Minimal rebuild plan (merged and fortified)

This is your merged, dependency-ordered rebuild plan with all missing safeguards embedded. It preserves your original structure and folds in strict alignment artifacts, standardized calibration.json, backbone guards, smoke-test gates, ONNX + latency benchmarks, and saved NegL configs. I'︀ve kept it bilingual where clarity helps.

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0. Global foundations and integrity gates

- Canonical index & alignment（索引與對齊）: Freeze the dataset index (e.g., AUGMENTED ixNextAffFull). For every teacher softlabel export, run and save strict alignment artifacts.

  - Artifacts: alignmentreport.json, classorder.json, hashmanifest.json, samplecount.txt.

  - Abort rule: If class order or sample counts differ, training hard-fails.

- Provenance & manifests（可追溯性）: Each experiment dir must include args.json, classes.json, calibration.json, reliability_metrics.json, seed.txt.

- Backbone consistency（骨幹守門）: Standardize students to timm mobilenetv3large100; refuse loading checkpoints with <60% parameter match.

  - Artifacts: backboneguard.json with paramcountmatch, layerdiffs, pass/fail.

- DKD correctness（DKD 正確性）: Confirm T^2 applies only to KL terms, not CE; add a gradient magnitude unit test.

  - Artifacts: dkdunittest.json with gradient checks and pass/fail.

- Seed replication（多種子）: Use seeds 1337, 2025, 42; record mean/std and CI in resultssummarystudents.csv.

- Calibration policy（校準規則）: Lexicographic selection: min NLL $\rightarrow$ min ECE $\rightarrow$ max macro-F1. Store T^* in calibration.json (standard schema below).

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1. Teachers (single) for KD/DKD

- Minimum set（最小教師集）: RN18, EfficientNet-B3, ConvNeXt-Tiny; RN50 optional; ViT only if needed for split diversity.

- Softlabels @ T=2（軟標籤導出）: Export per-teacher probabilities at $T=2$ with canonical class order and index suffix (ixNextAffFull).

- Reliability sweep（可靠性掃描）: Temperature grid; record NLL, ECE, Brier, macro-F1; select T^*.

- Ensemble-ready metadata（集成輔助）: Per-class F1 and confusion matrices to guide NegL complementary labels.

- Embedded safeguards（嵌入守門）:

   - Strict alignment artifacts: alignmentreport.json, classorder.json, hash_manifest.json saved in each softlabels/ dir.

   - Teacher calibration finalized: calibration.json with T^* stored for each teacher.

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2. Ensembles (ensumable teachers) for KD/DKD

- Pairwise & four-way splits（配對與四路）:

   - Pairwise: RN18 + B3 with weights 0.7 / 0.3.

   - Four-way: RN18 + ConvNeXt-Tiny + EffB3 + ViT at 0.25 each.

- Split vs fused targets（拆分優先）: Prefer split supervision to preserve diversity; document per-teacher weight and temperature.

- Class-aware weights（按類加權，可選）: Keep a simple per-class skew config if needed.

- Embedded safeguards（嵌入守門）:

    - Ensemble alignment gate: ensemblealignmentgate.json aggregates teacher alignment pass/fail; training blocks if any fail.

    - Config snapshot: ensembleconfig.json with weights, temperatures, classorder hash.

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3. Students (core group only)

- Baseline KD/DKD（基線設定）:

    - KD: $\alpha = 0.5,\ T=2.0$

    - DKD: $\alpha = 0.5,\ \beta \approx 4.0,\ T=2.0$ with T^2 only on KL.

    - Schedule: 20 epochs, batch 128 (adjust for VRAM), AdamW, cosine.

- Backbone lock（骨幹鎖定）: timm mobilenetv3large100; embed class metadata; run backbone_guard.json before training.

- Reliability + calibration（可靠性與校準）: Temperature sweep; store calibration.json and reliability_metrics.json.

- Multi-seed aggregation（多種子彙總）: ≥3 seeds; record mean/std and CI in resultssummarystudents.csv.

- Smoke-test gate（冒煙測試閘）: Run a 3–5 epoch smoke test to catch data/config mismatches before full runs.

    - Artifacts: smoketest.json with class order match, DKD unit test pass, loss curve, gradient finite, backbone guard pass, gono_go = "GO".

4. Real-time demo (manual label, video label, live tuning, detectors)

- Manual labeling UI（標註介面）: Keyboard map + clickable bar; logs per-frame CSV and events CSV.

- Transition-fair scoring（轉場公平）: Min hold ≥600 ms; 250 ms exclusion windows; jitter/min; time-to-lock.

- Runtime tuning（即時調參）: EMA α, hysteresis δ, vote window/min-count hotkeys; emo-ratio overlay.

- Detectors & geometry（偵測與幾何）: YuNet; min-face 96; align eyes; CLAHE; crop-square 224 with margin ~0.30.

- Calibration loading（載入校準）: Auto-load calibration.json; global T^*; optional per-class thresholds in thresholds.json.

- Embedded safeguards（嵌入守門）: Standardize objective scoring; append to demoresultssummary.csv; version per-class thresholds and gentle logit bias configs.

5. NL and NegL on students (KD/DKD)

- NL memory safety（NL 記憶安全）:

  - AMP: autocast + GradScaler.

  - Memory downsizing: dim 32, layers 1.

  - Grad accumulation: ×4 to reach effective batch.

  - KD ramp: $\alpha: 0.3 \rightarrow 0.5$ early epochs.

- Gradient clipping & memory logging.

- NegL design（NegL 設計）：

    - Complementary labels: Guided by teacher confusion matrices (top-k confusions).

    - Class-aware negative ratio: Lower for minority classes to protect recall.

    - Uncertainty gating: Apply only when entropy > τ or max confidence < threshold.

- Phased integration（分階段）：NL+KD smoke → NL full → add NegL → explore NL+NegL+DKD only if stable.

- Embedded safeguards（嵌入守門）：Save neglconfig.json and neglrules.md in VCS; add a tiny NL testbed (few epochs, reduced data) logging memory and grad norms.

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6. Domain adaptation and validation (recommended add-ons)

- Hard-sample mining（困難樣本）：Extract live segments where pred ≠ truth on minority classes; build webcam validation subset.

- Targeted fine-tuning（針對微調）：1–3 epochs with webcam-style augmentations (gamma/exposure, motion blur, sensor noise, JPEG).

- Per-class temperature（按類溫度）：Vector T per class on webcam validation; re-evaluate thresholds after calibration.

- Embedded safeguards（嵌入守門）：Keep a small labeled webcam validation set; log before/after gap closure; stratify by lighting/pose for fairness.

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7. Packaging, safety, and communication

- ONNX export + providers（ONNX 與供應器）: FP16 export; test DirectML/CUDA/CPU; record avg and p99 latency.

- Parity check（等效檢查）: Confirm ONNX vs PyTorch outputs within tolerance; save onnx_parity.json.

- Artifacts & snapshots（工件與快照）: onnxexportreport.json, latency_benchmarks.csv, loader script; link checkpoint hash.

- Privacy defaults（隱私預設）: No frame saving by default; explicit consent for clips; feature-only logs as needed.

- Professor-ready pack（教授展示包）: Executive summary, reproducibility manifest, alignment checks, calibration plots, live demo protocol, NL/NegL plan, risk log.

- Progress note（中英雙語）: "已加入嚴格軟標籤對齊、統一的 calibration.json、骨幹守門、冒煙測試閘、ONNX 等效與延遲基準、以及可版本化的 NegL 設定。"

Artifact templates (copy-paste ready)

Calibration.json (teachers and students)

```json
{
    "model_name": "RN18",
    "datasetindexid": "ixNextAffFull",
```

"selected_temperature": 1.7,

"grid": [1.0, 1.3, 1.5, 1.7, 2.0, 2.5],

"metrics": {

"NLL": {"1.0": 0.652, "1.3": 0.621, "1.5": 0.610, "1.7": 0.604, "2.0": 0.606, "2.5": 0.612},

"ECE": {"1.0": 0.048, "1.3": 0.034, "1.5": 0.030, "1.7": 0.028, "2.0": 0.029, "2.5": 0.033},

"macroF1": {"1.0": 0.742, "1.3": 0.748, "1.5": 0.751, "1.7": 0.753, "2.0": 0.751, "2.5": 0.746}

},

"selectionrule": "minNLL -> minECE -> maxmacroF1",

"calibration_date": "2025-12-05",

"seed": 1337

}

`

Alignment_report.json

`json
{

"datasetindexid": "ixNextAffFull",

"classordermatch": true,

"classorderhash": "f93c1b…",

"samplecountmatch": true,

"teacherdir": "softlabels/RN18T2",

"pass": true,

        "notes": "Canonical ordering verified. Hash manifest consistent."

}

`

Backbone_guard.json

`json

{

        "expectedbackbone": "timmmobilenetv3large100",

        "checkpointbackbone": "timmmobilenetv3large100",

        "paramcountmatch_ratio": 0.98,

        "layernamediff": [],

        "pass": true

}

`

Smoke_test.json

`json

{

        "datasetindexid": "ixNextAffFull",

        "classordermatch": true,

        "dkdunittest_pass": true,

```json
    "losscurve": {"epoch1": 1.21, "epoch2": 0.94, "epoch3": 0.81},

    "grad_finite": true,

    "backboneguardpass": true,

    "gonogo": "GO"

}
```

Negl_config.json

```json
{

    "datasetindexid": "ixNextAffFull",

    "class_names": ["neutral","happy","sad","angry","surprised","disgust","fear"],

    "globalnegativeratio": 0.2,

    "classnegativeratio": {

        "neutral": 0.15, "happy": 0.2, "sad": 0.15, "angry": 0.25, "surprised": 0.2, "disgust": 0.25, "fear": 0.2

    },

    "uncertaintygate": {"entropythreshold": 1.2, "max_confidence": 0.6},

    "teacherguidance": {"sourcemodels": ["RN18","EffB3","ConvNeXtT"], "useconfusiontopk": 2, "min_support": 30},

    "minorityprotection": {"minrecalltarget": 0.70, "reduceratio_factor": 0.5}

}
```

Onnxexportreport.json

```json
{

    "modelname": "mobilenetv3large100student_kd",

    "checkpoint_hash": "b7f2a9e",

    "opset": 18,

    "precision": "FP16",

    "input_shape": "1x3x224x224",

    "paritycheck": {"meanabsdiff": 0.0031, "maxabs_diff": 0.017, "pass": true},

    "date": "2025-12-05"

}
```

Quick go/no-go checklist（貼牆版）

- Teachers: alignment_report.json = pass; calibration.json present; softlabels @ $(T=2)$ complete.

- Ensemble: ensemblealignmentgate.json = pass; ensemble_config.json saved.

- Students: backboneguard = pass; smoketest = GO; 3-seed results aggregated; calibration.json saved.

- Demo: thresholds.json optional; demoresultssummary.csv updated.

- NL/NegL: negl_config.json saved; NL smoke logs healthy; gradients finite.

- ONNX: onnxexportreport.json = pass; latencybenchmarks.csv present;

onnxparity.json = pass.

If you want, tell me which section you'll run first and I'll generate ultra-condensed, bilingual templates tailored to your exact class names and directory layout.