| **Epoch** | **Val Acc** | **Precision** | **Recall** | **F1 Score** | **ROC-AUC** | **Notes** |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 0.6214 | 0.6381 | 0.5384 | 0.5840 | 0.6719 | Frozen ViT & MaxViT |
| 2 | 0.6050 | 0.5871 | 0.6729 | 0.6271 | 0.6526 | Slight drop, recall jumps |
| 3 | 0.6479 | 0.6431 | 0.6440 | 0.6435 | 0.6973 | Solid balanced metrics |
| 4 | 0.6193 | 0.6042 | 0.6628 | 0.6322 | 0.6805 | Small dip in all metrics |
| 5 | 0.6457 | 0.6387 | 0.6498 | 0.6442 | 0.6847 | Recovery begins |
| 6 | 0.6393 | 0.6462 | 0.5948 | 0.6194 | 0.6925 | 🔓 ViT unfrozen |
| 7 | 0.6571 | 0.6401 | 0.6975 | 0.6676 | 0.7019 | Gradual gains |
| 8 | 0.6729 | 0.6620 | 0.6889 | 0.6752 | 0.7229 | Consistent lift |
| 9 | 0.6800 | 0.6576 | 0.7337 | 0.6936 | 0.7291 | Best so far |
| 10 | 0.6779 | 0.6500 | 0.7525 | 0.6975 | **0.7327** | 🔓 MaxViT unfrozen, **Best ROC-AUC & F1** |

**📈 Validation Metric Trends Over Epochs :**

**🔍 Learning Rate vs Performance Summary :**

| **Learning Rate** | **Precision** | **Recall** | **F1 Score** | **ROC-AUC** | **Notes** |
| --- | --- | --- | --- | --- | --- |
| **1e-5** | 0.6117 | **0.7315** | 0.6662 | 0.7158 | Very high recall, good balance |
| **5e-5** | 0.6533 | 0.7240 | **0.6868** | **0.7430** | ⭐ Best overall performer |
| **5e-4** | 0.6479 | 0.7018 | 0.6738 | 0.7350 | Still strong, slightly behind |
| **1e-3** | **0.6713** | 0.5000 | 0.5731 | 0.6964 | High precision, recall collapsed |

📊 **Batch Size vs Performance Summary :**

| **Batch Size** | **Precision** | **Recall** | **F1 Score** | **ROC-AUC** | **Notes** |
| --- | --- | --- | --- | --- | --- |
| **8** | 0.6548 | 0.6230 | 0.6385 | **0.7069** | Balanced and highest ROC-AUC |
| **16** | **0.6571** | 0.6038 | 0.6293 | 0.7024 | Highest precision, but lower recall |
| **32** | 0.6394 | 0.6215 | 0.6303 | 0.7035 | Most stable mid-point |
| **64** | 0.6355 | **0.6701** | **0.6523** | 0.7052 | Highest recall and F1 |

📊 **Weight Decay vs Model Performance Summary (Best Epoch per Decay)**

| **Weight Decay** | **Best Epoch** | **Precision** | **Recall** | **F1 Score** | **ROC-AUC** | **Notes** |
| --- | --- | --- | --- | --- | --- | --- |
| **0.00** | 9 | 0.6544 | **0.7607** | **0.7036** | 0.7355 | Best **recall and F1** |
| **0.01** | 10 | **0.6864** | 0.6952 | **0.6907** | **0.7430** | Best **ROC-AUC**, balanced |
| **0.05** | 10 | 0.6426 | 0.6967 | 0.6686 | 0.7247 | Decent, but slightly lower |

📊 **Optimizer Comparison Summary** :

| **Optimizer** | **Precision** | **Recall** | **F1 Score** | **ROC-AUC** | **Notes** |
| --- | --- | --- | --- | --- | --- |
| **Adam** | 0.7205 | 0.6203 | 0.6667 | 0.7563 | Strong balance, popular baseline |
| **AdamW** | 0.6425 | **0.7751** | **0.7026** | 0.7490 | Best **recall** and **F1** |
| **SGD** | 0.6255 | 0.6533 | 0.6391 | 0.6860 | Weakest performance overall |
| **RMSprop** | **0.7438** | 0.5616 | 0.6400 | 0.7635 | Best **precision**, low recall |
| **Lion** | 0.7316 | 0.6562 | 0.6918 | **0.7720** | ⭐ Best **ROC-AUC**, great F1 too |

📊 **Dropout Rate vs Model Performance Summary** :

| **Dropout Rate** | **Precision** | **Recall** | **F1 Score** | **ROC-AUC** | **Notes** |
| --- | --- | --- | --- | --- | --- |
| **0.2** | **0.6747** | 0.6110 | 0.6413 | 0.7113 | Best **precision** |
| **0.3** | 0.6579 | 0.6502 | 0.6540 | **0.7148** | Most **balanced overall** |
| **0.5** | 0.6487 | 0.5762 | 0.6103 | 0.6937 | Slight underperformance |
| **0.7** | 0.6212 | **0.7402** | **0.6755** | 0.7032 | Best **recall and F1**, but precision drops |

📊 **ViT Variant Comparison Summary (Best Epoch Metrics)** :

| **ViT Variant** | **Precision** | **Recall** | **F1 Score** | **ROC-AUC** | **Best Epoch** | **Notes** |
| --- | --- | --- | --- | --- | --- | --- |
| **Tiny** | 0.6773 | 0.6294 | 0.6525 | 0.7137 | 5 | Lightest model, strong generalization |
| **Small** | 0.7046 | 0.5431 | 0.6134 | 0.7226 | 5 | High precision, recall drops |
| **Base** | 0.6878 | 0.5516 | 0.6122 | 0.7074 | 5 | Balanced but conservative |
| **Large** | **0.7300** | 0.4781 | 0.5778 | 0.7224 | 5 | Highest precision, lowest recall |
| **Huge** | 0.6806 | **0.6690** | **0.6748** | **0.7199** | 4 | ⭐ Best F1 + recall trade-off |

📊 **Dataset Size Sensitivity Summary**

| **Dataset Used** | **Samples** | **Precision** | **Recall** | **F1 Score** | **ROC-AUC** | **Notes** |
| --- | --- | --- | --- | --- | --- | --- |
| **100%** | 7000 | 0.6500 | **0.7525** | **0.6975** | **0.7327** | 🔓 MaxViT unfrozen, best |
| **90%** | 6300 | 0.6267 | 0.7618 | 0.6876 | 0.7200 | Balanced |
| **75%** | 5250 | 0.6448 | 0.6994 | 0.6710 | 0.7134 | Stable |
| **60%** | 4200 | 0.5875 | 0.8956 | 0.7096 | 0.6761 | High recall, low precision |
| **40%** | 2800 | 0.6391 | 0.7018 | 0.6690 | 0.6882 | Fair performance |

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