspective=0.0, plots=True, pose=12.0, pretrained=True,
profile=False, project=None, rect=False, resume=False, retina_masks=False, save=True,
save_conf=False, save_crop=False,
save_dir=C:\acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11m_custom_100,
        save_frames=False,
save_json=False, save_period=-1, save_txt=False, scale=0.5, seed=0, shear=0.0, show=False,
show_boxes=True, show_conf=True, show_labels=True, simplify=True, single_cls=False,
        source=None,
split=val, stream_buffer=False, task=detect, time=None, tracker=botsort.yaml,
        translate=0.1,
val=True, verbose=True, vid_stride=1, visualize=False, warmup_bias_lr=0.1,
        warmup_epochs=3,
warmup_momentum=0.8, weight_decay=0.0005, workers=8, workspace=None
Overriding model.yaml nc=80 with nc=182


                   from  n    params  module                                       arguments
  0                  -1  1      1856  ultralytics.nn.modules.conv.Conv             [3, 64, 3, 2]
  1                  -1  1     73984  ultralytics.nn.modules.conv.Conv             [64, 128, 3, 2]
  2                  -1  1    111872  ultralytics.nn.modules.block.C3k2            [128, 256, 1,
        True, 0.25]
  3                  -1  1    590336  ultralytics.nn.modules.conv.Conv             [256, 256, 3, 2]
  4                  -1  1    444928  ultralytics.nn.modules.block.C3k2            [256, 512, 1,
        True, 0.25]
  5                  -1  1   2360320  ultralytics.nn.modules.conv.Conv             [512, 512, 3, 2]
  6                  -1  1   1380352  ultralytics.nn.modules.block.C3k2            [512, 512, 1,
        True]
  7                  -1  1   2360320  ultralytics.nn.modules.conv.Conv             [512, 512, 3, 2]
  8                  -1  1   1380352  ultralytics.nn.modules.block.C3k2            [512, 512, 1,
        True]
  9                  -1  1    656896  ultralytics.nn.modules.block.SPPF            [512, 512, 5]
 10                  -1  1    990976  ultralytics.nn.modules.block.C2PSA           [512, 512, 1]
 11                  -1  1         0  torch.nn.modules.upsampling.Upsample         [None, 2,
        'nearest']
 12             [-1, 6]  1         0  ultralytics.nn.modules.conv.Concat           [1]
 13                  -1  1   1642496  ultralytics.nn.modules.block.C3k2            [1024, 512, 1,
        True]
 14                  -1  1         0  torch.nn.modules.upsampling.Upsample         [None, 2,
        'nearest']
 15             [-1, 4]  1         0  ultralytics.nn.modules.conv.Concat           [1]
 16                  -1  1    542720  ultralytics.nn.modules.block.C3k2            [1024, 256, 1,
        True]
 17                  -1  1    590336  ultralytics.nn.modules.conv.Conv             [256, 256, 3, 2]
 18            [-1, 13]  1         0  ultralytics.nn.modules.conv.Concat           [1]
```

```
 19          -1  1   1511424  ultralytics.nn.modules.block.C3k2     [768, 512, 1,
        True]
 20          -1  1   2360320  ultralytics.nn.modules.conv.Conv      [512, 512, 3, 2]
 21      [-1, 10]  1         0  ultralytics.nn.modules.conv.Concat    [1]
 22          -1  1   1642496  ultralytics.nn.modules.block.C3k2     [1024, 512, 1,
        True]
 23 [16, 19, 22]  1   1551346  ultralytics.nn.modules.head.Detect    [182, [256, 512,
        512]]
YOLO11m summary: 231 layers, 20,193,330 parameters, 20,193,314 gradients, 69.0 GFLOPs

Transferred 643/649 items from pretrained weights
ClearML Task: created new task id=4d88d8495b224537b71cc9f78d532fad
ClearML results page: https://app.clear.ml/projects/14f0119248fa451f826c387955b212a3/
        experiments/4d88d8495b224537b71cc9f78d532fad/output/log
WARNING ClearML Initialized a new task. If you want to run remotely, please add
        clearml-init and connect your arguments before initializing YOLO.
Freezing layer 'model.23.dfl.conv.weight'
AMP: running Automatic Mixed Precision (AMP) checks...
AMP: checks passed
train: Fast image access  (ping: 0.20.1 ms, read: 900.8340.6 MB/s, size: 1118.3 KB)
train: Scanning D:
        \ia4devs\module_05\05_hackaton\data\dataset\aws\train\labels.cache... 3457
        images, 0 backgrounds, 0 c
albumentations: Blur(p=0.01, blur_limit=(3, 7)), MedianBlur(p=0.01, blur_limit=(3,
        7)), ToGray(p=0.01, method='weighted_average', num_output_channels=3), CLAHE(p=0.01,
        clip_limit=(1.0, 4.0), tile_grid_size=(8, 8))
val: Fast image access  (ping: 0.10.1 ms, read: 432.2297.8 MB/s, size: 607.4 KB)
val: Scanning D:\ia4devs\module_05\05_hackaton\data\dataset\aws\valid\labels.cache...
        1488 images, 0 backgrounds, 0 cor
Plotting labels to C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11m_custom_100\labels.jpg...

optimizer: AdamW(lr=0.0005, momentum=0.937) with parameter groups 106
        weight(decay=0.0), 113 weight(decay=0.000515625), 112 bias(decay=0.0)
Image sizes 640 train, 640 val
Using 8 dataloader workers
Logging results to C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11m_custom_100
Starting training for 100 epochs...

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      1/100      7.37G      1.421      5.513      1.155        253        384:   2%|
        | 10/577 [00:04<03:27,
      1/100      7.55G      1.108      2.564     0.9695        242        576:  67%|██████
        | 388/577 [02:18<00:49,
      1/100      7.55G      1.071      2.245     0.9587         29        544: 100%|
        ██████████| 577/577 [03:18<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95):   7%|▋         | 9/124 [00:01
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 124/124 [00:
                   all       1488      30084      0.695      0.418      0.493
        0.376

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      2/100      7.54G     0.9569      1.188     0.9321         25        672: 100%|
        ██████████| 577/577 [02:54<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 124/124 [00:
                   all       1488      30084      0.754      0.715      0.794
        0.612

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
      3/100      7.86G     0.9032     0.9137     0.9158          9        672: 100%|
        ██████████| 577/577 [02:38<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 124/124 [00:
                   all       1488      30084      0.842      0.836      0.915
        0.727

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      4/100      7.69G     0.8737     0.8256     0.9097         12        736: 100%|
        ██████████| 577/577 [03:48<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 124/124 [00:
                   all       1488      30084      0.863      0.886      0.939
        0.764

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      5/100      7.72G     0.8313     0.7116     0.9021         24        896: 100%|
        ██████████| 577/577 [04:20<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 124/124 [00:
                   all       1488      30084      0.899      0.929      0.969
        0.803

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      6/100      7.78G     0.7875     0.6362     0.8858         80        768: 100%|
        ██████████| 577/577 [04:44<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 124/124 [00:
                   all       1488      30084      0.945      0.962      0.978
        0.836

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      7/100      7.69G     0.7651     0.6092     0.8865         27        960: 100%|
        ██████████| 577/577 [03:57<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 124/124 [00:
                   all       1488      30084      0.928      0.977       0.98
        0.853

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      8/100      7.64G       0.73      0.556     0.8752         16        864: 100%|
        ██████████| 577/577 [02:39<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 124/124 [00:
                   all       1488      30084      0.932       0.98       0.98
        0.85

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      9/100      7.76G     0.7183     0.5498     0.8703         29        640: 100%|
        ██████████| 577/577 [02:51<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 124/124 [00:
                   all       1488      30084      0.955      0.976      0.982
        0.872

(...)

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     49/100      7.66G     0.4436     0.3047     0.8118         52        608: 100%|
        ██████████| 577/577 [03:15<00:00,
                 Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 124/124 [00:
```

```
                 all       1488      30084      0.951      0.999      0.984
        0.948

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     50/100      7.56G     0.4367     0.3027     0.8113         32        928: 100%|
        ██████████| 577/577 [04:10<00:00,
               Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 124/124 [00:
                 all       1488      30084      0.971       0.99      0.982
        0.947

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     51/100      7.54G      0.438      0.303     0.8122         54        736: 100%|
        ██████████| 577/577 [03:39<00:00,
               Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 124/124 [00:
                 all       1488      30084      0.959      0.993      0.983
        0.948

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     52/100      7.87G     0.4401     0.3049     0.8098         48        864: 100%|
        ██████████| 577/577 [02:46<00:00,
               Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 124/124 [00:
                 all       1488      30084      0.958      0.994      0.984
        0.949

(...)

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     81/100       7.8G     0.3734     0.2554      0.799         68        320: 100%|
        ██████████| 577/577 [04:41<00:00,
               Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 124/124 [00:
                 all       1488      30084      0.959      0.997      0.982
        0.956

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     82/100      8.03G     0.3781     0.2593     0.7981         21        320: 100%|
        ██████████| 577/577 [02:51<00:00,
               Class     Images  Instances      Box(P          R      mAP50
        mAP50-95): 100%|██████████| 124/124 [00:
                 all       1488      30084      0.955      0.998      0.982
        0.957
EarlyStopping: Training stopped early as no improvement observed in last 10 epochs.
        Best results observed at epoch 72, best model saved as best.pt.
To update EarlyStopping(patience=10) pass a new patience value, i.e. `patience=300`
        or use `patience=0` to disable EarlyStopping.

82 epochs completed in 5.280 hours.
Optimizer stripped from C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11m_custom_100\weights\last.pt,
        40.8MB

Optimizer stripped from C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11m_custom_100\weights\best.pt,
        40.8MB


Validating C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11m_custom_100\weights\best.pt...
```

```
Ultralytics 8.3.161  Python-3.12.6 torch-2.7.1+cu128 CUDA:0 (NVIDIA GeForce RTX 4060
        Laptop GPU, 8188MiB)
YOLO11m summary (fused): 125 layers, 20,170,354 parameters, 0 gradients, 68.4 GFLOPs
                    Class  Images Instances   Box(P       R  mAP50  mAP50-95): 100%|
        ██████████| 124/124 [00:
                      all    1488     30084  0.955  0.995  0.984      0.936
                      ACM      62        62   0.99      1  0.995      0.953
                      ALB     228       332  0.998      1  0.995      0.947
                      AMI      29        44  0.986      1  0.995      0.979
              API-Gateway     774      1178  0.968      1  0.995      0.958
  Active Directory Service      31        31  0.981      1  0.995      0.978
                 Airflow_      15        30   0.98      1  0.995      0.984
                  Amplify      84        84  0.993      1  0.995      0.895
       Analytics Services      15        15  0.962      1  0.995      0.988
                  AppFlow      15        15  0.961      1  0.995      0.995
                  Appsync      61        61  0.991      1  0.995      0.826
                   Athena     143       148   0.84      1   0.99      0.965
                   Aurora      89       126  0.995      1  0.995      0.982
             Auto Scaling     173       307  0.995      1  0.995      0.929
       Auto Scaling Group      35        88  0.993      1  0.995      0.841
          Automated Tests      64        98  0.994      1  0.995      0.974
        Availability Zone      24        48  0.987      1  0.995      0.956
                   Backup      15        30   0.98      1  0.995      0.995
        Build Environment      44        44  0.975      1  0.995      0.868
                      CDN      20        20  0.884      1  0.995      0.975
                      CUR      42        42  0.987      1  0.995      0.801
             Call Metrics      15        15  0.961      1  0.995      0.963
          Call Recordings      15        15  0.961      1  0.995       0.91
      Certificate Manager      98        98  0.994      1  0.995      0.988
                   Client      16        61  0.669      1  0.742      0.667
          Cloud Connector      16        32  0.981      1  0.995       0.94
                Cloud Map      15        15  0.961      1  0.995      0.995
             Cloud Search      56        56  0.989      1  0.995       0.96
              Cloud Trail     187       192  0.996      1  0.995      0.972
              Cloud Watch     543       644  0.999      1  0.995      0.949
     CloudFormation Stack     150       168  0.994      1  0.995      0.961
                 CloudHSM      34        34  0.982      1  0.995      0.916
       CloudWatch Alarm      87       121  0.995      1  0.995      0.942
               Cloudfront     401       427  0.926  0.995  0.995      0.962
                CodeBuild     157       245  0.998      1  0.995      0.961
               CodeCommit      68        80  0.992      1  0.995      0.979
               CodeDeploy      17        17  0.965      1  0.995      0.995
             CodePipeline     214       220  0.861      1  0.995      0.934
                  Cognito     346       391  0.846      1  0.984      0.952
               Comprehend      72        72  0.991      1  0.995      0.994
                   Config     103       178  0.982   0.92  0.991      0.903
                  Connect      15        15      1      1  0.995      0.995
     Connect Contact Lens      15        15  0.961      1  0.995      0.987
                Container      79       346  0.984      1  0.995      0.903
            Control Tower      17        17  0.965      1  0.995      0.995
         Customer Gateway      38        74  0.992      1  0.995      0.965
                      DSI      34        68  0.991      1  0.995      0.884
            Data Pipeline      23        23  0.973      1  0.995      0.928
                 DataSync      32        32  0.981      1  0.995      0.991
             Deploy Stage      30        30   0.98      1  0.995      0.924
                Detective      15        15  0.961      1  0.995      0.915
           Direct Connect      91       126  0.995      1  0.995      0.958
             Distribution      15        15  0.609      1  0.895      0.887
             Docker Image      56       179  0.912      1  0.995      0.836
                Dynamo DB     660       979  0.957      1  0.995      0.964
                      EBS      92       147  0.996      1  0.995      0.953
                      EC2     707      1935  0.986      1  0.995      0.936
```

EFS	100	133	0.995	1	0.995	0.945
EFS Mount Target	99	129	0.995	1	0.995	0.958
EKS	161	184	0.997	1	0.995	0.977
ELB	425	583	0.994	0.969	0.975	0.944
EMR	15	15	0.961	1	0.995	0.895
Edge Location	20	42	0.985	1	0.995	0.982
ElastiCache	138	170	0.996	1	0.995	0.954
Elastic Container Registry	235	235	0.997	1	0.995	0.958
Elastic Container Service	258	331	0.909	1	0.994	0.901
Elastic Search	142	147	0.996	1	0.995	0.948
Elemental MediaConvert	49	66	0.952	0.788	0.965	0.951
Elemental MediaPackage	15	15	0.462	1	0.605	0.605
Email	25	25	0.977	1	0.995	0.987
Endpoint	27	27	0.979	1	0.995	0.927
Event Bus	16	16	0.963	1	0.995	0.995
EventBridge	60	120	0.971	1	0.995	0.881
Experiment Duration	17	17	0.56	1	0.612	0.588
Experiments	17	17	0.559	1	0.675	0.675
Fargate	193	427	0.981	1	0.995	0.925
Fault Injection Simulator	49	49	0.988	1	0.995	0.919
Firewall Manager	15	15	1	1	0.995	0.914
Flask	15	45	0.964	1	0.995	0.868
Flow logs	15	60	0.99	1	0.995	0.848
GameLift	17	17	0.966	1	0.995	0.924
Git	15	15	0.961	1	0.995	0.968
Github	81	95	0.993	1	0.995	0.962
Glacier	15	15	1	1	0.995	0.978
Glue	58	116	0.993	1	0.995	0.933
Glue DataBrew	26	26	0.977	1	0.995	0.995
Grafana	20	20	1	1	0.995	0.995
GuardDuty	72	132	0.995	1	0.995	0.928
IAM	201	334	0.894	1	0.991	0.9
IAM Role	98	207	0.872	1	0.98	0.836
IOT Core	40	54	0.989	1	0.995	0.978
Image	74	74	0.992	1	0.995	0.876
Image Builder	15	15	0.961	1	0.995	0.995
Ingress	15	15	0.961	1	0.995	0.985
Inspector Agent	15	15	0.961	1	0.995	0.878
Instances	19	38	0.57	0.488	0.651	0.561
Internet	240	345	1	0.965	0.994	0.963
Internet Gateway	167	247	0.998	1	0.995	0.936
Jenkins	15	30	0.98	1	0.995	0.945
Key Management Service	127	155	0.996	1	0.995	0.99
Kibana	15	15	0.962	1	0.995	0.923
Kinesis Data Streams	150	198	0.996	1	0.995	0.968
Kubernetes	15	15	0.962	1	0.995	0.96
Lambda	945	2489	0.948	1	0.995	0.954
Lex	16	16	0.963	1	0.995	0.995
MQ	25	57	0.99	1	0.995	0.916
Machine Learning	56	56	0.829	1	0.982	0.923
Macie	65	146	0.996	1	0.995	0.95
Marketplace	21	21	0.974	1	0.995	0.634
Memcached	18	36	0.983	1	0.995	0.98
Mobile Client	198	249	0.985	1	0.995	0.93
Mongo DB	26	70	0.929	1	0.995	0.904
MySQL	15	15	0.961	1	0.995	0.99
NAT Gateway	187	375	0.998	1	0.995	0.962
Neptune	42	42	0.6	1	0.995	0.764
Network Adapter	15	15	0.961	1	0.995	0.995
Network Firewall	15	15	0.961	1	0.995	0.961
Notebook	18	18	0.967	1	0.995	0.995
Order Controller	18	18	0.967	1	0.995	0.989

Organization Trail	32	77	0.992	1	0.995	0.854
Parameter Store	26	26	0.977	1	0.995	0.995
Pinpoint	16	16	0.963	1	0.995	0.995
PostgreSQL	15	15	0.961	1	0.995	0.986
Private Link	89	89	0.985	1	0.995	0.949
Private Subnet	368	930	0.973	0.982	0.986	0.864
Prometheus	20	20	0.969	1	0.995	0.995
Public Subnet	338	841	0.995	1	0.995	0.865
Quarkus	20	20	0.97	1	0.995	0.984
Quicksight	41	51	0.988	1	0.995	0.986
RDS	345	685	0.999	1	0.995	0.95
React	15	15	0.961	1	0.995	0.814
Redis	49	100	0.994	1	0.995	0.975
Redshift	73	80	0.992	1	0.995	0.951
Region	183	269	0.997	1	0.995	0.879
Rekognition	33	33	0.982	1	0.995	0.992
Results	17	17	0.558	1	0.901	0.901
Route 53	53	53	0.989	1	0.995	0.995
Route53	428	611	0.999	1	0.995	0.957
S3	977	2096	0.94	1	0.995	0.943
SAR	18	18	1	1	0.995	0.995
SDK	123	403	1	0.975	0.995	0.965
SES	72	87	0.992	1	0.995	0.951
SNS	258	279	0.998	1	0.995	0.977
SQS	189	199	0.997	1	0.995	0.968
SSM Agent	15	15	0.961	1	0.995	0.865
Sagemaker	81	267	0.718	1	0.968	0.809
Secret Manager	46	46	0.987	1	0.995	0.926
Security Group	15	15	1	1	0.995	0.995
Security Hub	31	91	0.994	1	0.995	0.895
Server	101	193	0.997	1	0.995	0.953
Service Catalog	40	91	0.993	1	0.995	0.936
Shield	58	58	0.99	1	0.995	0.994
Sign-On	15	15	0.96	1	0.995	0.995
Slack	37	37	0.984	1	0.995	0.979
Snowball	15	15	0.961	1	0.995	0.995
Stack	22	22	0.973	1	0.995	0.901
Step Function	32	96	0.994	1	0.995	0.914
Storage Gateway	15	15	0.961	1	0.995	0.995
SwaggerHub	15	15	0.961	1	0.995	0.995
Systems Manager	61	76	0.992	1	0.995	0.956
TV	22	22	0.974	1	0.995	0.936
Table	88	196	0.997	1	0.995	0.957
Task Runner	18	18	0.968	1	0.995	0.986
Terraform	32	32	0.981	1	0.995	0.935
Text File	54	122	0.943	1	0.994	0.964
Textract	17	17	0.965	1	0.995	0.995
Transcribe	17	17	0.965	1	0.995	0.995
Transfer Family	68	68	0.991	1	0.995	0.976
Transit Gateway	35	35	0.983	1	0.995	0.978
Translate	49	49	0.987	1	0.995	0.99
Trusted Advisor	36	36	0.983	1	0.995	0.995
Twilio	15	15	0.961	1	0.995	0.995
Users	574	790	0.994	0.996	0.995	0.922
VDA	16	16	0.964	1	0.995	0.964
VP Gateway	30	36	0.984	1	0.995	0.959
VPC Router	50	102	0.994	1	0.995	0.962
VPN Connection	21	57	0.989	1	0.995	0.984
WAF	112	131	0.995	1	0.995	0.962
Web Clients	213	248	0.82	1	0.984	0.904
Websites	31	31	0.98	1	0.995	0.956
X-Ray	83	95	0.972	1	0.995	0.968

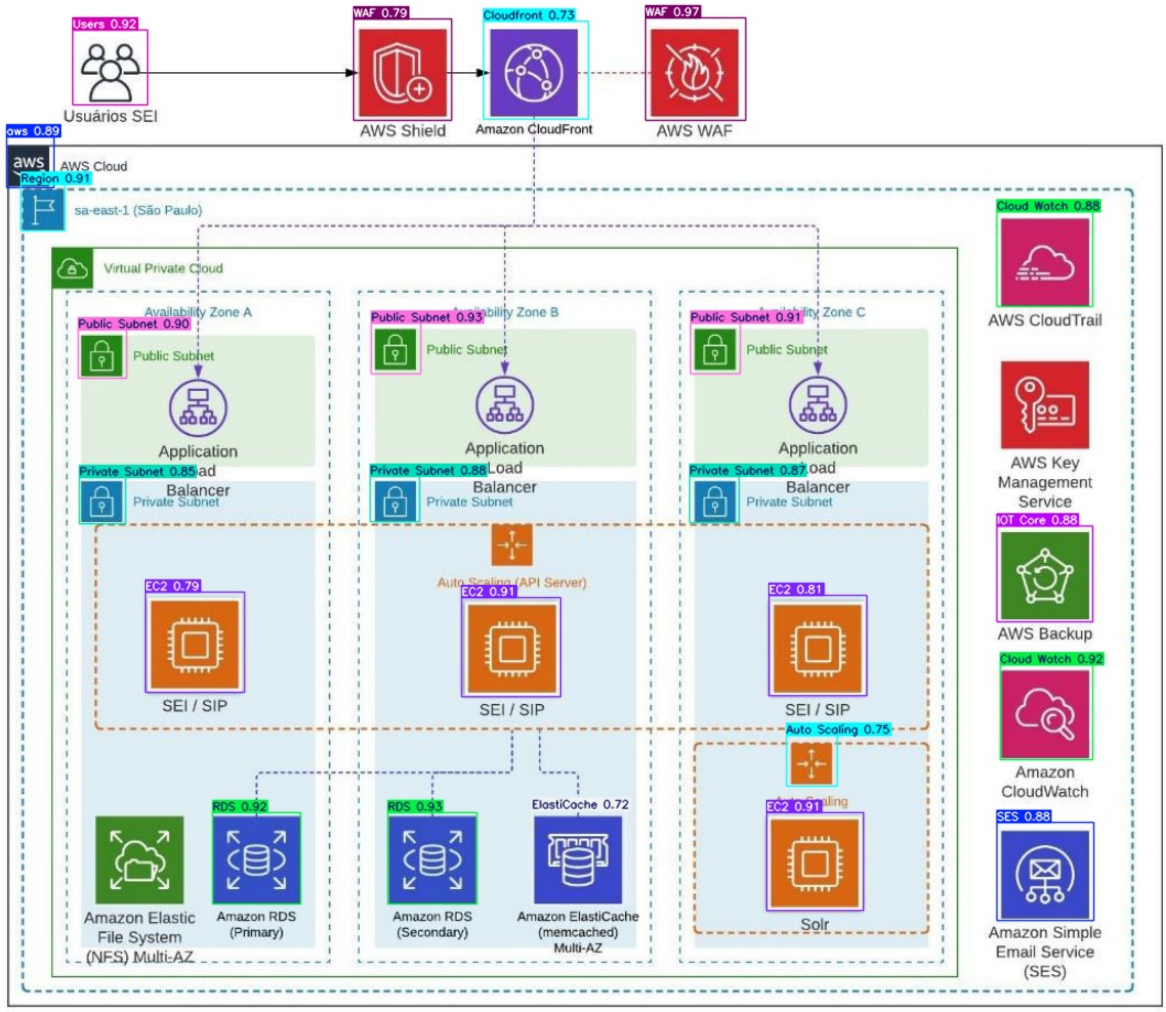
```
                             aws        971       1219   0.997          1    0.995        0.899
                    cache Worker         36         36   0.983          1    0.995        0.995
Speed: 0.2ms preprocess, 12.1ms inference, 0.0ms loss, 1.0ms postprocess per image
Results saved to C:\acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11m_custom_100
🚀 Save dir: C:\acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11m_custom_100
✅ best.pt:  C:
        \acmattos\dev\tools\Python\ia4devs\runs\detect\yolo11m_custom_100\weights\best.pt

Ultralytics 8.3.161  Python-3.12.6 torch-2.7.1+cu128 CUDA:0 (NVIDIA GeForce RTX 4060
        Laptop GPU, 8188MiB)
YOLO11m summary (fused): 125 layers, 20,170,354 parameters, 0 gradients, 68.4 GFLOPs
val: Fast image access  (ping: 0.00.0 ms, read: 713.9422.1 MB/s, size: 628.8 KB)
val: Scanning D:\ia4devs\module_05\05_hackaton\data\dataset\aws\test\labels.cache...
        1327 images, 0 backgrounds, 0 corr
                           Class Images Instances    Box(P          R     mAP50   mAP50-95): 100%|
        ██████████| 166/166 [00:
                             all   1327      26828    0.958    0.989      0.98        0.957: 100%|
        ██████████| 166/166 [00:
                             ACM     42         42    0.985          1    0.995        0.995
                             ALB    206        292        1      0.989    0.995         0.96
                             AMI     24         39    0.984          1    0.995        0.995
                     API-Gateway    707       1063    0.973          1    0.995         0.98
        Active Directory Service     29         29     0.98          1    0.995        0.995
                        Airflow_     15         30     0.98          1    0.995        0.988
                         Amplify     76         76    0.994          1    0.995        0.925
              Analytics Services     15         15    0.961          1    0.995        0.995
                         AppFlow     15         15     0.96          1    0.995        0.995
                         Appsync     50         50    0.989          1    0.995        0.857
                          Athena    133        141    0.914          1    0.995        0.979
                          Aurora     79        112    0.994      0.964    0.978        0.975
                    Auto Scaling    126        211    0.999          1    0.995        0.949
              Auto Scaling Group     25         58     0.99          1    0.995        0.931
                 Automated Tests     58         89    0.993          1    0.995        0.974
               Availability Zone     23         46    0.987          1    0.995        0.995
                          Backup     16         32    0.981          1    0.995        0.995
               Build Environment     34         34    0.979          1    0.995        0.852
                             CDN     21         21    0.971          1    0.995        0.983
                             CUR     35         35    0.984          1    0.995        0.865
                    Call Metrics     15         15    0.961          1    0.995        0.995
                 Call Recordings     15         15    0.961          1    0.995        0.921
             Certificate Manager    103        103    0.994          1    0.995        0.995
                          Client     16         61      0.5          1    0.616        0.562
                 Cloud Connector     14         28    0.978          1    0.995        0.974
                       Cloud Map     15         15    0.908          1    0.995        0.995
                    Cloud Search     48         48    0.987          1    0.995        0.993
                     Cloud Trail    140        142    0.995          1    0.995        0.988
                     Cloud Watch    468        566    0.999          1    0.995        0.972
           CloudFormation Stack     124        138    0.995          1    0.995        0.994
                        CloudHSM     33         33    0.981          1    0.995        0.995
                CloudWatch Alarm     75        106    0.994          1    0.995        0.954
                      Cloudfront    346        366    0.941          1    0.995        0.975
                       CodeBuild    140        208    0.997          1    0.995        0.978
                      CodeCommit     52         66    0.991          1    0.995        0.994
                      CodeDeploy     13         13    0.949          1    0.995         0.99
                    CodePipeline    183        190    0.851          1    0.992        0.956
                         Cognito    310        354    0.893      0.992    0.989        0.977
                      Comprehend     73         73    0.992          1    0.995        0.995
                          Config     72        147    0.995      0.898     0.99        0.966
                         Connect     15         15        1          1    0.995        0.995
            Connect Contact Lens     15         15    0.961          1    0.995        0.995
                       Container     86        403    0.994          1    0.995         0.95
                   Control Tower     14         14    0.958          1    0.995        0.995
```

Customer Gateway	35	62	0.99	1	0.995	0.974
DSI	31	62	0.991	1	0.995	0.888
Data Pipeline	22	22	0.972	1	0.995	0.995
DataSync	30	30	1	1	0.995	0.995
Deploy Stage	27	27	0.978	1	0.995	0.873
Detective	15	15	0.961	1	0.995	0.995
Direct Connect	77	112	0.994	0.991	0.995	0.972
Distribution	15	15	0.855	0.333	0.888	0.888
Docker Image	44	174	0.977	0.983	0.989	0.891
Dynamo DB	619	958	0.976	0.992	0.995	0.971
EBS	65	107	0.995	0.991	0.995	0.95
EC2	609	1692	0.982	0.994	0.994	0.967
EFS	90	116	0.991	0.971	0.988	0.983
EFS Mount Target	95	128	1	0.974	0.984	0.971
EKS	147	164	0.995	1	0.995	0.981
ELB	379	521	0.981	0.964	0.975	0.96
EMR	15	15	1	1	0.995	0.995
Edge Location	15	27	0.977	1	0.995	0.967
ElastiCache	101	121	0.993	0.983	0.99	0.978
Elastic Container Registry	212	212	0.998	1	0.995	0.98
Elastic Container Service	236	302	0.918	1	0.995	0.937
Elastic Search	116	117	0.995	1	0.995	0.962
Elemental MediaConvert	49	64	0.965	0.797	0.965	0.965
Elemental MediaPackage	15	15	0.493	1	0.568	0.568
Email	29	29	1	0.987	0.995	0.986
Endpoint	22	22	0.974	1	0.995	0.942
Event Bus	15	15	0.96	1	0.995	0.995
EventBridge	41	101	0.994	1	0.995	0.992
Experiment Duration	14	14	0.512	1	0.642	0.634
Experiments	14	14	0.511	1	0.647	0.647
Fargate	180	423	0.992	1	0.995	0.964
Fault Injection Simulator	45	45	0.987	1	0.995	0.957
Firewall Manager	15	15	0.962	1	0.995	0.995
Flask	17	51	0.985	1	0.995	0.882
Flow logs	15	60	0.99	1	0.995	0.946
GameLift	15	15	0.959	1	0.995	0.941
Git	17	17	0.965	1	0.995	0.939
Github	73	90	0.993	1	0.995	0.98
Glacier	15	15	1	1	0.995	0.995
Glue	59	118	0.995	1	0.995	0.967
Glue DataBrew	22	22	0.973	1	0.995	0.995
Grafana	14	14	0.958	1	0.995	0.995
GuardDuty	57	117	0.995	1	0.995	0.984
IAM	180	335	0.911	0.997	0.991	0.967
IAM Role	78	185	0.86	1	0.984	0.903
IOT Core	46	52	1	0.994	0.995	0.995
Image	63	63	0.991	1	0.995	0.914
Image Builder	15	15	0.956	1	0.995	0.995
Ingress	17	17	0.965	1	0.995	0.995
Inspector Agent	15	15	0.961	1	0.995	0.995
Instances	16	32	0.515	0.438	0.589	0.584
Internet	201	272	0.992	0.945	0.993	0.975
Internet Gateway	133	200	0.992	1	0.995	0.942
Jenkins	15	30	0.979	1	0.995	0.995
Key Management Service	111	139	0.995	1	0.995	0.994
Kibana	18	18	0.967	1	0.995	0.932
Kinesis Data Streams	156	207	1	0.989	0.995	0.99
Kubernetes	17	17	0.967	1	0.995	0.995
Lambda	830	2220	0.974	1	0.995	0.982
Lex	18	18	0.967	1	0.995	0.995
MQ	34	86	0.993	1	0.995	0.974
Machine Learning	47	47	0.803	1	0.979	0.976

Macie	56	119	0.995	1	0.995	0.985
Marketplace	19	19	0.972	1	0.995	0.689
Memcached	11	22	0.973	1	0.995	0.967
Mobile Client	150	196	0.995	0.996	0.995	0.942
Mongo DB	26	62	0.99	1	0.995	0.903
MySQL	15	15	0.961	1	0.995	0.986
NAT Gateway	147	293	0.999	0.99	0.995	0.988
Neptune	35	35	0.973	1	0.995	0.755
Network Adapter	15	15	0.96	1	0.995	0.995
Network Firewall	15	15	1	1	0.995	0.995
Notebook	15	15	0.961	1	0.995	0.995
Order Controller	17	17	0.924	1	0.995	0.995
Organization Trail	26	71	0.992	1	0.995	0.977
Parameter Store	27	27	0.978	1	0.995	0.995
Pinpoint	16	16	0.963	1	0.995	0.995
PostgreSQL	15	15	0.961	1	0.995	0.957
Private Link	87	87	0.983	1	0.995	0.995
Private Subnet	335	936	0.983	0.981	0.987	0.926
Prometheus	14	14	0.958	1	0.995	0.995
Public Subnet	299	715	0.999	0.992	0.995	0.925
Quarkus	14	14	0.958	1	0.995	0.995
Quicksight	40	50	0.988	1	0.995	0.995
RDS	266	551	0.984	0.985	0.984	0.967
React	15	15	0.961	1	0.995	0.96
Redis	47	98	1	0.996	0.995	0.989
Redshift	65	72	0.991	1	0.995	0.995
Region	161	243	0.997	1	0.995	0.931
Rekognition	37	37	0.984	1	0.995	0.995
Results	14	14	0.509	1	0.572	0.572
Route 53	39	39	0.96	1	0.995	0.995
Route53	376	532	0.997	0.998	0.995	0.979
S3	867	1862	0.957	0.991	0.994	0.971
SAR	14	14	0.957	1	0.995	0.995
SDK	98	301	0.991	0.963	0.993	0.976
SES	69	84	0.993	0.988	0.994	0.988
SNS	232	254	0.999	1	0.995	0.99
SQS	184	197	0.997	1	0.995	0.981
SSM Agent	15	15	0.961	1	0.995	0.995
Sagemaker	76	241	0.746	0.986	0.951	0.819
Secret Manager	44	44	0.986	1	0.995	0.995
Security Group	16	16	0.963	1	0.995	0.985
Security Hub	25	85	0.994	1	0.995	0.989
Server	88	165	0.996	1	0.995	0.952
Service Catalog	30	72	0.992	1	0.995	0.977
Shield	52	52	0.988	1	0.995	0.995
Sign-On	15	15	0.96	1	0.995	0.995
Slack	30	30	0.98	1	0.995	0.995
Snowball	15	15	0.961	1	0.995	0.995
Stack	14	14	1	1	0.995	0.991
Step Function	30	90	0.993	1	0.995	0.926
Storage Gateway	15	15	0.96	1	0.995	0.995
SwaggerHub	15	15	0.96	1	0.995	0.995
Systems Manager	53	68	0.991	1	0.995	0.995
TV	12	12	0.957	1	0.995	0.97
Table	72	154	0.993	1	0.995	0.952
Task Runner	17	17	1	1	0.995	0.995
Terraform	38	38	0.984	1	0.995	0.994
Text File	49	99	0.913	1	0.975	0.965
Textract	14	14	0.957	1	0.995	0.995
Transcribe	19	19	0.968	1	0.995	0.995
Transfer Family	67	67	0.991	1	0.995	0.988
Transit Gateway	31	31	0.96	1	0.995	0.992

```
                  Translate      53         53     0.988        1     0.995       0.995
            Trusted Advisor      13         13     0.956        1     0.995        0.99
                     Twilio      18         18     0.967        1     0.995       0.995
                      Users     486        656     0.999    0.991     0.995        0.96
                        VDA      14         14     0.958        1     0.995       0.995
                 VP Gateway      27         39         1    0.992     0.995       0.957
                 VPC Router      39         80     0.992        1     0.995       0.962
             VPN Connection      21         48     0.989        1     0.995       0.993
                        WAF      99        109     0.994        1     0.995       0.992
                Web Clients     202        268      0.83        1     0.973       0.917
                   Websites      34         34     0.981        1     0.995       0.995
                      X-Ray      88        112     0.992        1     0.995       0.994
                        aws     845       1067     0.991    0.998     0.994        0.94
               cache Worker      26         26     0.977        1     0.995       0.995
Speed: 0.2ms preprocess, 8.5ms inference, 0.0ms loss, 0.8ms postprocess per image
Saving C:\acmattos\dev\tools\Python\ia4devs\runs\detect\val\predictions.json...
Results saved to C:\acmattos\dev\tools\Python\ia4devs\runs\detect\val

🎯 Test Metrics (mean per class):
  Precision:    0.958
  Recall:       0.989
  mAP@0.5:      0.980
  mAP@0.5:0.95: 0.957

image 1/1 D:\ia4devs\module_05\05_hackaton\data\sample\aws_02.png: 576x640
3 ALBs, 1 Auto Scaling, 1 Cloud Trail, 1 Cloud Watch, 1 Cloudfront, 4 EC2s,
3 Private Subnets, 3 Public Subnets, 2 RDSs, 1 Region, 1 S3, 1 SES, 1 Users,
2 WAFs, 1 aws, 50.6ms
Speed: 3.2ms preprocess, 50.6ms inference, 3.6ms postprocess per image at shape (1,
        3, 576, 640)
Results saved to C:\acmattos\dev\tools\Python\ia4devs\runs\detect\predict
1 label saved to C:\acmattos\dev\tools\Python\ia4devs\runs\detect\predict\labels
✅ Detailed JSON saved to data\reports\yolo11m_custom_100\results.json
✅ Summary JSON saved to data\reports\yolo11m_custom_100\report.json
[ultralytics.engine.results.Results object with attributes:

boxes: ultralytics.engine.results.Boxes object
keypoints: None
masks: None
(...)
obb: None
(...)
orig_shape: (993, 1167)
path: 'D:\\ia4devs\\module_05\\05_hackaton\\data\\sample\\aws_02.png'
probs: None
save_dir: 'C:\\acmattos\\dev\\tools\\Python\\ia4devs\\runs\\detect\\predict'
speed: {'preprocess': 3.1897000153549016, 'inference': 50.62539997743443,
        'postprocess': 3.644100041128695}]
████████████████████████████████ 100% | 38.90/38.9 MB [01:27<00:00,  2.24s/MB]:
```

Predição do Yolo 11 - Modelo `M`



Detecção do Modelo M

🎯 Métricas Médias de Teste por Classe

Métrica	Modelo N	Modelo S	Modelo M
Precision	0.957	0.960	0.958
Recall	0.992	0.996	0.989
mAP@0.5	0.979	0.980	0.980
mAP@0.5:0.95	0.911	0.950	0.957

- **Nano (N)**: Extremamente leve, mantém Precision/Recall/mAP@0.5 quase iguais aos demais, mas tem mAP@0.5:0.95 mais baixo (0.911), ou seja, caixas um pouco menos precisas.

- **Small (S)**: Bom equilíbrio: maior Precision/Recall, mAP@0.5 e um mAP@0.5:0.95 sólido (0.950). Ótima escolha geral para baixa latência com boa exatidão.
- **Medium (M)**: Caixa mais refinada (mAP@0.5:0.95 de 0.957), com Precision/Recall/mAP@0.5 no mesmo patamar de S, mas exige mais recursos.

Com base nos testes, decidimos utilizar o modelo `S` em nosso projeto, visando o melhor desempenho com o menor gasto em recursos (disco e tempo de processamento).

Geração de Relatórios de Ameaças STRIDE

Para fazer a geração de relatórios de ameaças STRIDE, usando os modelos treinado, basta ajustar a variável abaixo:

```
trained_dir_name: str = "yolo11@_custom_100"
```

onde `@ = n, s, m`. Depois, execute a chamada a seguir:

```
py report_generator_test.py
```

Os relatórios podem ser encontrados aqui. E o resultado da execução do script pode ser visto abaixo:

```
image 1/1 D:\ia4devs\module_05\05_hackaton\data\sample\aws_01.jpg: 544x640
1 Cloud Watch, 1 Dynamo DB, 1 Event Bus, 5 Lambdas, 1 S3, 3 SNSs, 1 Users, 1 aws,
        46.0ms
Speed: 6.2ms preprocess, 46.0ms inference, 154.7ms postprocess per image at shape (1,
        3, 544, 640)
Results saved to C:\acmattos\dev\tools\Python\ia4devs\runs\detect\predict
1 label saved to C:\acmattos\dev\tools\Python\ia4devs\runs\detect\predict\labels
✅ Detailed JSON saved to data\reports\yolo11s_custom_100\results.json
✅ Summary JSON saved to data\reports\yolo11s_custom_100\report.json
Reports generated: data/reports/yolo11s_custom_100
```

Nosso gerador cria duas versões de relatório por análise: uma em Markdown e outra em HTML.

As ameaças STRIDE estão definidas aqui. Baseado nestas definições, nosso script é capaz de categorizar e gerar o relatório para um diagrama de arquitetura AWS informado.

Aplicação Demo

Uma aplicação simples foi elaborada para demonstrar as funcionalidades desejadas para a realização deste trabalho. Ela é baseada no Streamlit e funciona da seguinte maneira:

```
streamlit run app.py
```

Após executar a chamada acima, o browser deve abrir expondo a aplicação exemplo:

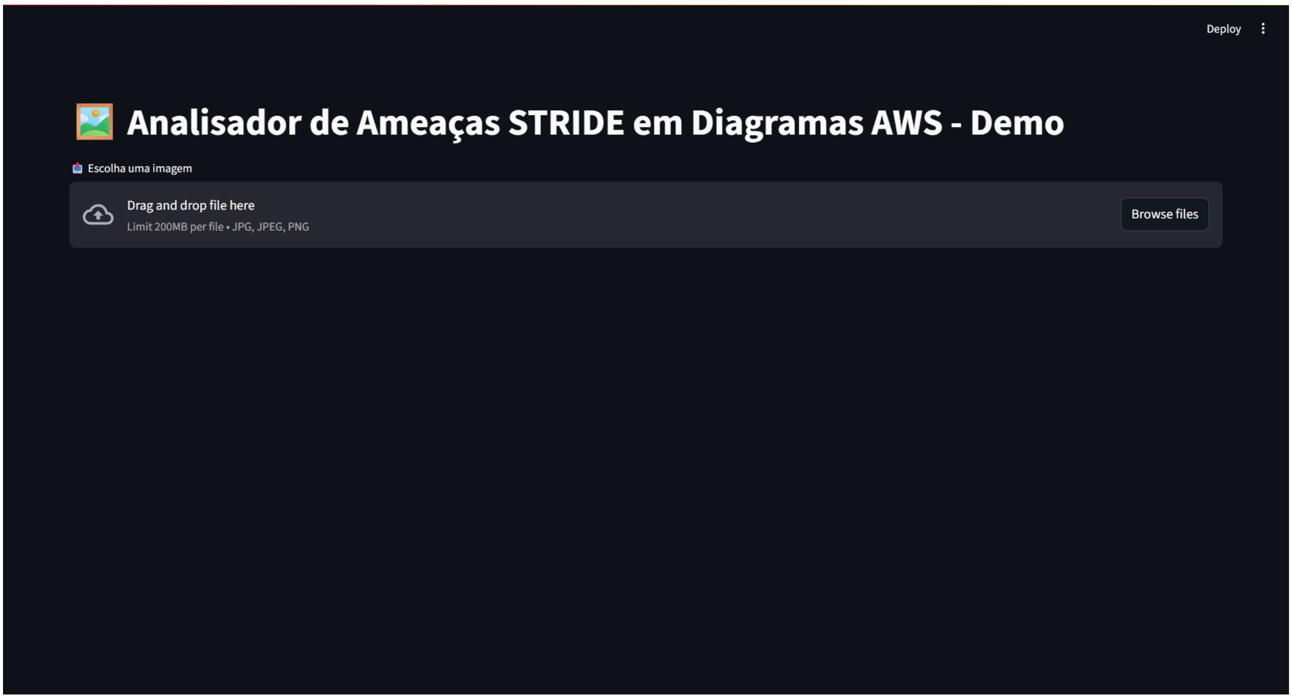


Imagem Inicial

Vamos utilizar este arquivo exemplo de arquitetura AWS. Após submetermos o arquivo exemplo para análise, vemos que a aplicação permite executar a detecção de componentes:

Imagem Detecção

Ao clicar no botão `Executar detecção`, os componentes da arquitetura são detectados pelo modelo treinado, conforme visto abaixo:

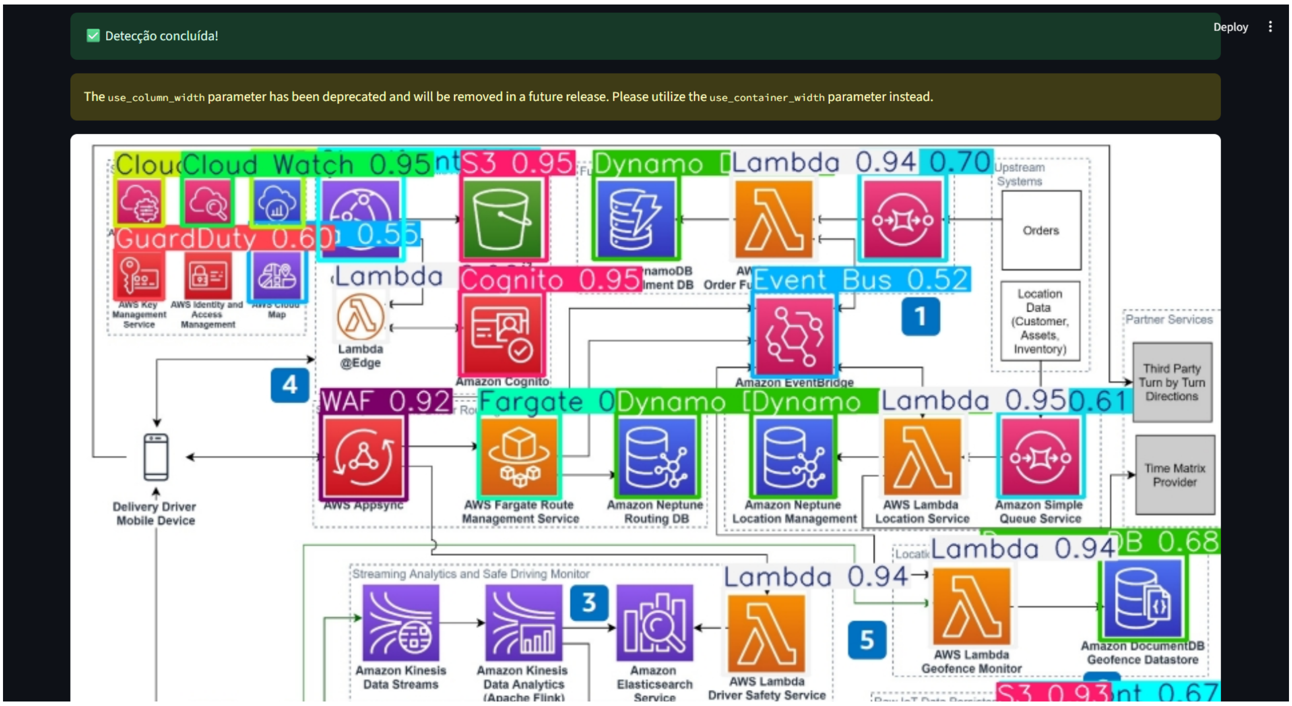


Imagem Detectado

Rolando a página, podemos ver o relatório gerado pela aplicação exemplo:

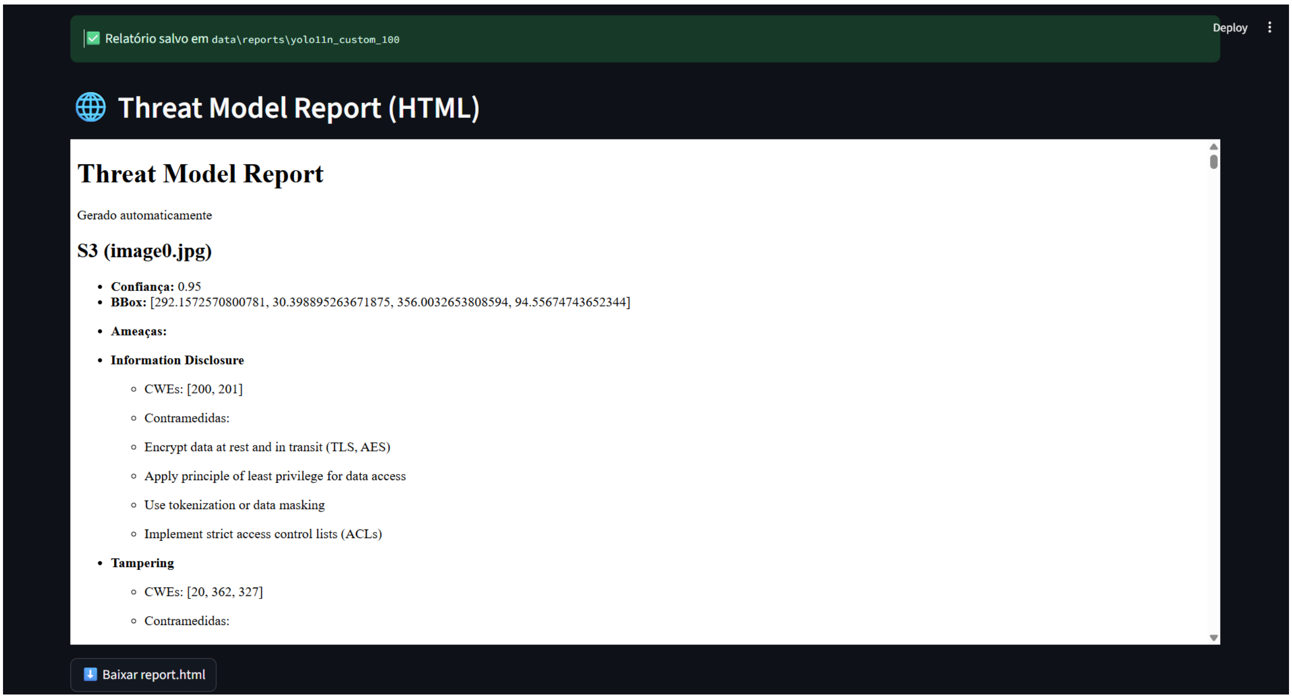


Imagem Relatório

O relatório apresentado reporta os componentes da arquitetura detectados, as ameaças STRIDE correspondentes e suas respectivas contramedidas.

Estratégia de RAG Para Aplicação Demo

Para tornar a análise de ameaças STRIDE mais contextual e precisa, foi implementado um pipeline de **RAG (Retrieval-Augmented Generation)**. A ideia é combinar um modelo de linguagem local (LLM) com uma base vetorial de conhecimento sobre segurança e STRIDE.

Essa estratégia foi considerada apenas na aplicação Demo como mais um estudo de caso de possível solução para o report.

Como funciona:

1. Indexação

O script `create-stride-rag-faiss.py` é responsável por preparar a base de conhecimento que será usada pelo sistema RAG (Retrieval-Augmented Generation). Ele realiza as seguintes etapas:

- 📂 **Leitura dos documentos PDF**
  Todos os arquivos na pasta `./STRIDE-PDF/` são carregados. Esses arquivos contêm informações técnicas sobre modelagem de ameaças com STRIDE, recomendações da OWASP, boas práticas da AWS, entre outros temas relacionados à segurança de arquiteturas em nuvem.

- ✂️ **Divisão em chunks**
  Cada documento é segmentado em trechos menores (também chamados de *chunks*), usando uma estratégia de separação por número de tokens com sobreposição (`RecursiveCharacterTextSplitter`). Isso melhora a granularidade na busca e evita perda de contexto em trechos longos.

- 🔡 **Geração de embeddings**
  Cada chunk de texto é convertido em um vetor numérico (embedding) usando o modelo `"all-MiniLM-L6-v2"` da `SentenceTransformers`. Esse modelo é leve, rápido e fornece boa qualidade para recuperação semântica de textos técnicos.

- 🧠 **Criação do índice FAISS**
  Os embeddings são armazenados localmente utilizando o **FAISS**, uma biblioteca de indexação vetorial otimizada para busca rápida por similaridade. O índice permite que, mais tarde, quando o usuário envie um conjunto de componentes (ex: “S3”, “Lambda”, “IAM”), o sistema recupere os trechos mais relevantes desses documentos que tratam dos riscos associados a esses serviços.

- 💾 **Armazenamento local**
  O índice final é salvo no diretório `./FAISS/`, e pode ser recarregado dinamicamente pela aplicação durante o uso. Esse processo garante que o sistema tenha uma **base vetorial eficiente e contextual** para embasar a geração dos pareceres técnicos via LLM, mesmo em ambiente local e offline.

1. **Consulta com LLM local**
   Durante a execução da aplicação, o script `stride_rag_runner.py` recebe a lista de componentes detectados no diagrama e utiliza um modelo LLM local, conectado via **Ollama**, para elaborar um relatório técnico contextualizado com base nos dados recuperados do índice FAISS.

Imagem Relatório

1. **Relatório Técnico com STRIDE**
   O modelo gera automaticamente um relatório com os possíveis riscos categorizados por tipo de ameaça STRIDE (Spoofing, Tampering, Repudiation, etc.), explicando cada caso e sugerindo formas de mitigação.

Imagem Relatório

1. Ao final é exibido a fonte consultada:

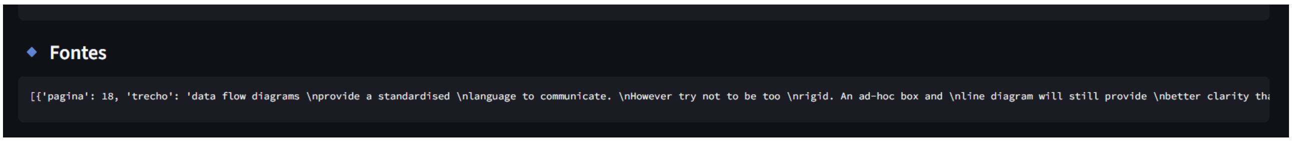


Imagem Relatório

Requisitos

Para que o modelo funcione corretamente:

- Instale o **Ollama** em sua máquina:
  👉 [Download Ollama para Windows]
- Execute o servidor com o modelo desejado, por exemplo:
  ```bash ollama run mistral

Obs.: A aplicação demo funcionará sem o RAG caso o Ollama não seja instalado.

## Estratégia de RAG Para Aplicação Demo

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  ```

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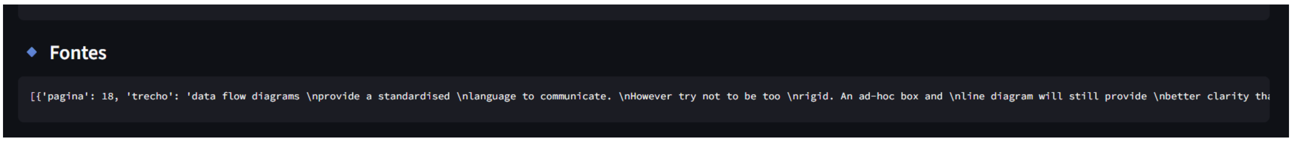

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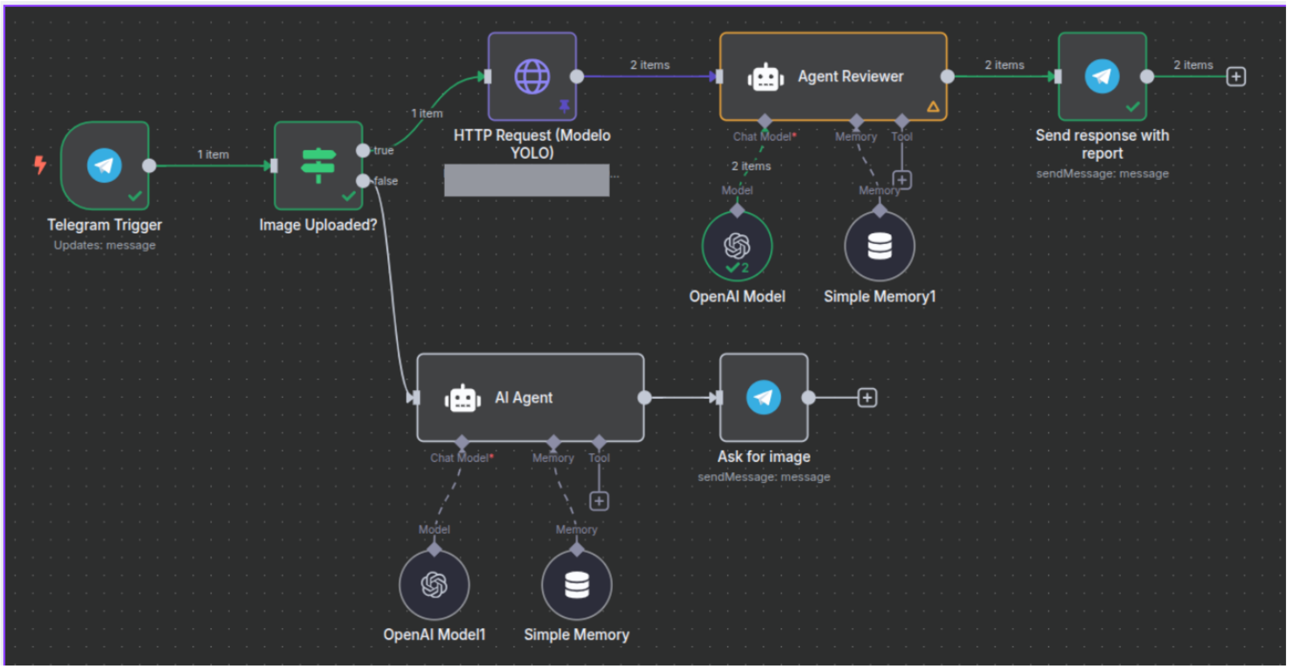
  ```bash ollama run mistral

Obs.: A aplicação demo funcionará sem o RAG caso o Ollama não seja instalado.
  ```

Arch Wise - Agente de feedback de arquitetura

Agente de Arch Wise

Um agente de feedback foi desenvolvido para utilização do modelo YOLO 11 (small) treinado para avaliar diagramas de arquitetura AWS. Este agente é capaz de receber um diagrama por meio do Telegram, enviar para o modelo treinado e por fim, enviar o resultado de volta para o usuário do Telegram. Esta solução foi desenvolvida utilizando uma API escrita em Flask e hospedada num Droplet da Digital Ocean.

Arquitetura



Arquitetura do workflow do N8N

A arquitetura do agente de feedback é composta por quatro componentes principais:

- **API**: API escrita em Flask que recebe o diagrama do usuário e envia para o modelo treinado.
- **Modelo**: Modelo YOLO 11 (small) treinado para detecção de componentes de arquitetura AWS.
- **Telegram**: Interface com o usuário via Telegram.
- **N8N**: Workflow de automação, responsável por orquestrar todas as etapas deste agente.

API

A API é responsável por receber o diagrama do usuário e enviar para o modelo treinado, que está sendo chamado através da API Flask. Este endpoint é chamado como um dos passos do workflow de automação do N8N.

Definições da API:

- **Endpoint**: `/architecture-detect`
- **Método**: `POST`
- **Body**: `image` (base64), `chat_details` (json)
- **Response**: `json`

O body da requisição é composto por:

- `image`: base64 da imagem do diagrama de arquitetura AWS.

- `chat_details`: detalhes do chat do usuário, incluindo o ID do chat e o ID do usuário.

O response da requisição é composto por:

- `status`: status da requisição:
    - `201`: sucesso.
    - `400`: erro de requisição.
    - `500`: erro interno do servidor.
- `message`: mensagem de resposta.
- `markdown_report`: relatório de ameaças STRIDE em formato Markdown.

Modelo

O modelo YOLO 11 (small) treinado para detecção de componentes de arquitetura AWS é responsável por receber o diagrama do usuário e enviar e gerar um relatório de ameaças STRIDE em formato Markdown.

Agent Reviewer

Este agente faz parte de um dos passos do workflow do N8N. Ele é responsável por receber o relatório de ameaças STRIDE, realizar uma análise que incluí os seguintes pontos do relatório gerado pelo modelo YOLO 11:

- **Ameaças**: Ameaças STRIDE encontradas no diagrama.
- **Overview de Arquitetura**: Overview de arquitetura AWS, com os componentes detectados e suas respectivas ameaças STRIDE.
- **Matrix de Ameaças**: Matrix de ameaças, com uma lista de ameaças divididas por impacto, risco e categoria.
- **Recomendações de priorização**: Recomendações para melhoria da arquitetura, baseadas no nível do risco que cada ameaça representa.
- **Possível roadmap de melhoria**: Possível roadmap de melhoria da arquitetura, criando um planejamento e plano de ação de acordo com as recomendações de priorização.
- **Próximos passos**: Com as ameçadas identificadas, o agente deve sugerir os próximos passos para desenvolvimento da estratégia de mitigação.

Telegram

Um bot foi criado para permitir a interação entre o agente e o usuário. Este bot é responsável por receber as mensagens do usuário, imagens de diagramas de arquitetura AWS e enviar para o agente de feedback.

N8N

O N8N é responsável por orquestrar todas as etapas deste agente. As etapas são:

- **Receber mensagem do usuário enviada no Telegram**: O N8N recebe a mensagem do usuário e verifica se é uma imagem de diagrama de arquitetura AWS.
- **Enviar imagem para o modelo**: O N8N envia a imagem para o modelo YOLO 11 (small) treinado para detecção de componentes de arquitetura AWS, via endpoint da API.
- **Receber relatório do modelo**: O N8N recebe o relatório de ameaças STRIDE em formato Markdown do modelo YOLO 11 (small) treinado para detecção de componentes de arquitetura AWS.
- **Enviar relatório para o agente de review**: O N8N envia o relatório de ameaças STRIDE em formato Markdown para o agente de review.
- **Relatório melhorado**: O agente de review realiza uma análise do relatório gerado pelo modelo YOLO 11 (small) e gera um relatório melhorado, com base nos pontos mencionados anteriormente.
- **Enviar relatório para o usuário**: O N8N envia final, gerado pelo agente de review, para o usuário.

Testar o agente: Caso queira testar o agente, basta enviar uma mensagem para o bot do Telegram **bot_arch_wise** com o comando `/start`.