AI Factory Austria AI:AT

Modern Computer Vision & Knowledge Distillation Day 2: Hands-On Lab

Shaping the Future of AI

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Day 1 Recap: The Four Pillars

The Four Pillars (Recap)

1. CLIP

- Text and images in the same embedding space. 400M image-caption pairs trained two encoders to agree.

2. Vision Transformers

- Chop image into patches. Every patch talks to every other patch in one step. No more drinking straw & narrow receptive field.

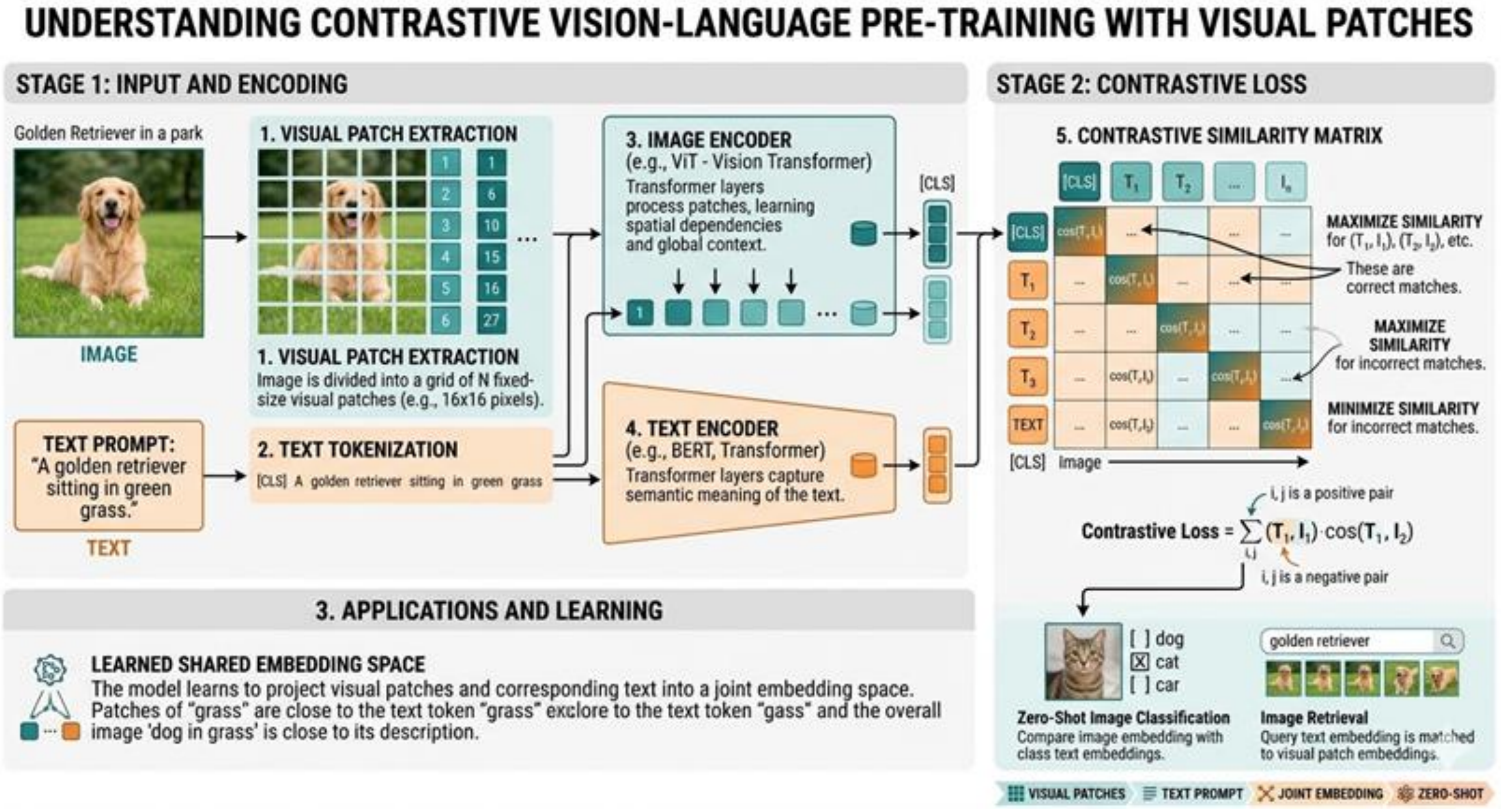
3. Open Vocabulary Detection

- Dense grid of vectors over the image. Match your text query at every position. Text becomes bounding boxes.

4. Distillation

- Big slow teacher labels data. Small fast student learns from those labels (OR, probability distributions).

CLIP - Contrastive Image-Language Pretraining



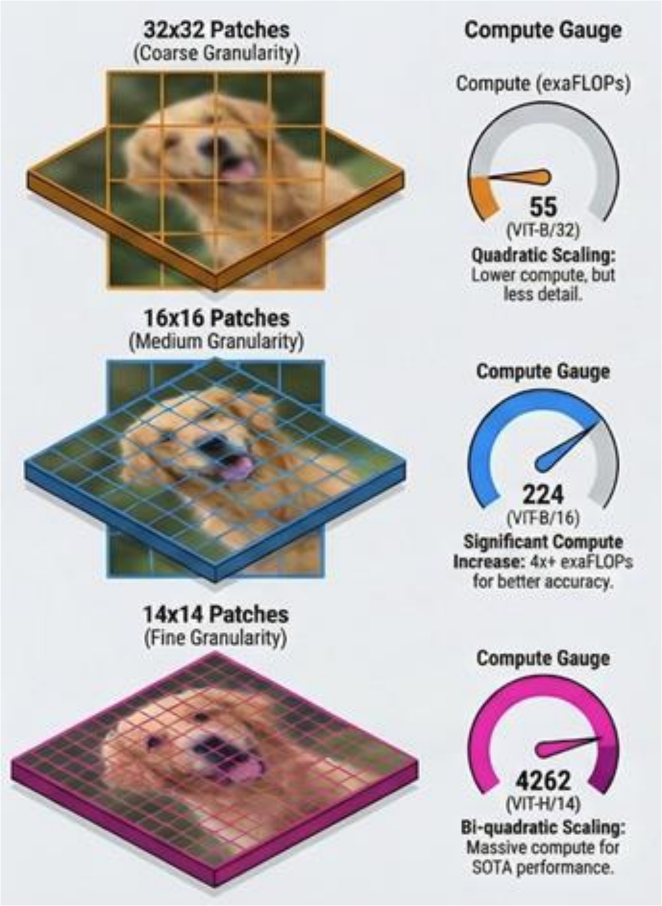
CNN vs ViT in Practice

"Is this a bottle or a cap?"

- CNN approach:
- pixels → edges → shapes → cylinder → bottle → yes
- 50 layers of local processing

- ViT approach:
- [bottle patch] ←— attention —→ [cap patch]
- One attention step. Sees both at once.

- The tradeoff:
- ViTs are data-hungry. No built-in spatial bias.
- CLIP's 400M pairs was the breakthrough.



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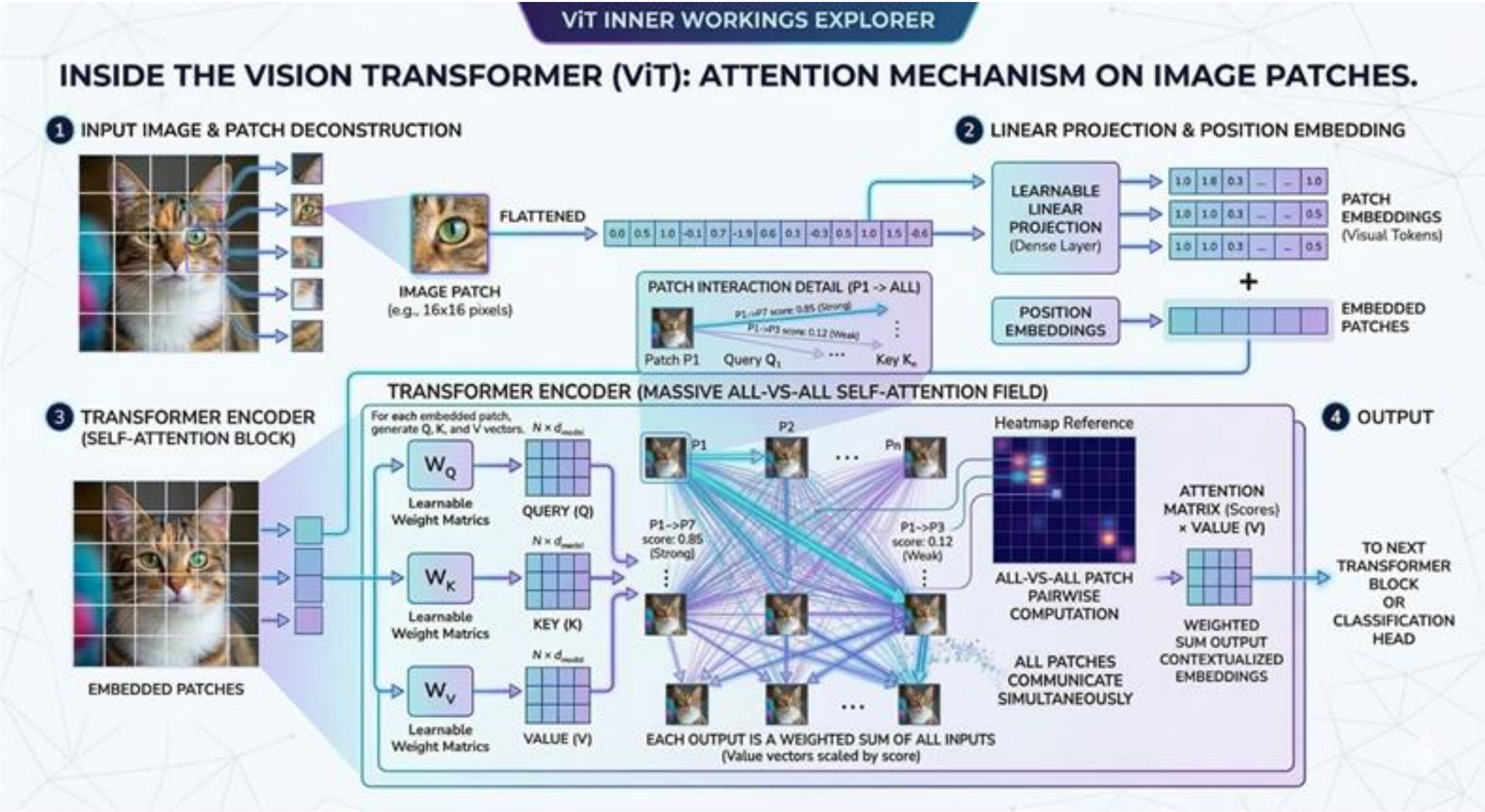
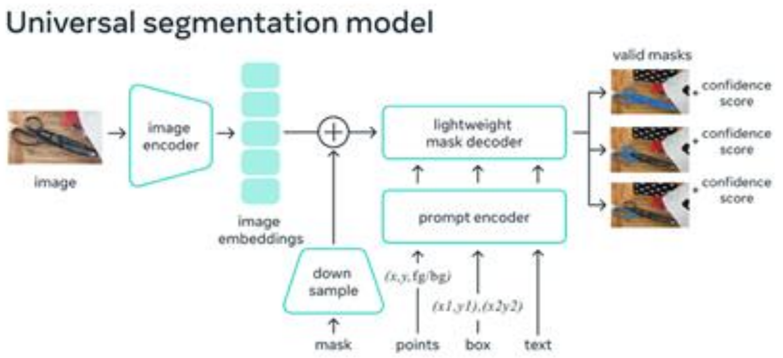


From "What" to "Where"

How SAM3 works: text prompt becomes bounding box



The problem:

- CLIP tells me WHAT is in the image.
- But I need WHERE. I need bounding boxes.

The solution:

- Instead of ONE vector per image...
- create a DENSE GRID of vectors. (basically just the ViT approach)
- One vector at every spatial position.

Like a chessboard - every square has its own fingerprint.

Embedding similarity is the key: https://huggingface.co/spaces/webml-community/dinov3-web

The Key Insight

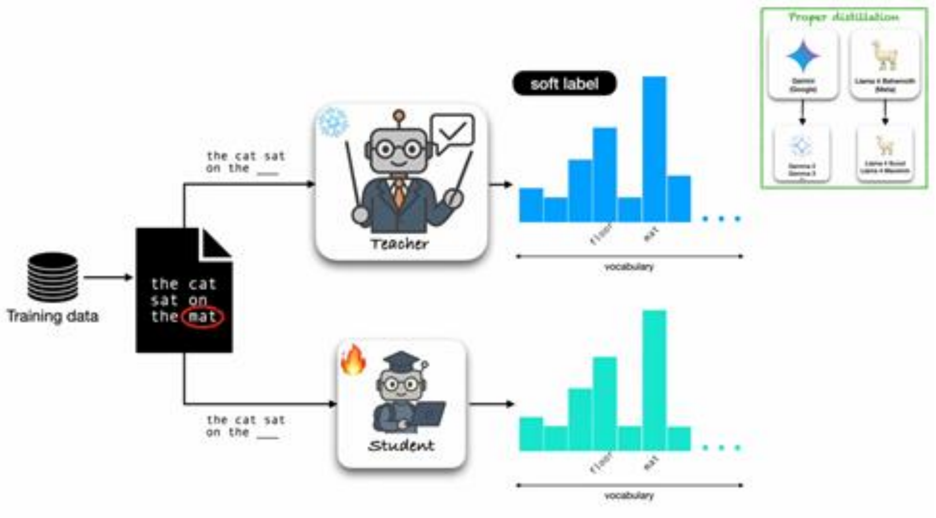
Annotation IS Distillation

Manual annotation:

- Human looks at image, draws box, writes label
- The human brain is the teacher model

Foundation model annotation:

- SAM3 looks at image, draws box, writes label
- 400M image-text pairs is the teacher's education

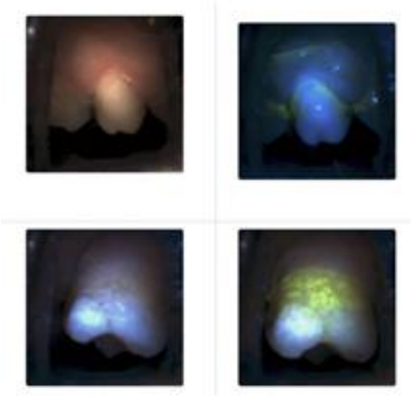


What Actually Goes Wrong (And How We Fix It Today)

The Data Problem Nobody Budgeted For

Pitfall 1: The Annotation Treadmill

- Hardware gen 1 → Collect → Annotate → Train → Ship ✓
- Hardware gen 2 → New sensor → 40% labels stale → Re-annotate
- Hardware gen 3 → New optics → 60% labels stale → Re-annotate
- Hardware gen 4 → ...



- Each cycle: $50K+ and 3-4 months
- The model was fine.
- The data pipeline was the bottleneck.

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Pitfall 1: The Annotation Treadmill

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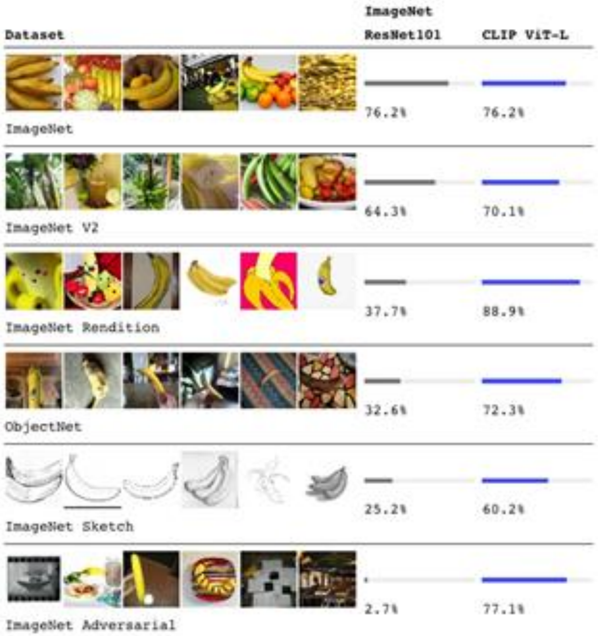
- The model was fine.
- The data pipeline was the bottleneck.

- **Fix:**
  - **Use heavy data augmentation to inject priors**
  - **Generate synthetic data**
  - **Try fine tuning foundation-level models for more stable features, allowing for faster re-annotation cycles**
    - Reminder from Day 1 about better of open vocabulary models generalizability →

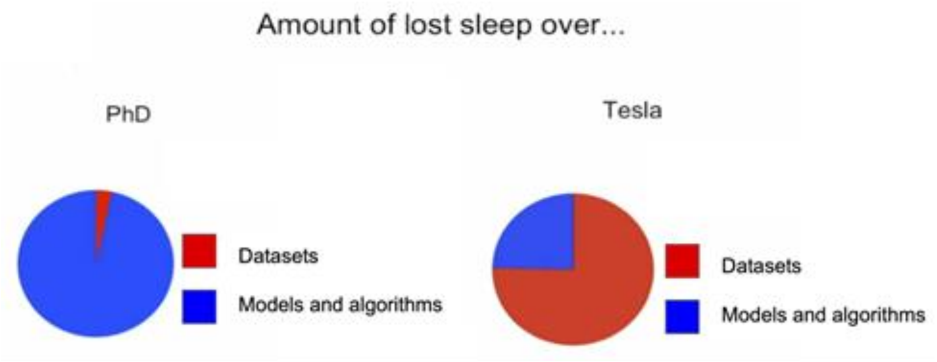


"Just Use a Better Model"

Pitfall 2: Model-Centric Thinking

The instinct when accuracy drops:

- → Try YOLOv26 instead of v11
- → Larger model variant
- → Tune hyperparameters for 2 weeks



What actually moves the needle:

- → Fix 200 mislabeled images +3 mAP
- → Remove ambiguous objects +2 mAP
- → 500 targeted images for hard class +5 mAP
- → Right prompt for auto-labeling +15 mAP

"Just Use a Better Model"

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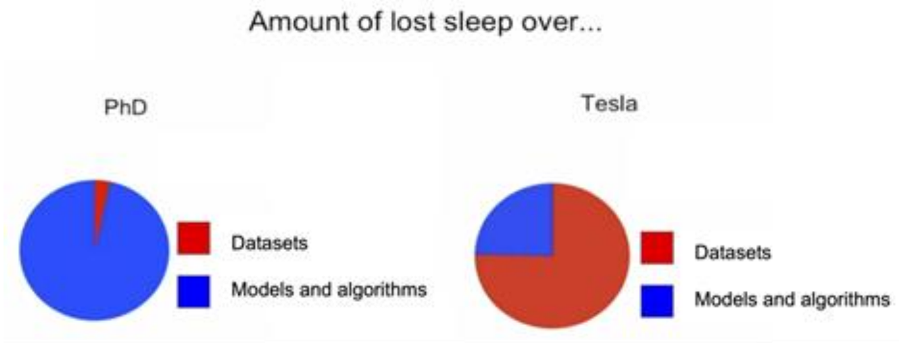

Fix:

- **No shortcuts, look at the data**
- **Uniqueness / Mistakeness metrics help**
- **Visualize your failures and your good cases, think why they occur**

"Works in the Notebook"

Pitfall 3: The Deployment Gap

Your dev setup:

- A100 GPU • 80GB VRAM • unlimited power

Your deployment target:

- Jetson Orin Nano • 8GB • 15W • <50ms latency

- SAM3: 2.9B params | ~200ms on A40
- YOLO26: 2.4M params | ~1.7ms on T4

- That's 1,200× smaller.
- You don't deploy the teacher. You distill it.

"Works in the Notebook"

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Fix:

- **Requirements, requirements, requirements**
- **…or is it?**

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- **Requirements, requirements, requirements**
- **…or is it?**
- **Thinking outside the box, stakeholder management, holistic usecase & business thinking**

Today's Challenge

Your challenge today:

You have been contracted to develop a system evaluating the worksite safety compliance of workers, i.e. What is the percentage of workers wearing hard hats?

1. Generate the synthetic data
   a. Done
2. Inspect it, think about it, try out different prompts, strategies of how you will approach the problem
   a. Experiment with SAM3, Qwen3.5, YOLOE26
3. Auto-annotate the data
   a. Inspect the annotations, think about the fail cases, are you happy
4. Train a model & evaluate its performance
   a. Bonus points: deploy / measure throughput / latency

Let’s Build