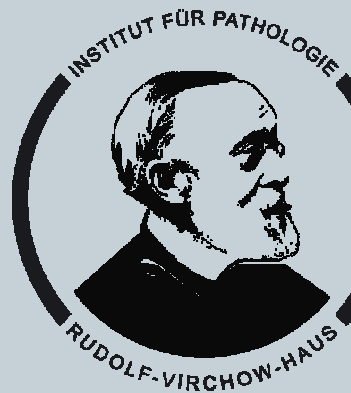


Distributed computing in image analysis using open source frameworks and application to image sharpness assessment of histological whole slide images



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Introduction (1)



Motivation

- Automated image analysis is evolving rapidly
- Computational cost for full resolution processing is immense
- Manual sharpness assessment is a laborious and time consuming task
- Availability of free image processing libraries and parallelization frameworks

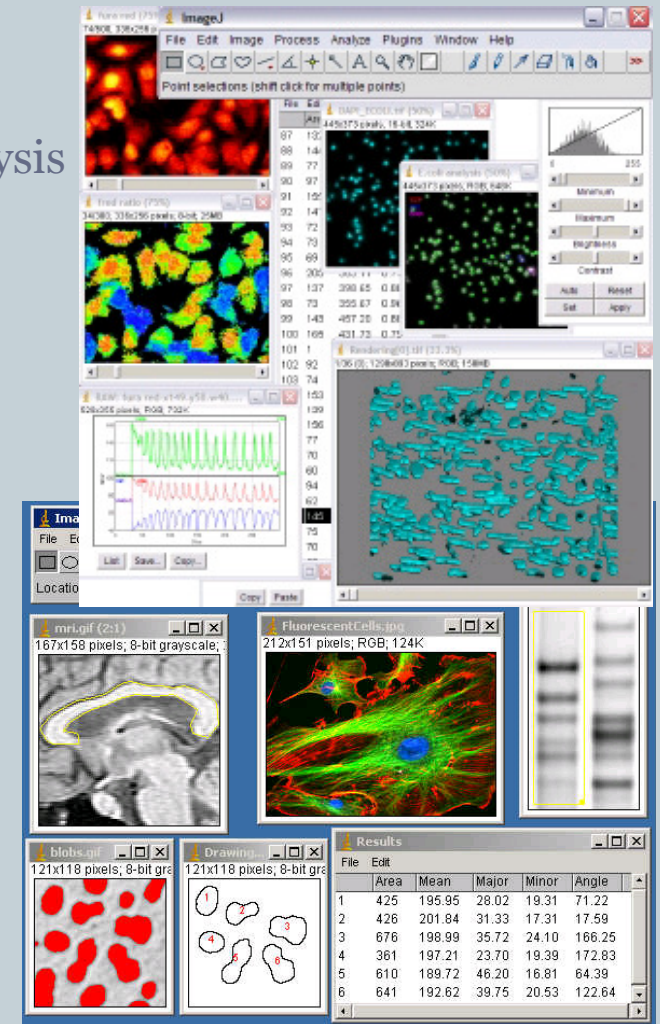
Goal

- Combine virtual microscope techniques and open source image analysis libraries within a distributed parallel processing framework
- Automatic sharpness assessment of whole slide images

Introduction (2)



- Application and library for image processing and analysis
- Developed by Wayne Rasband at NIH
- Large active developer and user community
- Public domain and platform independent
- Many available plugins
- Specialized plugin-bundles for microscopy (MBF, Fiji)



Introduction (3)



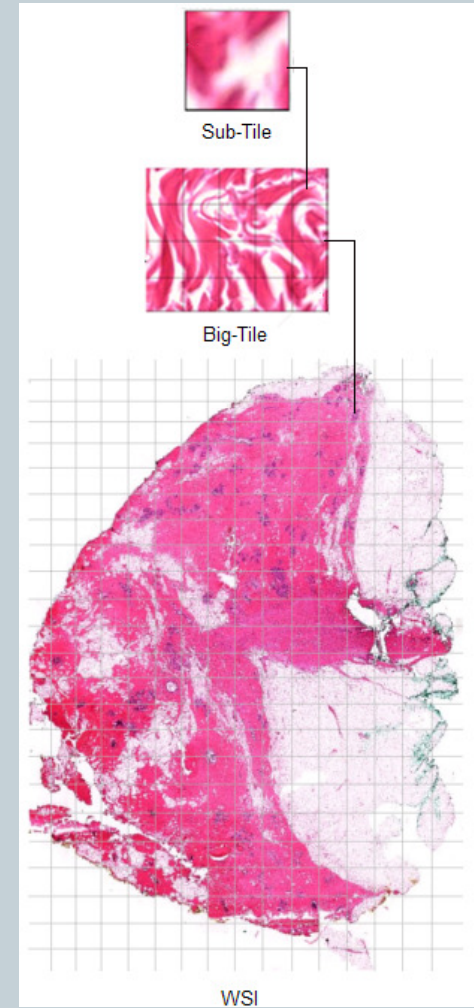
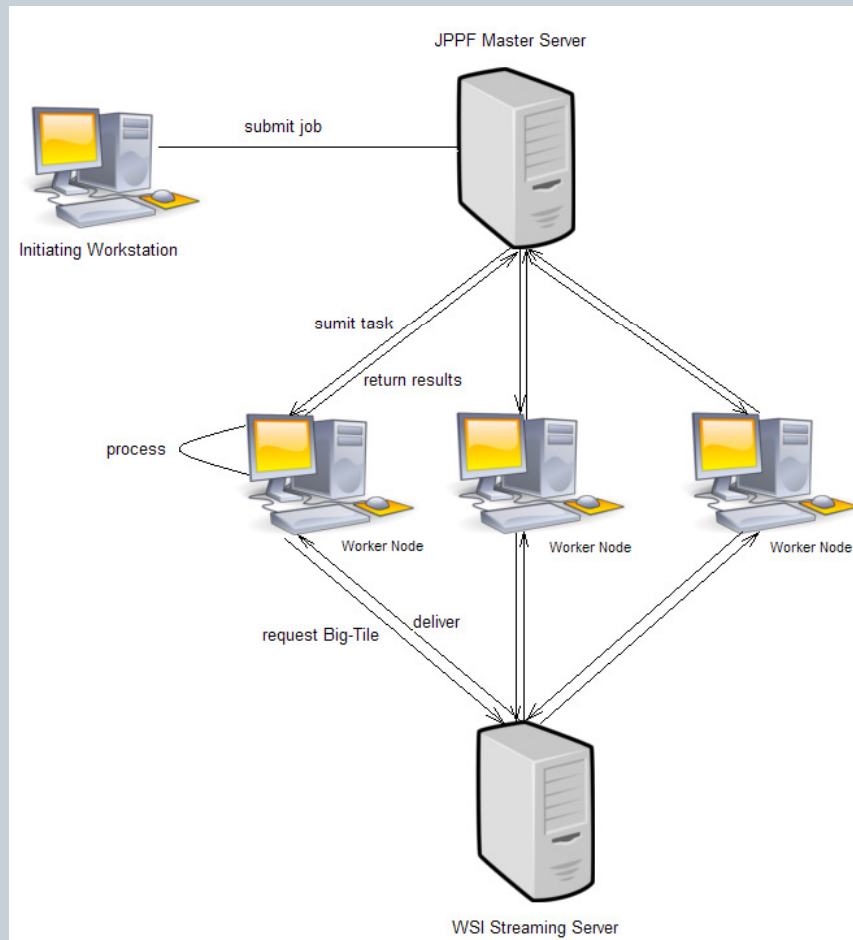
- Java Parallel Processing Framework
- Open source and platform independent
- Dynamically scalable on-demand
- Fault-tolerance and self-repair capabilities
- Low priority service on worker nodes
- Monitoring and administration

Node	Threads / Priority	Node Status	Exec status	Tasks Exec...	Task Status
patho-cscw.charite.de:11198					
c05mw-pt-klp-60.charite.de:12001	2 / 5	END_CONNECT	START_EXEC	9884	
wsi-vm01.charite.de:12001	2 / 5	END_CONNECT	TASK_EXECUTED	12242	
c05mw-pt-klp-28.charite.de:12001	2 / 5	END_CONNECT	START_EXEC	2350	
c05mw-pt-klp-27.charite.de:12001	2 / 5	END_CONNECT	TASK_EXECUTED	2513	
c05mw-pt-klp-56.charite.de:12001	2 / 5	END_CONNECT	START_EXEC	1909	
wsi-assist.charite.de:12001	2 / 5	END_CONNECT	TASK_EXECUTED	1393	
c05mw-pt-klp-26.charite.de:12001	2 / 5	END_CONNECT	START_EXEC	1929	
wsi-vm02.charite.de:12001	2 / 5	END_CONNECT	TASK_EXECUTED	2132	
wsi-vm05.charite.de:12001	2 / 5	END_CONNECT	START_EXEC	1882	
wsi-vm04.charite.de:12001	2 / 5	END_CONNECT	TASK_EXECUTED	1961	
c05mw-pt-klp-53.charite.de:12001	2 / 5	END_CONNECT	START_EXEC	1898	
c05mw-pt-klp-57.charite.de:12001	2 / 5	END_CONNECT	TASK_EXECUTED	1843	



Material & Methods (1)

System Architecture



Material & Methods (2)

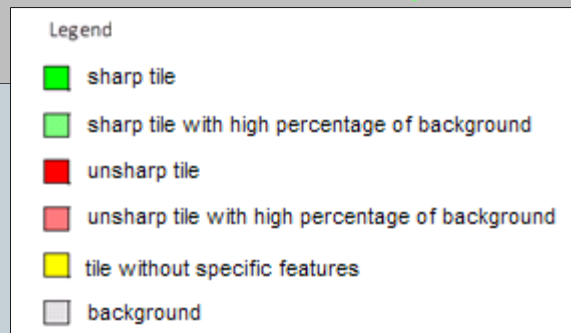
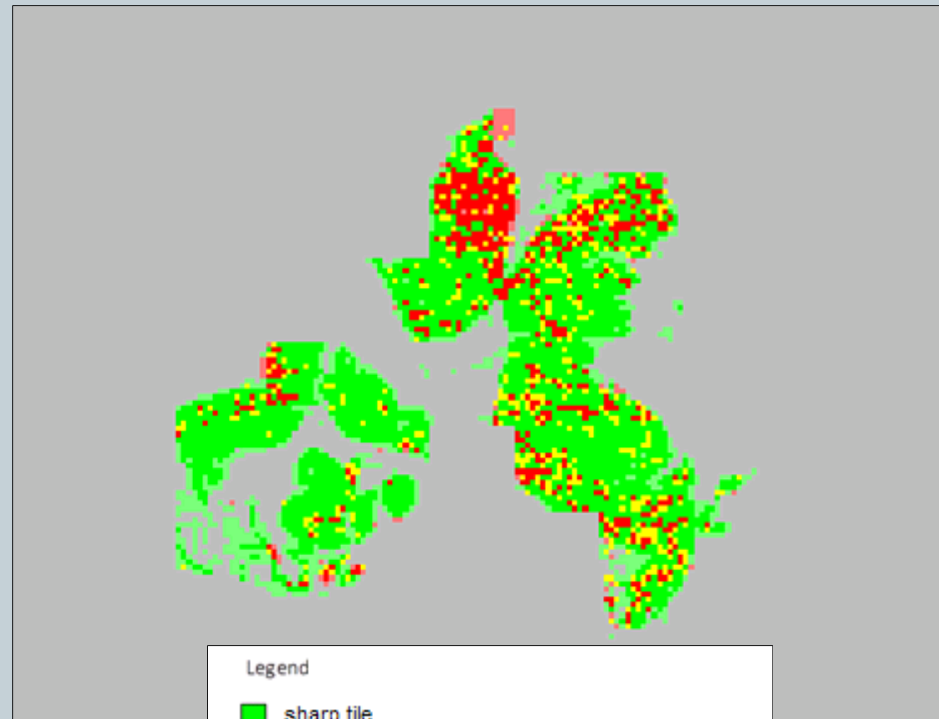
- Tenengrad sharpness measure :

$$|\nabla I(x,y)| = \sqrt{I_x^2 + I_y^2}$$

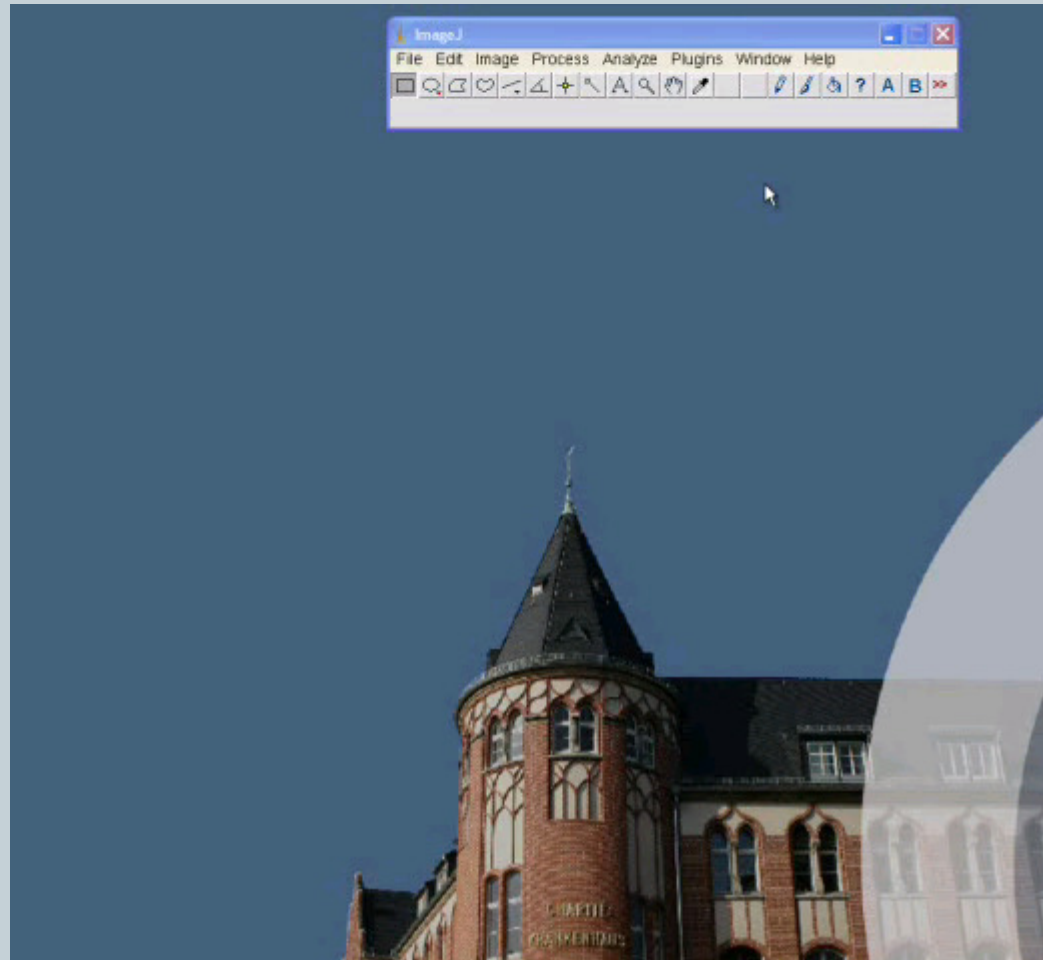
$$S(x,y) = \sqrt{(i_x * I(x,y))^2 + (i_y * I(x,y))^2}$$

$$\max \sum_x \sum_y S(x,y)^2 \quad \text{für} \quad S(x,y) \geq T$$

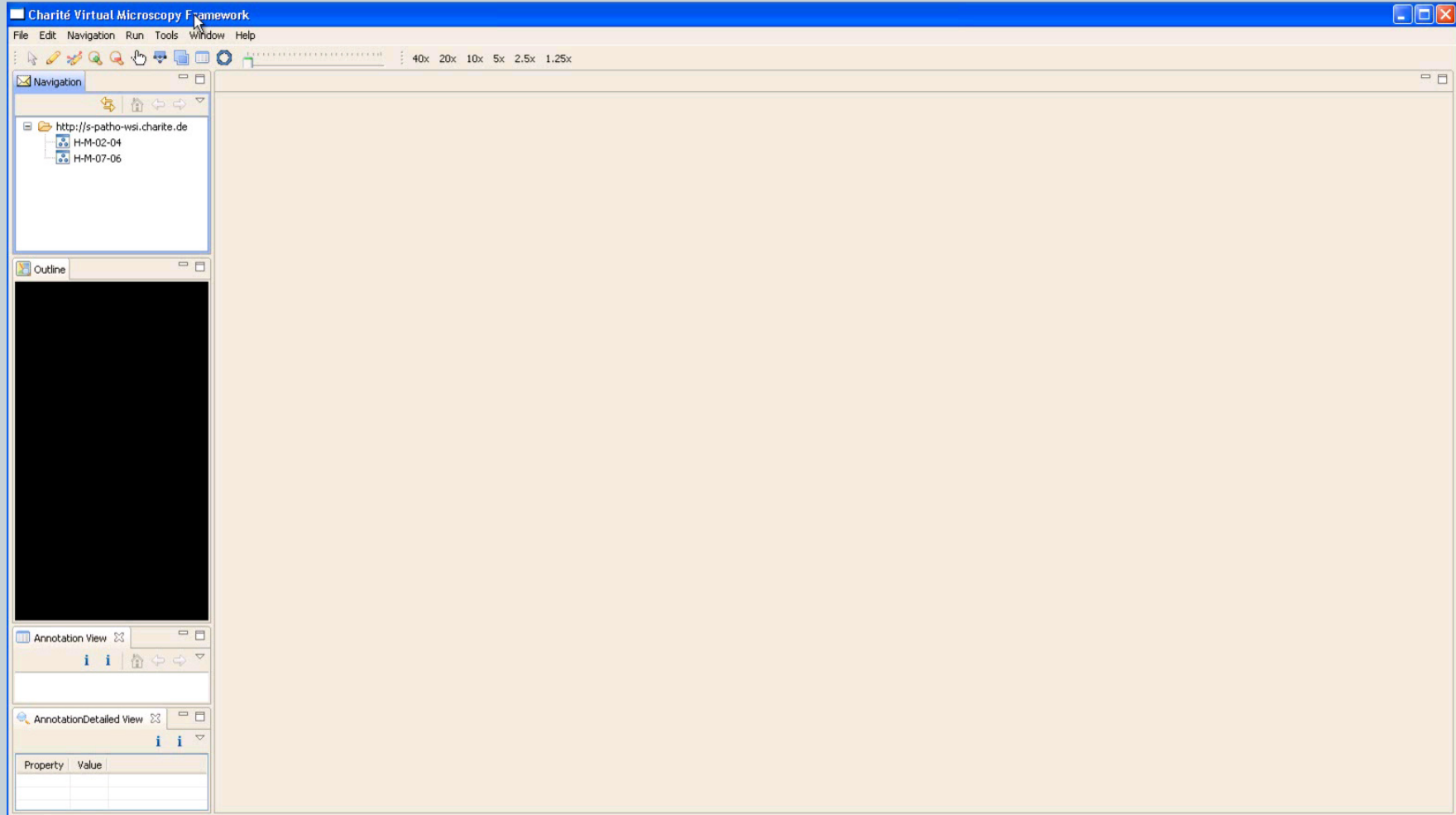
- Aggregation of tile based results
- Return task based results
- Merge results
- Classification of virtual slides
 - Excellent quality
 - Acceptable quality
 - To be reviewed
 - Defective quality



Results (1)



Results(2)



Future Work



- Merge resulting data inside a relational DBMS
- Load balancing for multiple WSI streaming servers
- Enhancements related to special tissue types, eg. fat, stroma, bone
- Evaluation during the scanning process

Conclusion



- Upgrade ImageJ to a virtual microscope
- Distributed batch processing of WSI for sharpness inspection
- Open system architecture for various application contexts



Thank you for your attention!

This work has been supported by Zukunftsfonds Berlin (TSB, IBB).

