AI in Astrophotography

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What is AI (Artificial Intelligence)

- Machines capable of perception, logic, and learning
- Machine learning employs algorithms that learn from data to make predictions or decisions and whose performance improves when exposed to more data over time
- Deep learning uses many-layered neural networks to build algorithms that find the best way to perform tasks on their own based on vast sets of data

Definition from Intel Corporation

AI applications in photography

- AI allows the developer to focus on solving the problem rather than coding for it
- AI has been a part of digital photography for some time now
  - ✓ Adobe Photoshop CC
  - ✓ Topaz DeNoise AI, Gigapixel AI, Sharpen AI, etc.
  - ✓ DxO DeepPrime
- AI used in graphic arts
  - ✓ Builds images based on a plethora of images, including stock photos by using text descriptions provided by the maker
  - ✓ Not true photography
  - ✓ MidJourney, StableFusion and many others
  - ✓ Not what we will be discussing in this presentation

Where is AI in Astrophotography?

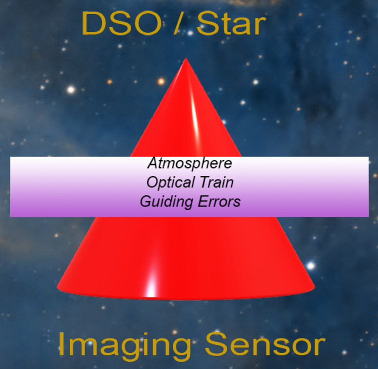
- Astrophotography has lagged behind the photography industry in adopting AI
- Many astrophotographers have used Topaz Denoise AI
  - ✓ Topaz Denoise AI does an excellent job for non-astrophotos but lacks features needed for astrophotography
  - ✓ Topaz AI neural networks were not trained using astrophotos
- Russ Croman's RC-Astro introduced AI to astrophotography
  - ✓ StarXterminator
  - ✓ NoiseXterminator
  - ✓ Most recently, BlurXterminator (deconvolution)
  - ✓ All use neural networks built with carefully selected astro images
  - ✓ The neural network is continuously learning from new images over time, and they are released to the user base as new databases

What are the advantages of AI over past methods?

- Again, it allows the developer to focus on solving the problem (noise reduction, deconvolution, star recognition) rather than writing code.
  - ✓ Think of it as a different approach to solving the mathematical problems we face in digital image processing
- Eliminates tedious guesswork in running the traditional PixInsight processes (use of masks, wavelet layers, switches and dials)
- Yields much better results in much less time
- Virtually free of processing artifacts
- And it is using YOUR image data without replacing any part of it with another image
  - ✓ Deconvolution is about recovering fine-scale image signal buried in low contrast
  - ✓ It is NOT large-scale recovery such as the multiscale functions in PixInsight
  - ✓ BXT only recovers detail if the detail exists in your data at low contrast

Importance of PSF in BXT (Deconvolution)

- The ideal point spread function (PSF) is the three-dimensional diffraction pattern of light emitted from an infinitely small point source in space and transmitted to the image plane through a high numerical aperture objective.
- Think of PSF as a cone where light is diffracted through the atmosphere and an optical train, causing the light to spread beyond the center spike of the cone. Stars are selected for the PSF since they represent a tiny point of light in the overall image.
- Deconvolution is never perfect, but it reduces the spread of light captured on the imaging sensor, resulting in clearer structures and tighter stars.
- PSF is expressed as the FWHM (Full Width Half Maximum)



Hardware

- Will run on any Windows, Mac or Linux platform
- Easy to install in PixInsight
- Updates are automatic
- Windows platforms with NVIDIA Graphics GPU will speed up processing significantly
  - ✓ Install CUDA 11.8 (NOT 12.0!)
  - ✓ Follow Russ Croman's instructions on BXT for enabling CUDA support
  - ✓ My image processing computer is an AMD Ryzan 9 5950 with 32 logical processors, 128GB RAM, NVMe storage and a NVIDIA RTX 3080 Graphics card

Workflow Considerations

- BlurXterminator (BXT) should be used early in post-processing
  - ✓ After integration of images, Channel Combination, cropping, DBE/GraXpert, Color Calibration but before noise reduction while in a linear state
    - ➢ AI Training was performed on images before noise reduction
  - ✓ Most accurate if given the FWHM of the image rather than relying on AutoPSF
    - ➢ Use Hartmut Bornemann PSFImage script on RGB
    - ➢ Use PI's FWHMEccentricity script on monochrome
  - ✓ Use on luminance (either acquired or extracted)
  - ✓ Can be used on RGB images – new revision allows for the selection of luminance only for RGB images
  - ✓ Look Ma! No masks!
  - ✓ BXT can correct aberrations caused by
    - ➢ Guiding errors
    - ➢ Astigmatism
    - ➢ Primary and Secondary coma
    - ➢ Chromatic aberrations
    - ➢ Varying FWHM star diameters and halos in each color channel

Workflow Considerations

- NoiseXterminator (NXT)
  - ✓While in a linear state after BXT
  - ✓Immediately after permanent histogram stretching – non-linear
- StarXterminator (SXT)
  - ✓Anytime when processing is better on a starless image or when a star mask is needed
  - ✓Can be done in linear and non-linear states
  - ✓Recommended to use “unscreen” mode if reblending stars back into the starless image
    - ❑PixelMath: ~((~starless)*(~stars))

Links

- Russ Croman's RC-Astro site: www.rc-astro.com
  - Russ Croman's AI Presentation to AIC https://www.youtube.com/watch?v=JlSUVJI93jg
  - Adam Block Interview with Russ Croman: https://youtu.be/6hkVBnYYlss
  - RC-Astro page on GPU acceleration: www.rc-astro.com/resources/gpu_nn_acceleration.php
- PixInsight: www.pixinsight.com
- Hartmut Bornemann scripts: www.skypixels.at/pixinsight_scripts.html
- Using New Processes to Improve Image Quality in Post Processing: https://chamberlainobservatory.com/using-new-processes-to-improve-image-quality-in-post-processing/
- Chamberlain Observatory: www.chamberlainobservatory.com/