

# Göğüs Kanseri Metastaz Bölgelerinin Otomatik Belirlenmesi



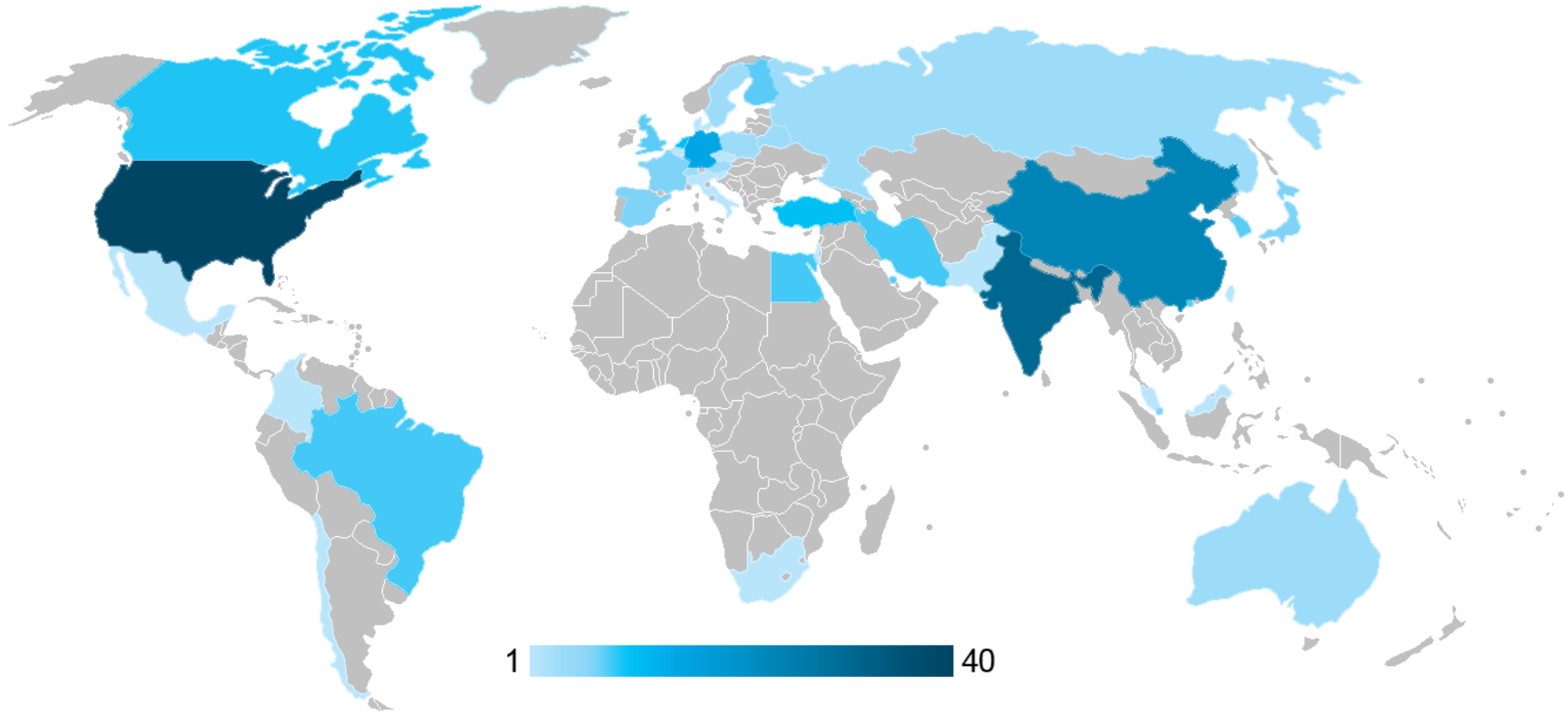
ORTA DOĞU TEKNİK ÜNİVERSİTESİ

Uğur HALICI<sup>1,2</sup> Prof. Dr.  
Mustafa Ümit ÖNER<sup>1</sup>, MSc Student  
Rengül ÇETİN ATALAY<sup>3</sup>, Prof. Dr.

<sup>1</sup>Elektrik ve Elektronik Mühendisliği Bölümü

<sup>2</sup>Nörobilim ve Nöroteknoloji Doktora Programı


<sup>3</sup>Enformatik Enstitüsü





















- 38 ülkeden 198 başvuru yapıldı
- 23 takım sonuç teslim etti

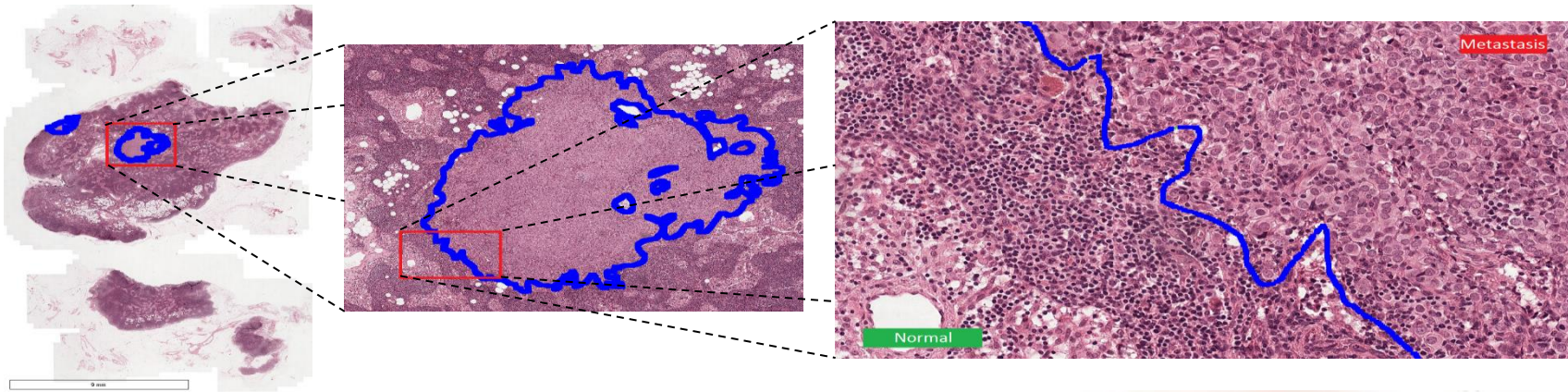


## Bütün-Slayt ROC Analizi Kategorisi Sonuçları

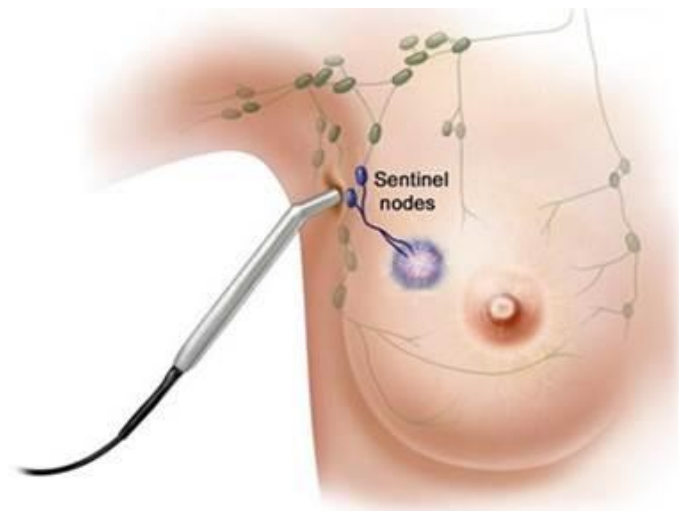
Rank ▲	Team ◇	AUC ◇	Description ◇
01	Harvard Medical School (BIDMC) and Massachusetts Institute of Technology (CSAIL), USA	0.9250	 
02	EXB Research and Development co., Germany	0.9173	 
03	Independent participant, Germany	0.8680	 
04	Middle East Technical University, Departments of EEE, NSNT and HS, Turkey	0.8669	 
05	NLP LOGIX co., USA	0.8332	 
06	University of Toronto, Electrical and Computer Engineering, Canada	0.8181	 
07	The Warwick-QU Team, United Kingdom	0.7999	 
08	Radboud University Medical Center, Diagnostic Image Analysis Group, Netherlands	0.7828	 
09	HTW-BERLIN, Germany	0.7717	
10	University of Toronto, Electrical and Computer Engineering, Canada	0.7666	 

## Metastaz FROC Analizi Kategorisi Sonuçları

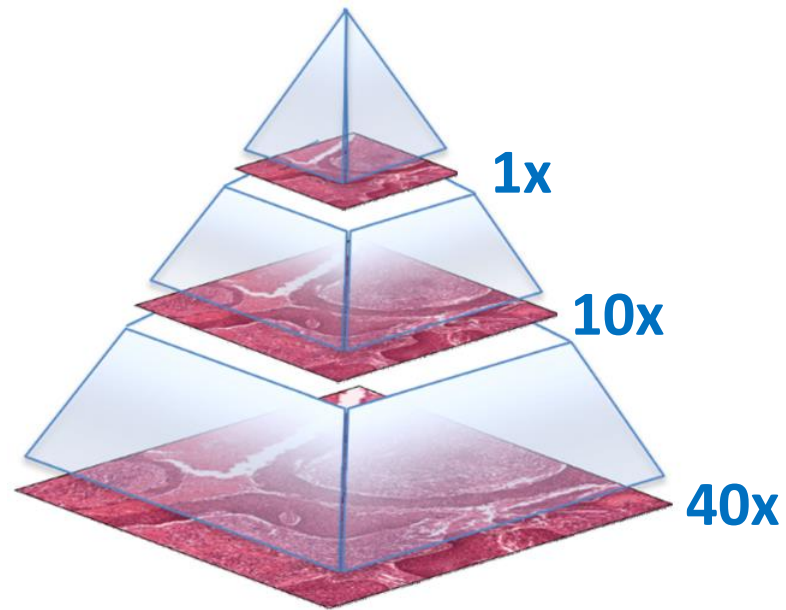
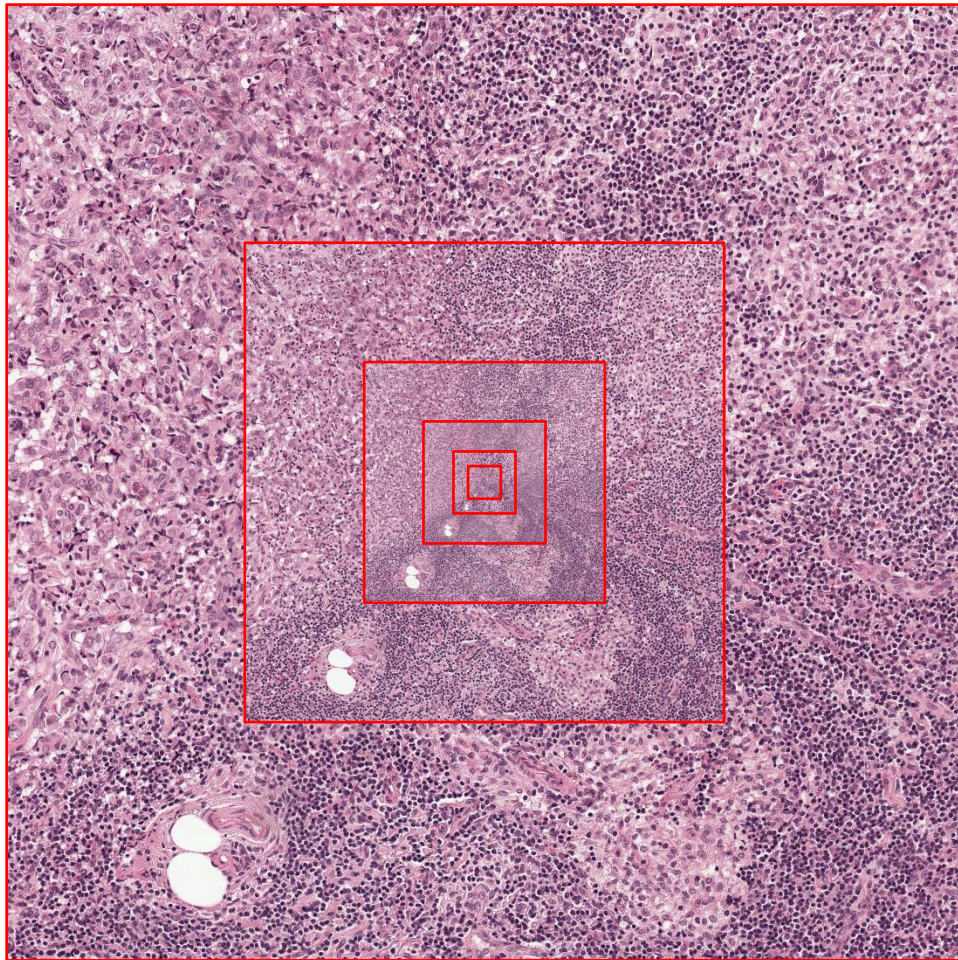
Rank	Team	score	Description
01	Harvard Medical School (BIDMC) and Massachusetts Institute of Technology (CSAIL), USA	0.7051	 
02	Radboud University Medical Center, Diagnostic Image Analysis Group, Netherlands	0.5761	 
03	EXB Research and Development co., Germany	0.5192	 
04	Middle East Technical University, Departments of EEE, NSNT and HS, Turkey	0.4060	 
05	NLP LOGIX co., USA	0.4040	 
06	Independent participant, Germany	0.3964	 
07	University of Toronto, Electrical and Computer Engineering, Canada	0.3944	 
08	Osaka University, Department of Bioinformatic Engineering, Japan	0.3663	 
09	University of Toronto, Electrical and Computer Engineering, Canada	0.3615	 
10	The Warwick-QU Team, United Kingdom	0.3155	 



- 20 Gigapixel slayt görüntüleri
- 160 nanometre çözünürlük







~65 Gbyte Ham Veri

Lenf Düğümü Bütün-Slayt Görüntüleri



**Ön İşleme:** Lenf düğümü bölgelerinin belirlenmesi



**Sınıflandırma:** Derin Öğrenme algoritması



**Son İşleme:** Tümör metastaz bölgelerinin ve olasılıklarının hesaplanması



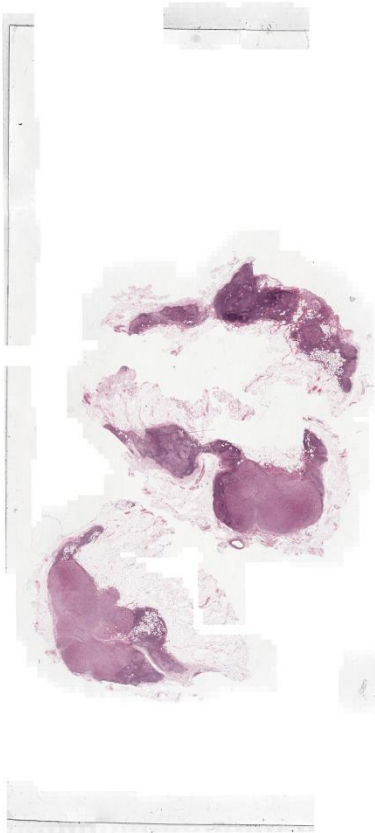
Metastaz bölgeleri ve  
olasılıkları



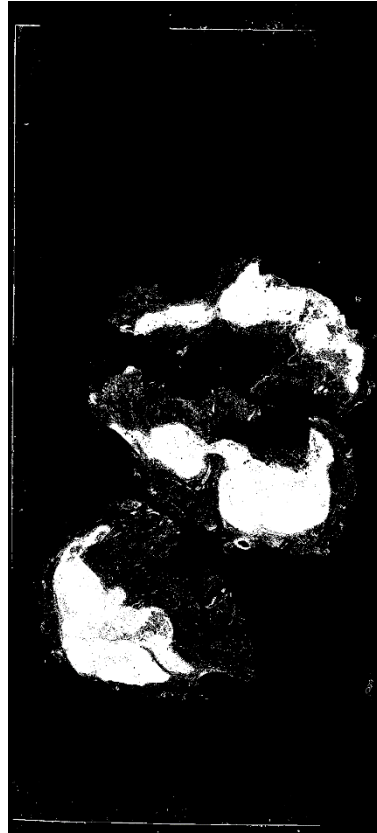
Bütün-Slayt Olasılıkları



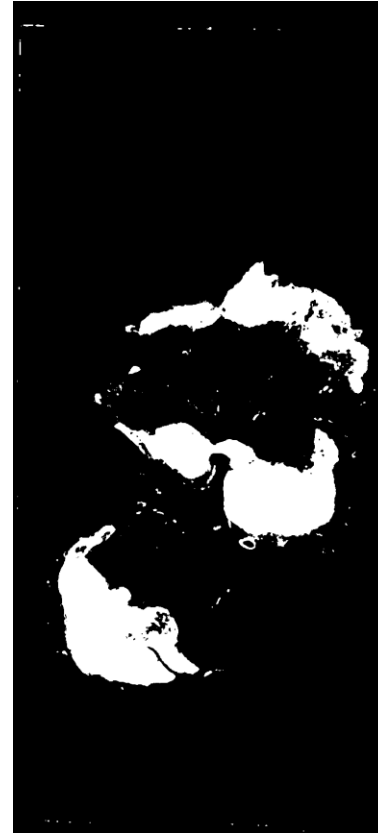
# Ön İşleme: Lenf Düğümü Bölgelerinin Belirlenmesi



WSI



OTSU

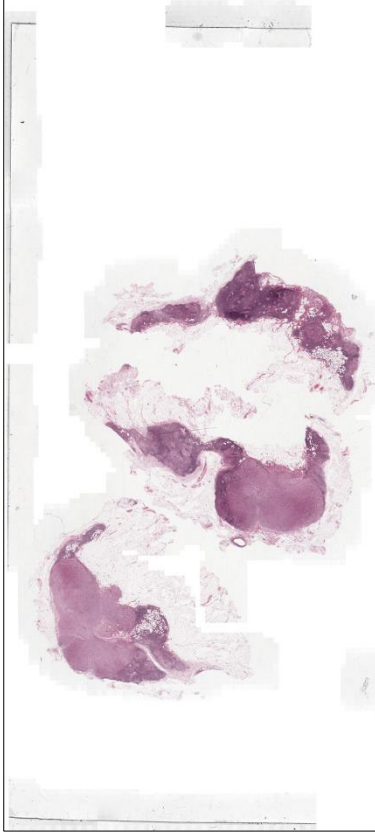


Median Filter



CC Elimination

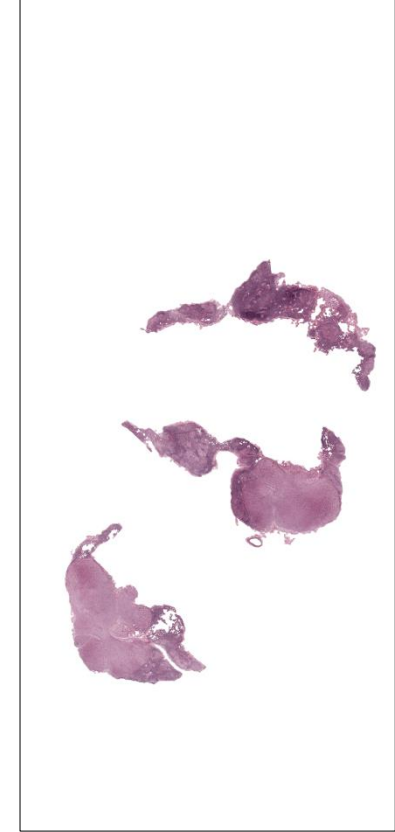
# Ön İşleme: Lenf Düğümü Bölgelerinin Belirlenmesi



WSI

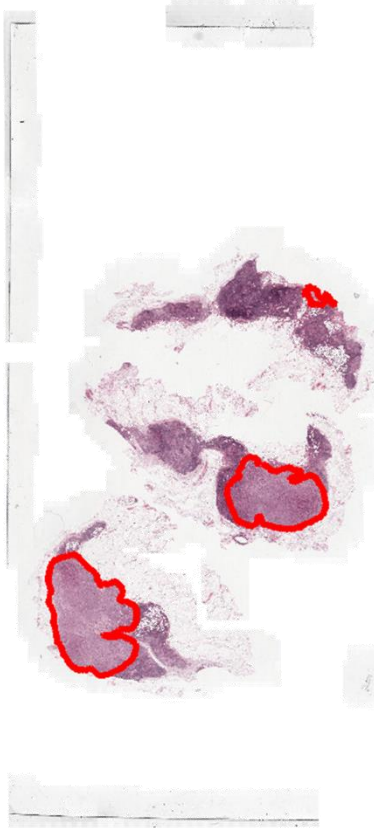


Lenf Düğümleri (Binary)

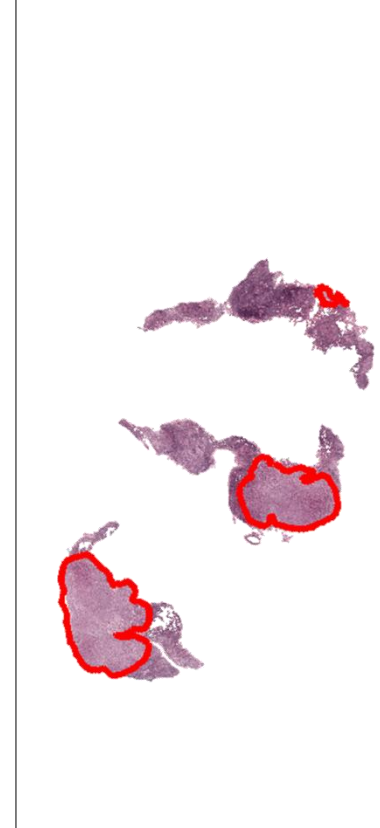


Lenf Düğümleri (RGB)

# Ön İşleme: Lenf Dügümü Bölgelerinin Belirlenmesi

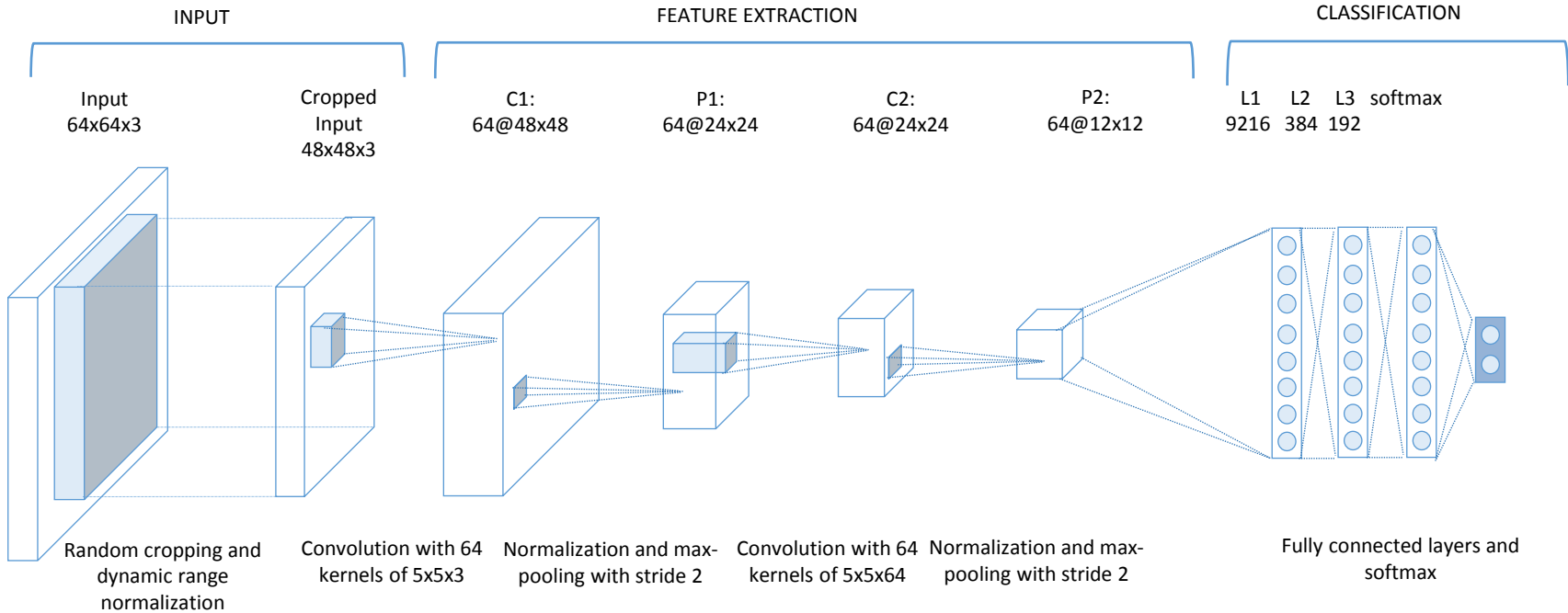


WSI Metastaz Bölgeleri

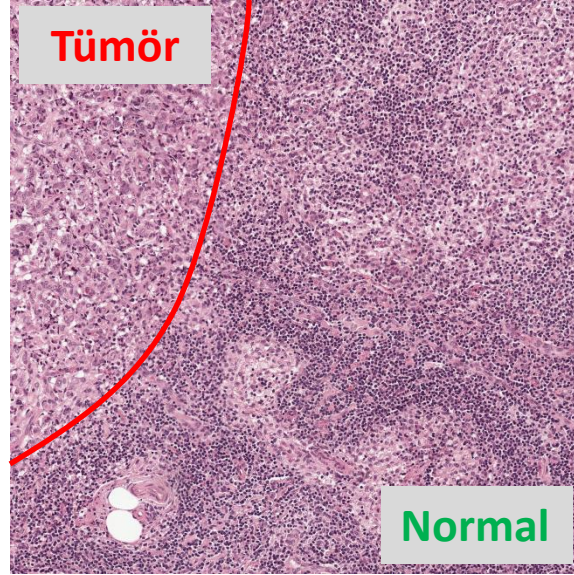


İşlenmiş WSI Metastaz Bölgeleri

# Sınıflama: Derin Öğrenme Mimarisi

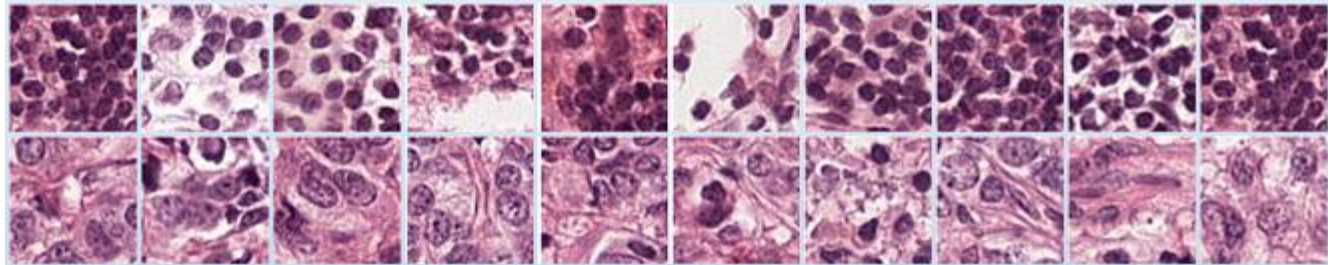


# Sınıflama: Derin Öğrenme Mimarisi



Normal

Tümör

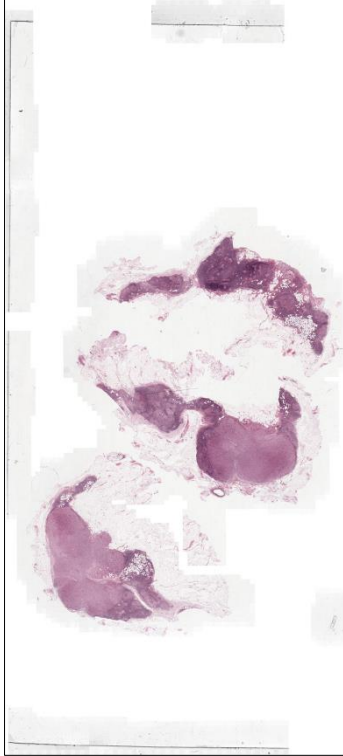




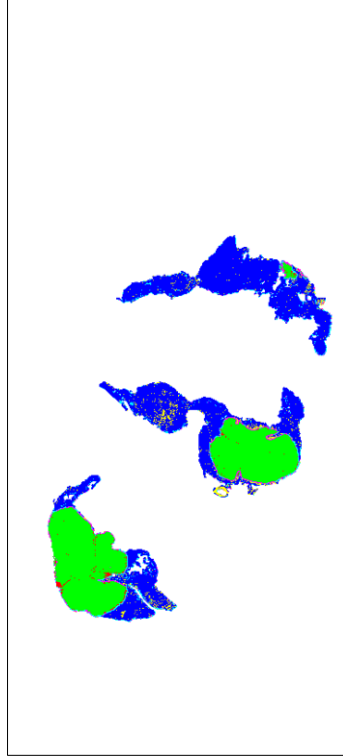
# Sınıflama: Derin Öğrenme Mimarisi

Tümör 009

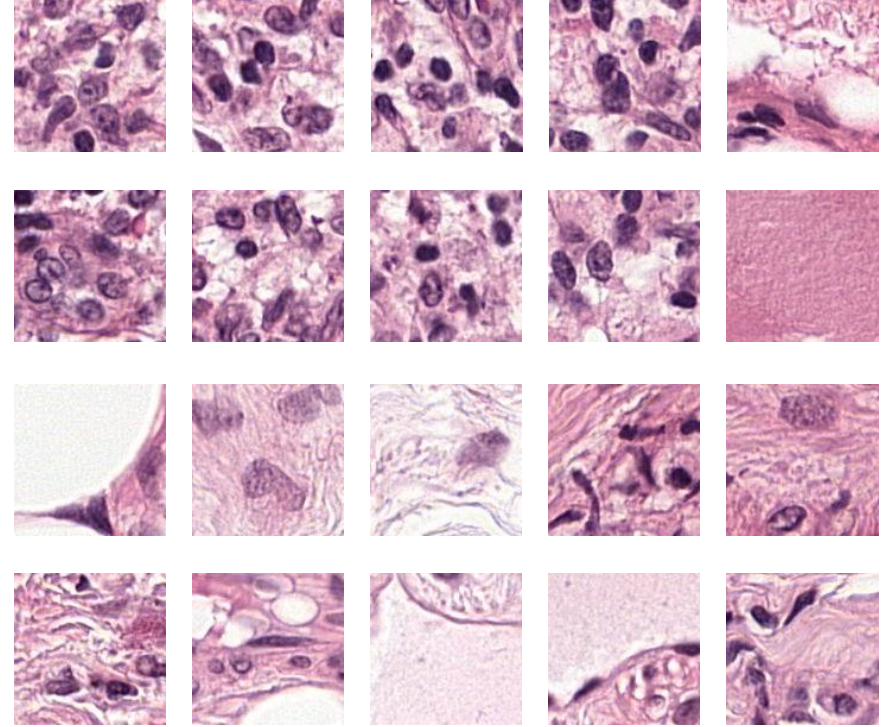
False Positives



WSI

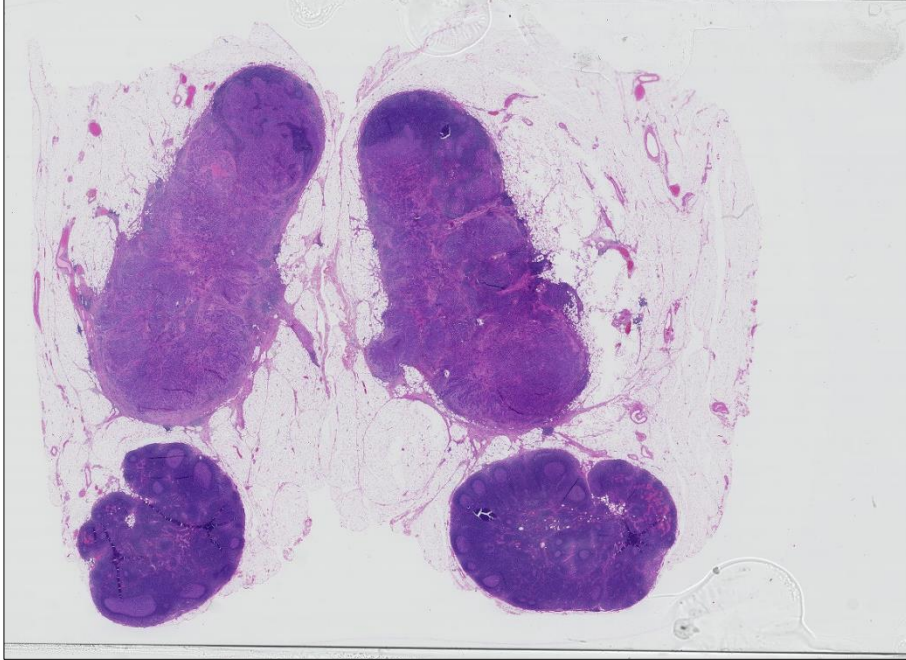


Model Çıktısı Renk Kodu Haritası

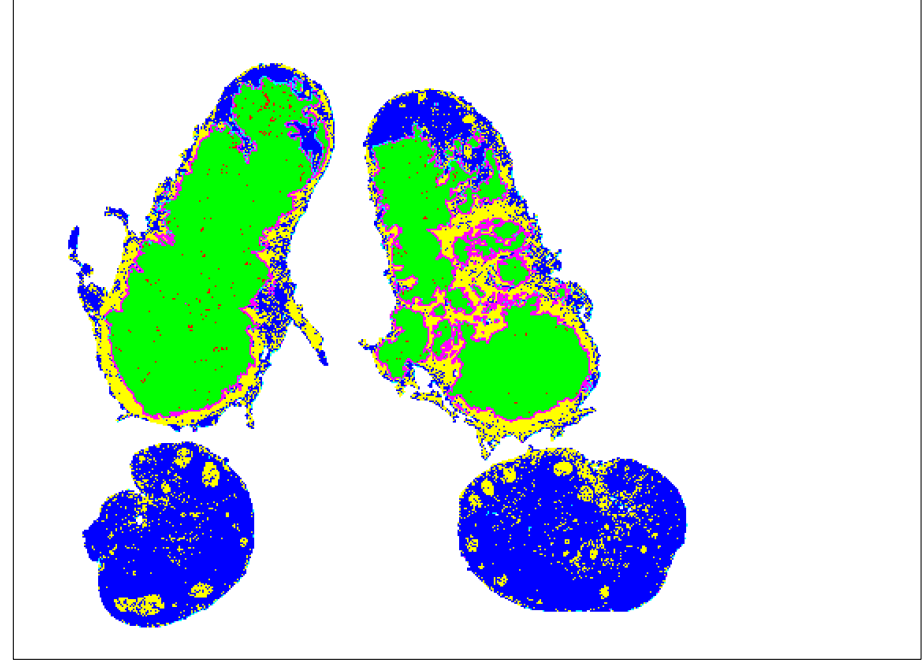


# Sınıflama: Derin Öğrenme Mimarisi

## Tümör 089



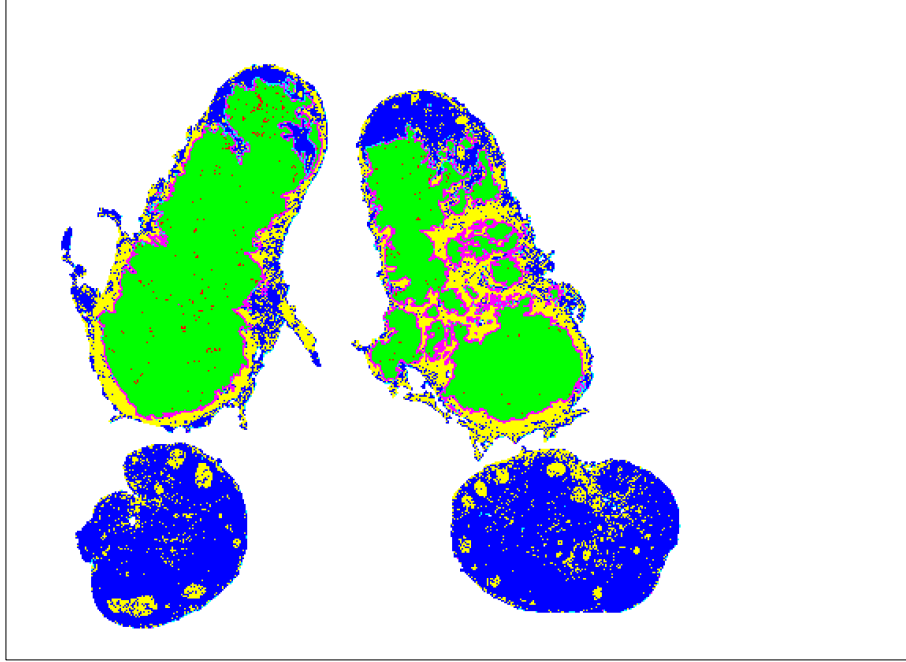
WSI



Model Çıktısı Renk Kodu Haritası

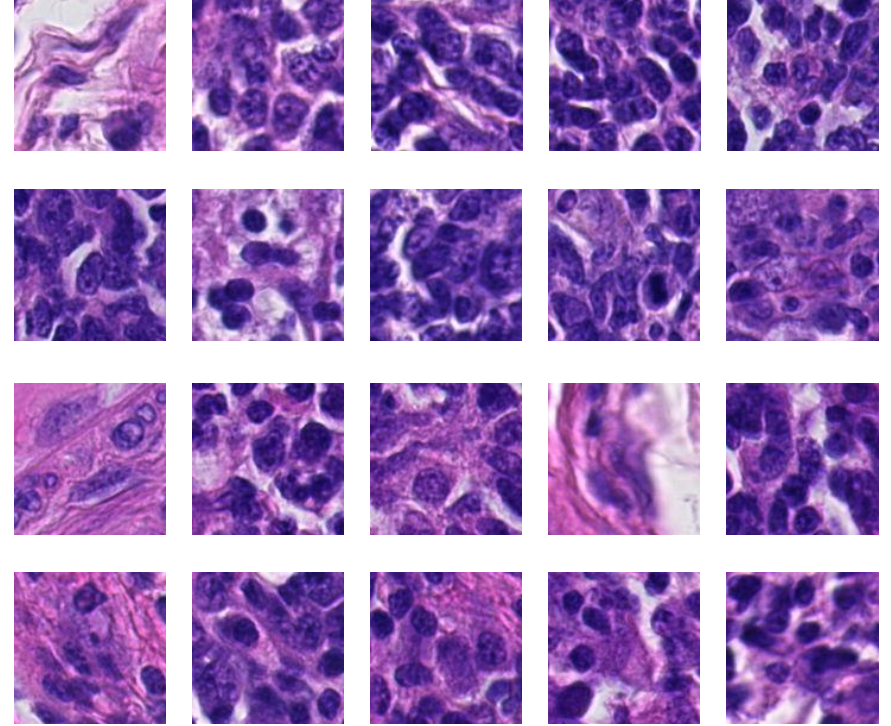
# Sınıflama: Derin Öğrenme Mimarisi

Tümör 089



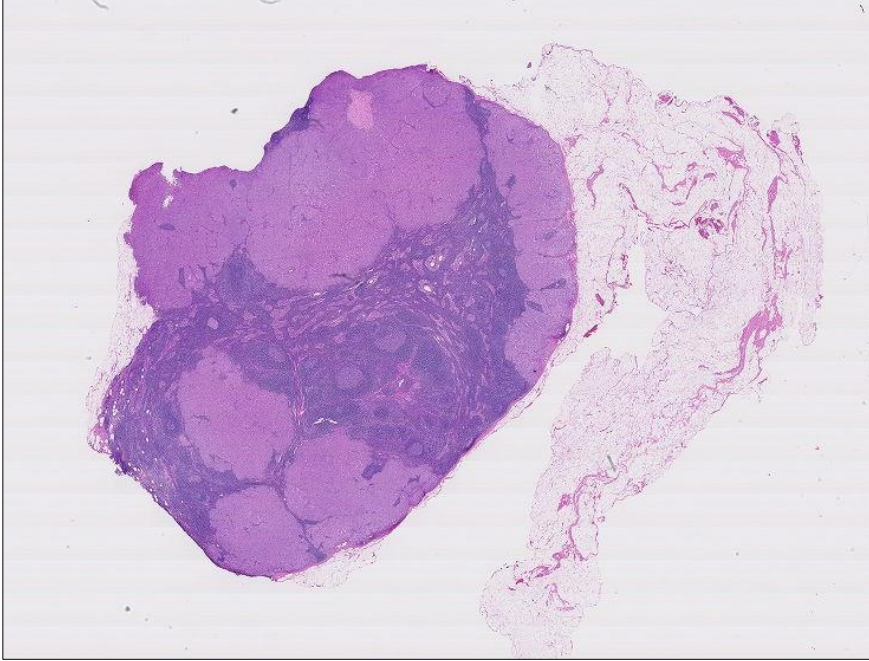
Model Çıktısı Renk Kodu Haritası

False Positives

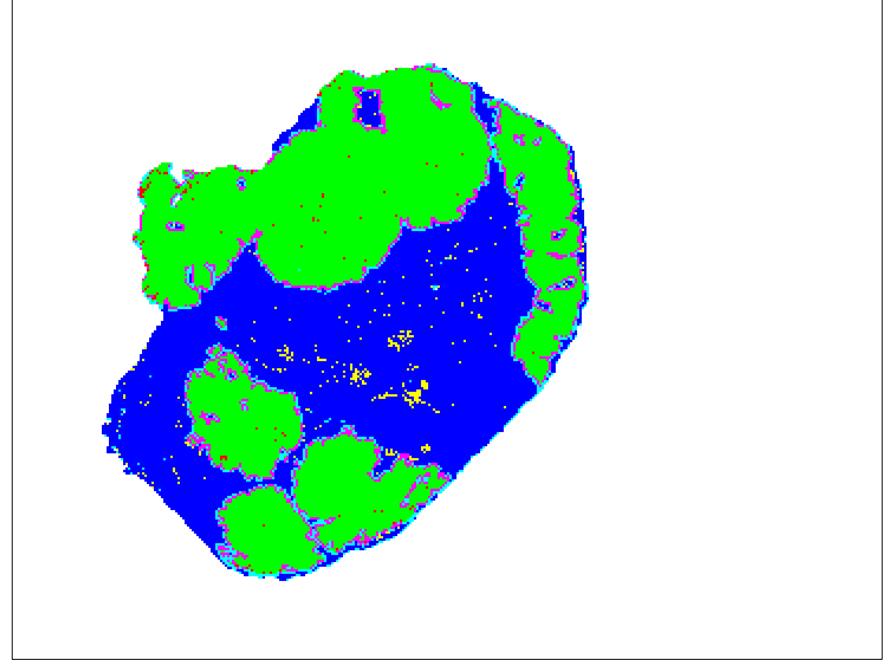


# Sınıflama: Derin Öğrenme Mimarisi

## Tümör 110



WSI

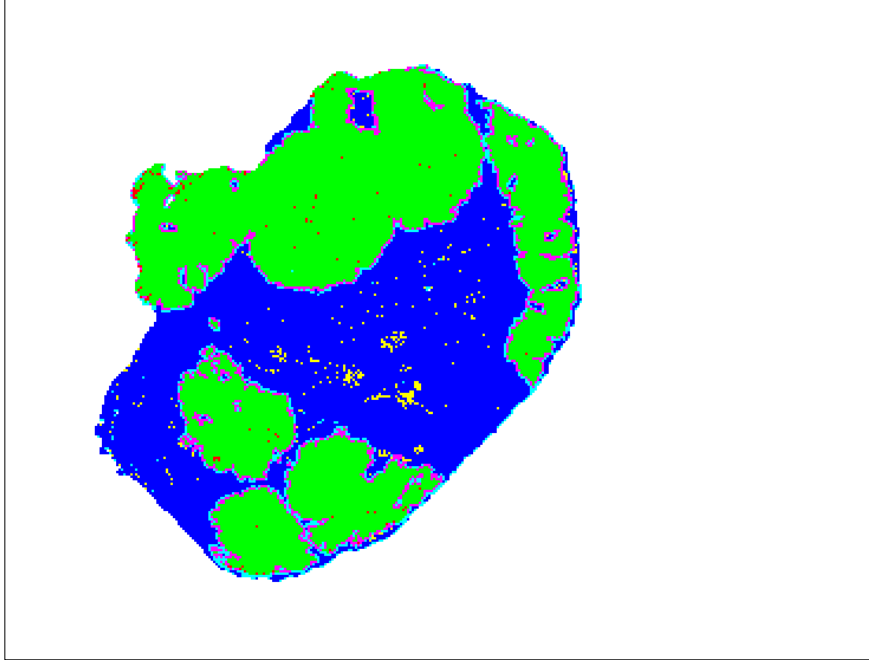


Model Çıktısı Renk Kodu Haritası



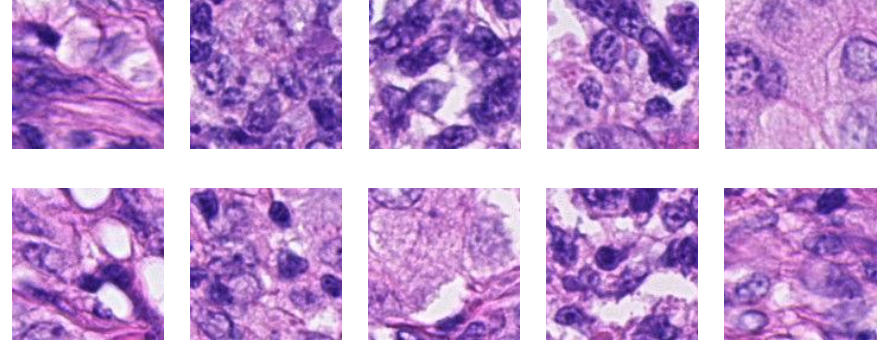
# Sınıflama: Derin Öğrenme Mimarisi

Tümör 110



Model Çıktısı Renk Kodu Haritası

False Positives



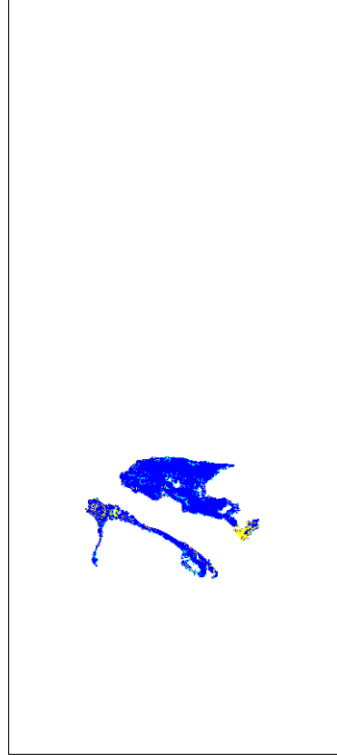


# Sınıflama: Derin Öğrenme Mimarisi

Normal 049

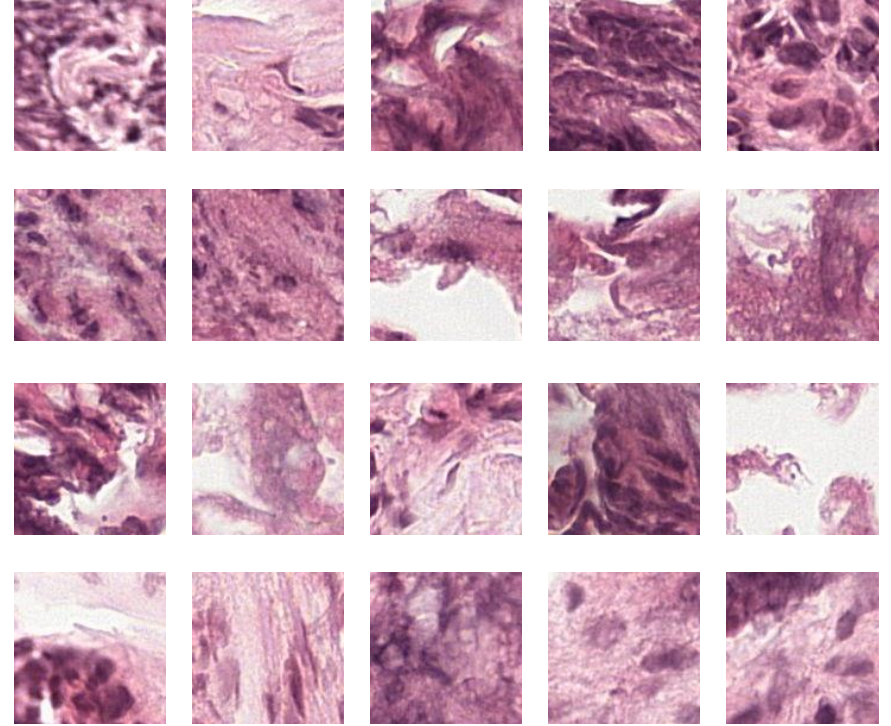


WSI



Model Çıktısı Renk Kodu  
Haritası

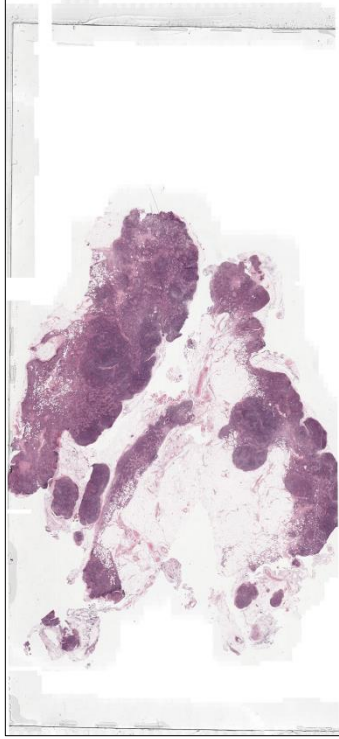
False Positives



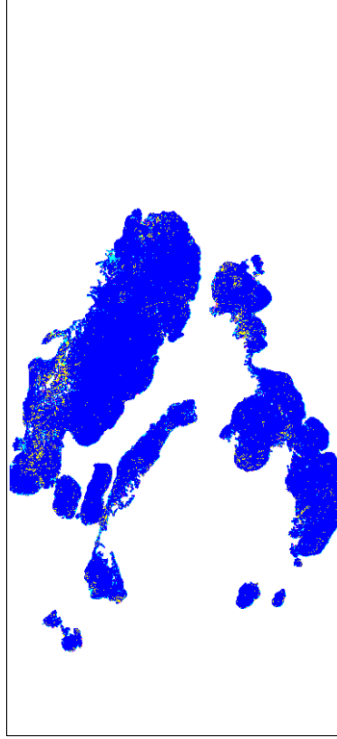
# Sınıflama: Derin Öğrenme Mimarisi

Normal 066

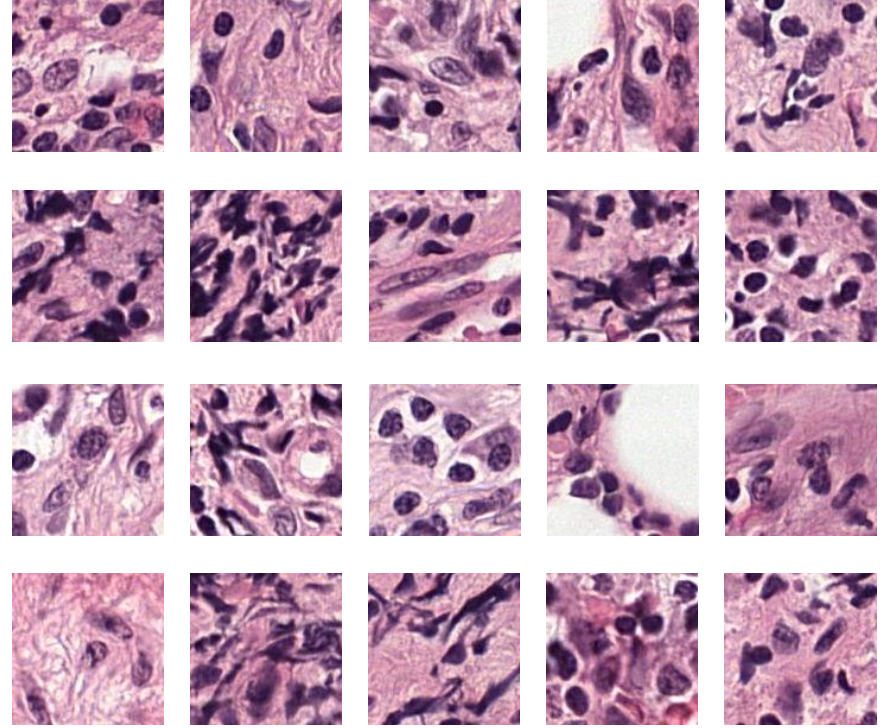
False Positives



WSI



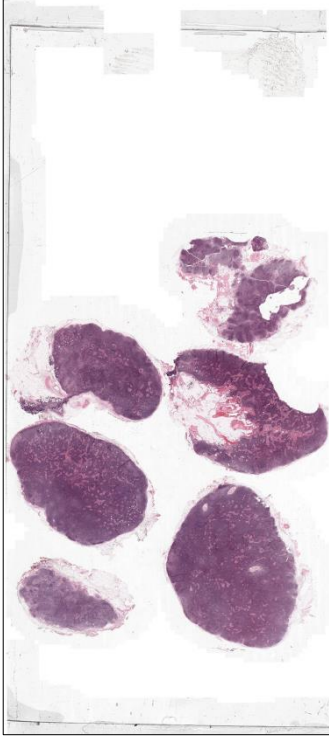
Model Çıktısı Renk Kodu  
Haritası



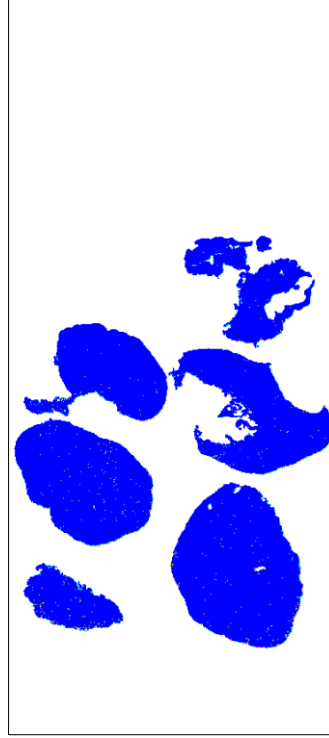
# Sınıflama: Derin Öğrenme Mimarisi

Normal 076

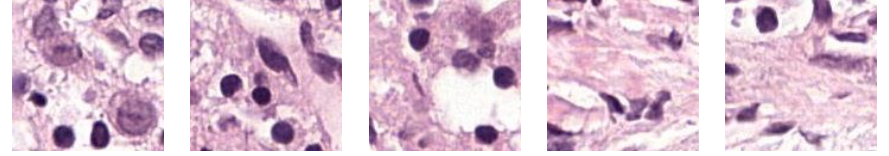
False Positives



WSI



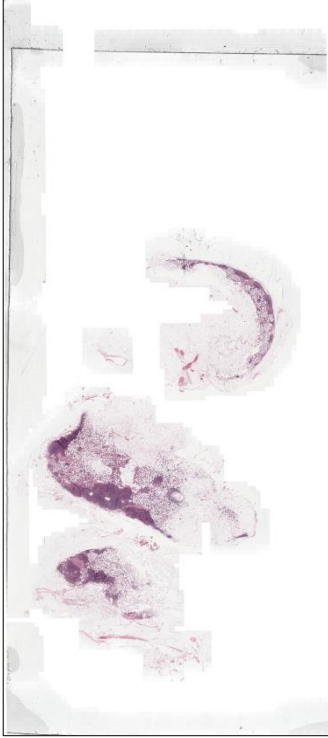
Model Çıktısı Renk Kodu  
Haritası



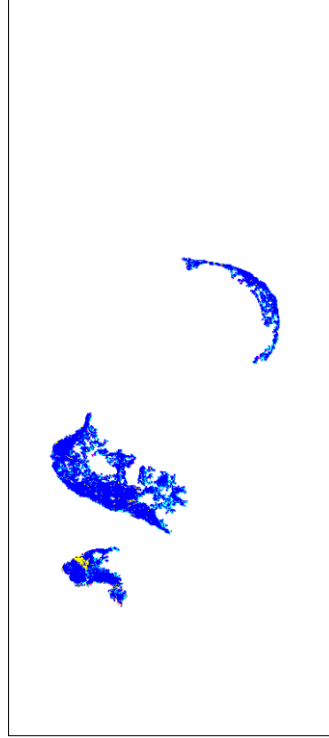
# Sınıflama: Derin Öğrenme Mimarisi

Normal 086

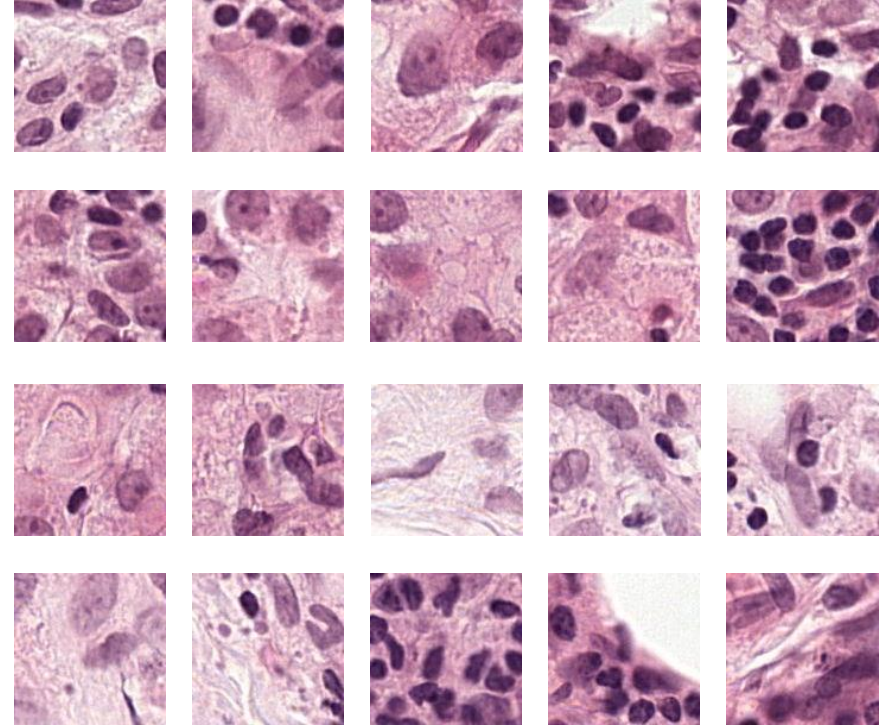
False Positives



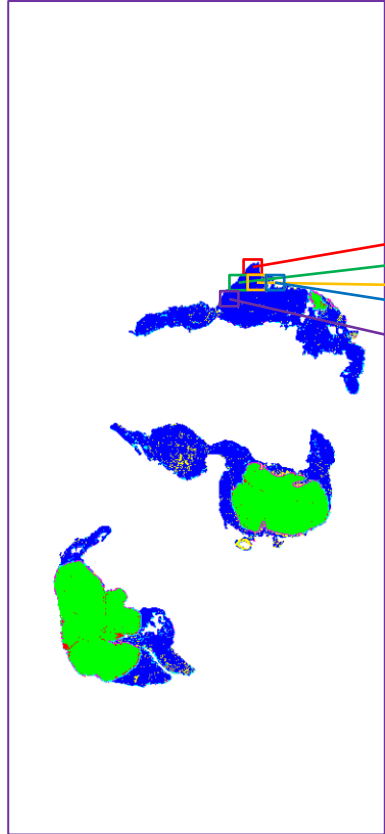
WSI



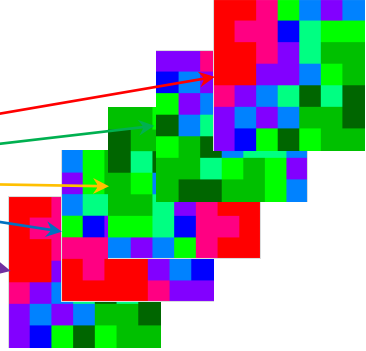
Model Çıktısı Renk Kodu  
Haritası



# Son İşleme: Metastaz Bölgeleri ve Olasılıkları



Renk Kodlu Model Çıktısı Olasılık Değerleri



Model Çıktısı @ $(I,J)$ : $CNN(I+i,J+j)$						
0.000	0.800	0.820	0.850	0.800	0.800	0.700
0.000	0.800	0.800	0.850	0.700	0.700	0.750
0.000	0.000	0.900	0.850	0.900	0.900	0.900
-0.900	0.000	0.520	0.820	0.900	0.600	0.900
-0.900	0.000	0.000	0.900	-0.900	0.700	0.900
-0.900	0.000	0.000	0.700	-0.900	0.900	0.000
-0.950	-0.700	0.000	0.000	0.000	0.900	0.000
$CNN(I,J) = 0.820$						

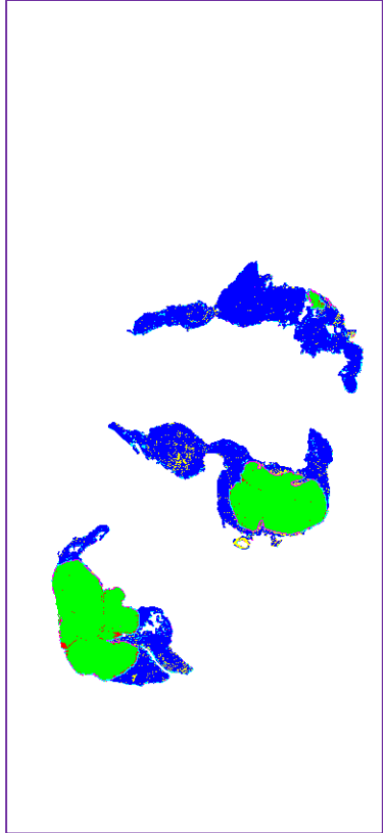


Filtre: $CF(i,j)$						
0.004	0.004	0.004	0.004	0.004	0.004	0.004
0.004	0.054	0.054	0.054	0.054	0.054	0.004
0.004	0.054	0.242	0.242	0.242	0.054	0.004
0.004	0.054	0.242	0.399	0.242	0.054	0.004
0.004	0.054	0.242	0.242	0.242	0.054	0.004
0.004	0.054	0.054	0.054	0.054	0.054	0.004
0.004	0.004	0.004	0.004	0.004	0.004	0.004
$CF_{sum} = 3.295$						

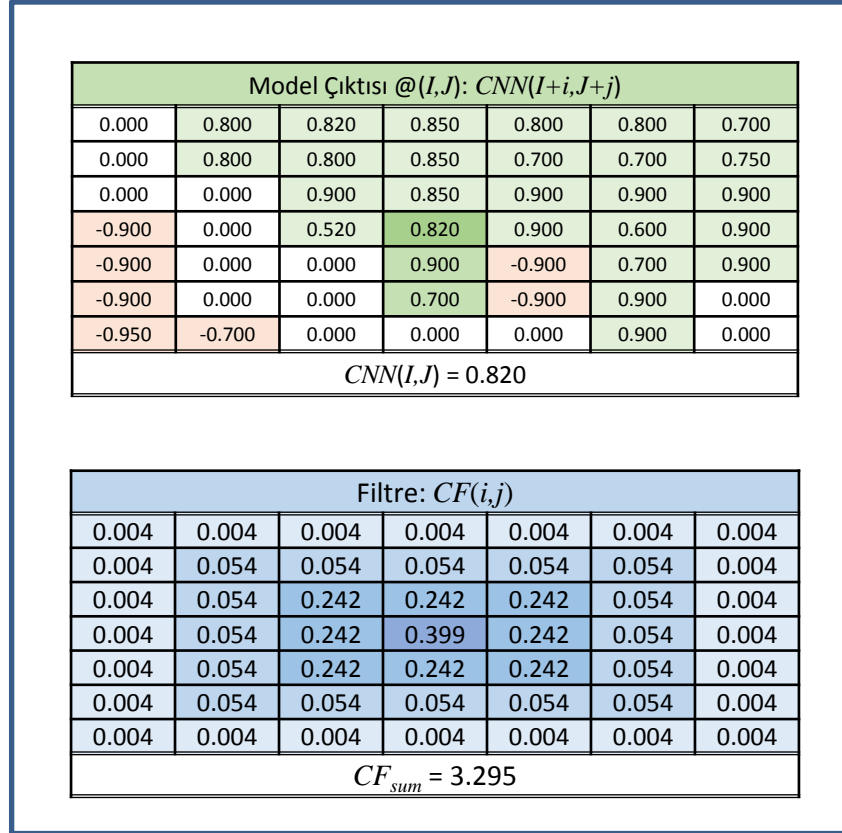
Model Çıktısı Renk Kodu Haritası



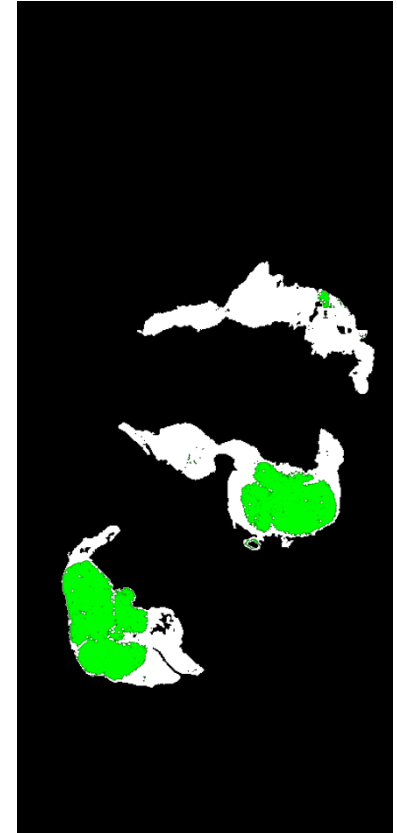
# Son İşleme: Metastaz Bölgeleri ve Olasılıkları



Model Çıktısı Renk Kodu Haritası

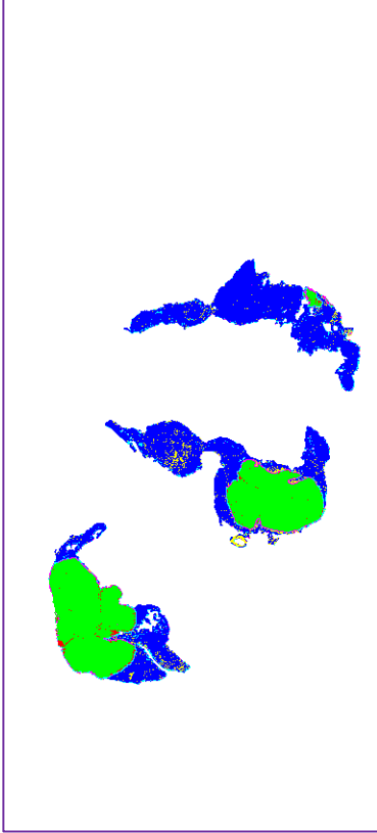


Filtreleme

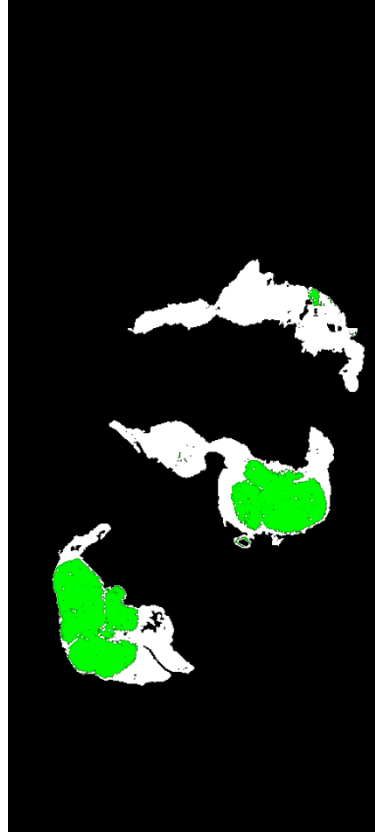


Metastaz Bölgeleri ve Olasılıkları

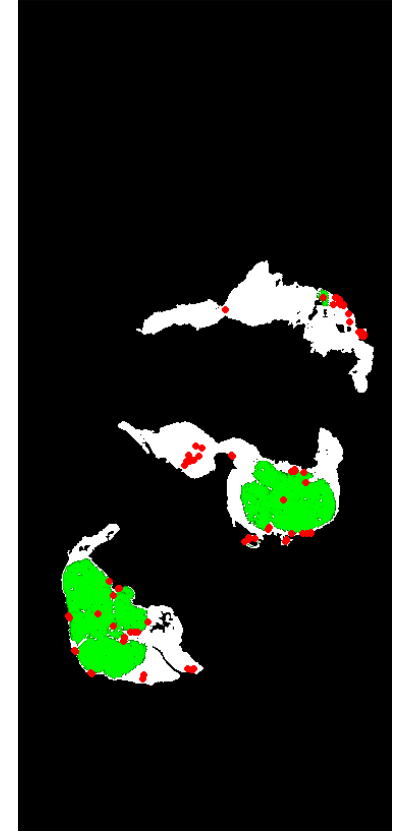
# Son İşleme: Metastaz Bölgeleri ve Olasılıkları



Model Çıktısı Renk Kodu Haritası



Metastaz Bölgeleri ve Olasılıkları



Metastaz Bölgeleri Temsilci Noktaları

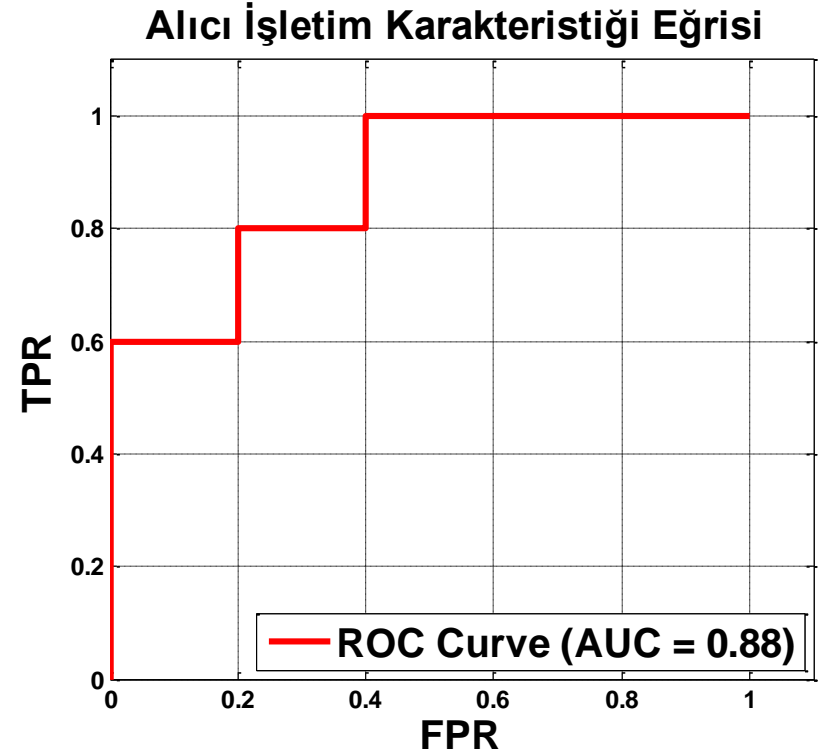
## Son İşleme: Metastaz Bölgeleri ve Olasılıkları

		Tahmin Edilen Sınıf	
		Pozitif	Negatif
Doğru Sınıf	Pozitif	Doğru Pozitif	Yanlış Negatif
	Negatif	Yanlış Pozitif	Doğru Negatif

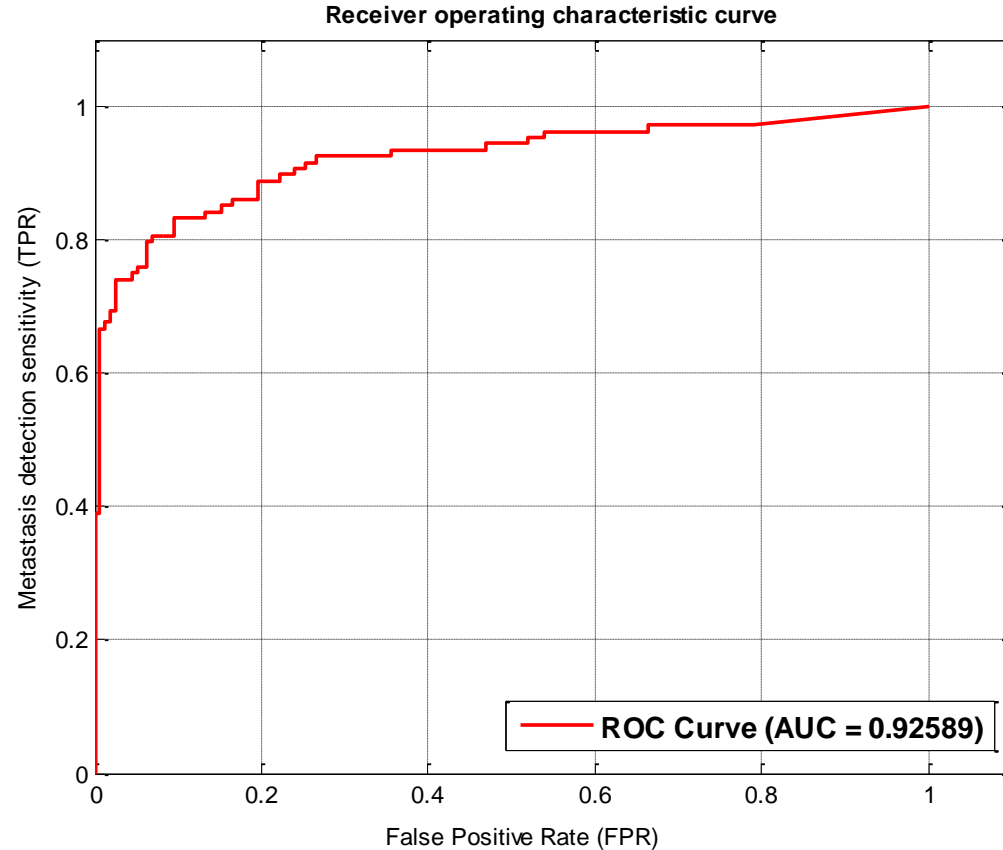
- Doğru Pozitif Oranı ( $TPR$ ) = 
$$\frac{\sum \text{Doğru pozitif}}{\sum \text{Doğru sınıf pozitif}}$$
- Yanlış Pozitif Oranı ( $FPR$ ) = 
$$\frac{\sum \text{Yanlış pozitif}}{\sum \text{Doğru sınıf negatif}}$$

# Son İşleme: Metastaz Bölgeleri ve Olasılıkları

Eşik	1	0.85	0.75	0.65	0.55	0.45	0.35	0.25	0.15	0.05	0
Olasılık	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.01	
Doğru Sınıf		P	P	P	N	P	N	P	N	N	N
TPR	0/5	1/5	2/5	3/5	3/5	4/5	4/5	5/5	5/5	5/5	5/5
FPR	0/5	0/5	0/5	0/5	1/5	1/5	2/5	2/5	3/5	4/5	5/5



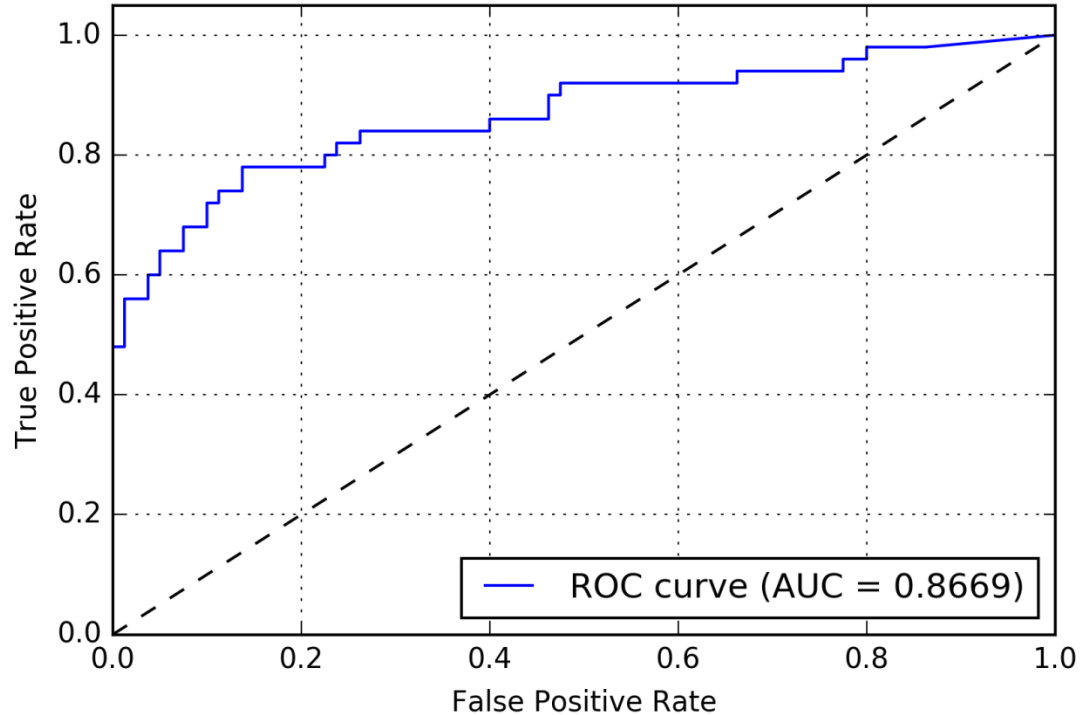
# Öğretme Seti Bütün-Slayt ROC Analizi



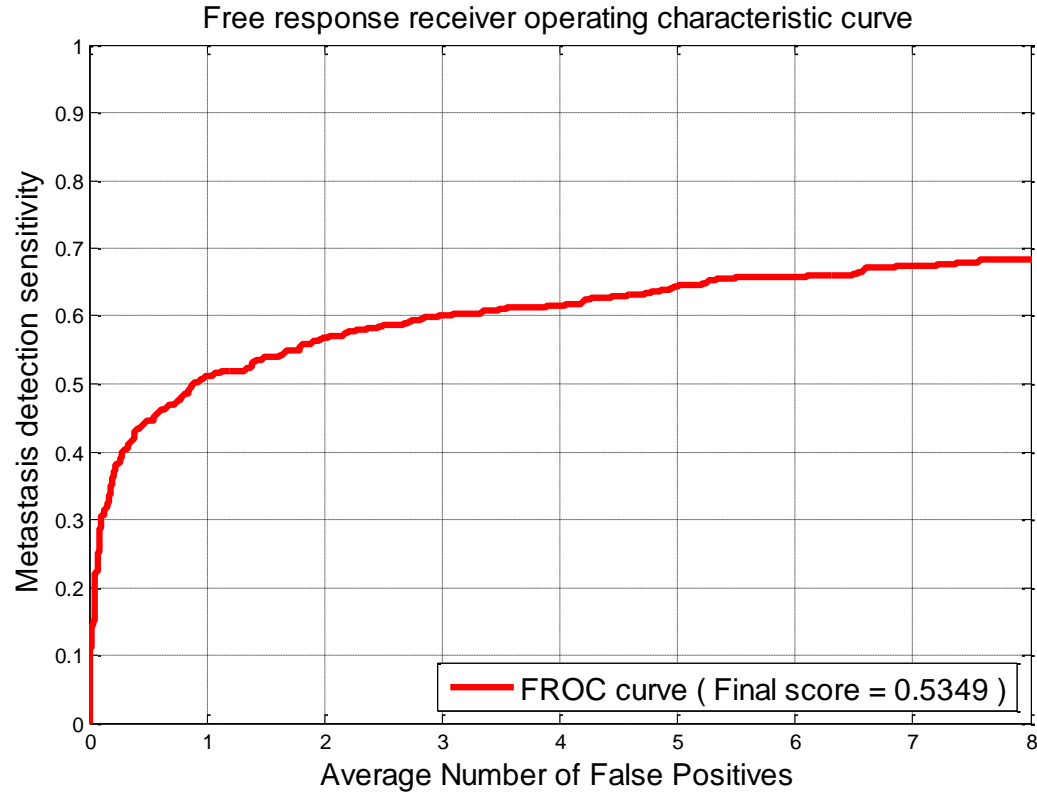


# Test Seti Bütün-Slayt ROC Analizi

ROC curve - Health Sciences Middle East Technical University



# Öğretme Seti Metastaz FROC Analizi



# Test Seti Metastaz FROC Analizi

FROC curve - Health Sciences Middle East Technical University

