



Photography

from mathematical
perspectives:

An introduction



Outline

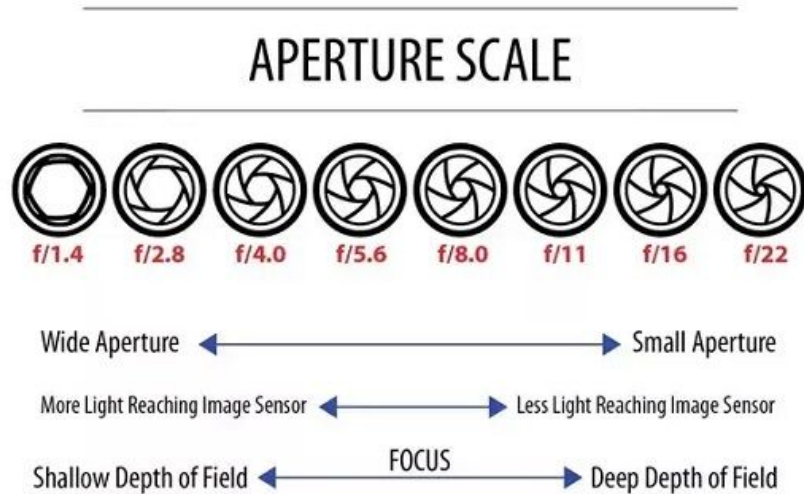
- Mechanisms behind basic parameters
 - Aperture
 - Shutter speed
 - ISO
- Parameter combination (& its visual perception)
 - Same exposure, different visual perception (aperture)
 - Common shooting mode
- Photographic composition
 - Rule of thirds

Parameters



Aperture

- Opening in a lens through which light passes to enter the camera
 - Think about how our eyes work



Aperture

- Expressed as f-stop / f-number
 - f/1.4, f/2, ... , f/22
 - Smaller the number, larger the aperture
 - "F" stands for "focal length"

f/1.4	f/2.8	f/4.0	f/5.6	f/8.0	f/11	f/16	f/22
Fraction		Exact number		F-stop			
	$\sqrt{2}^0$	1		f/1.0			
	$\sqrt{2}^1$	1.414213		f/1.4			
	$\sqrt{2}^2$	2		f/2.0			
	$\sqrt{2}^3$	2.828427		f/2.8			
	$\sqrt{2}^4$	4		f/4.0			
	$\sqrt{2}^5$	5.656854		f/5.6			
	$\sqrt{2}^6$	8		f/8.0			
	$\sqrt{2}^7$	11.31370		f/11			

Aperture

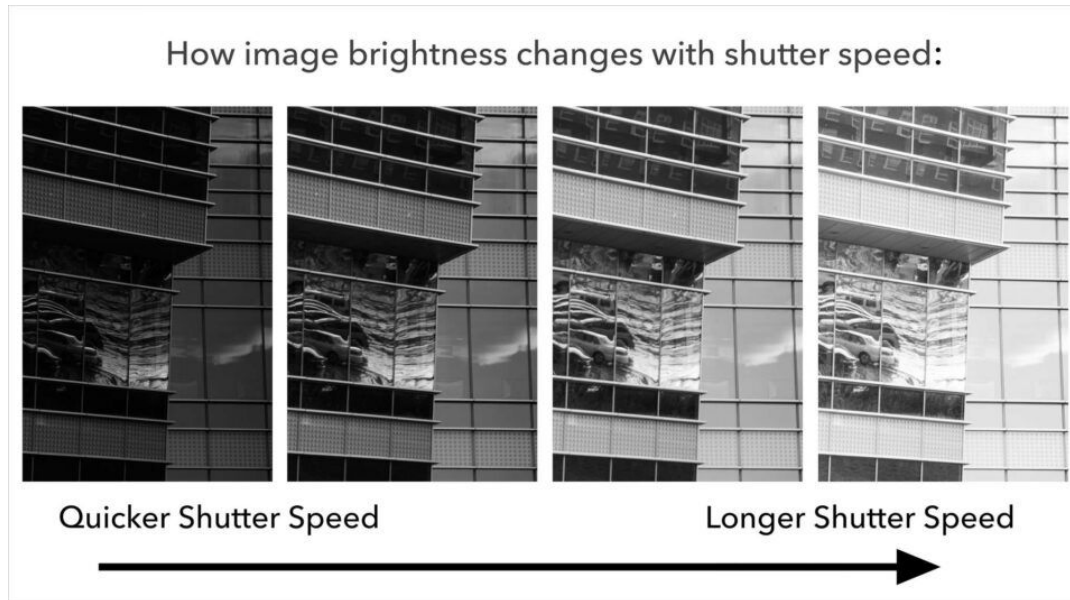
- The F-stop scale
 - $S = \pi * ((F1/Fs)/2)^2$

f/stop	Diameter of aperture (mm)	Radius of aperture (mm)	Area of Aperture (sq. mm)
f/1.0	50.0	25.0	1,963
f/1.4	35.7	17.9	1,002
f/2.0	25.0	12.5	491
f/2.8	17.9	8.9	250
f/4	12.5	6.3	123
f/5.6	8.9	4.5	63
f/8	6.3	3.1	31
f/11	4.5	2.3	16
f/16	3.1	1.6	8
f/22	2.3	1.1	4

(As shown on lens) (50mm divided by f/stop) (1/2 the diameter) (pi X the radius squared)

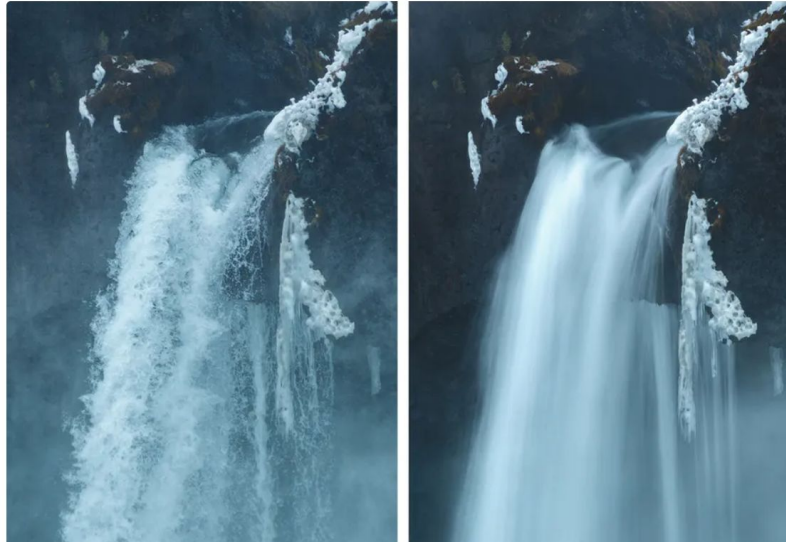
Shutter speed

- Shutter speed is how long an image is exposed to light
 - Written in seconds or a fraction of a second



Shutter speed

- Standard Shutter Speed: Geometric sequence
 - 1, 1/2, 1/4, 1/8, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, 1/1000, 1/2000, 1/5000



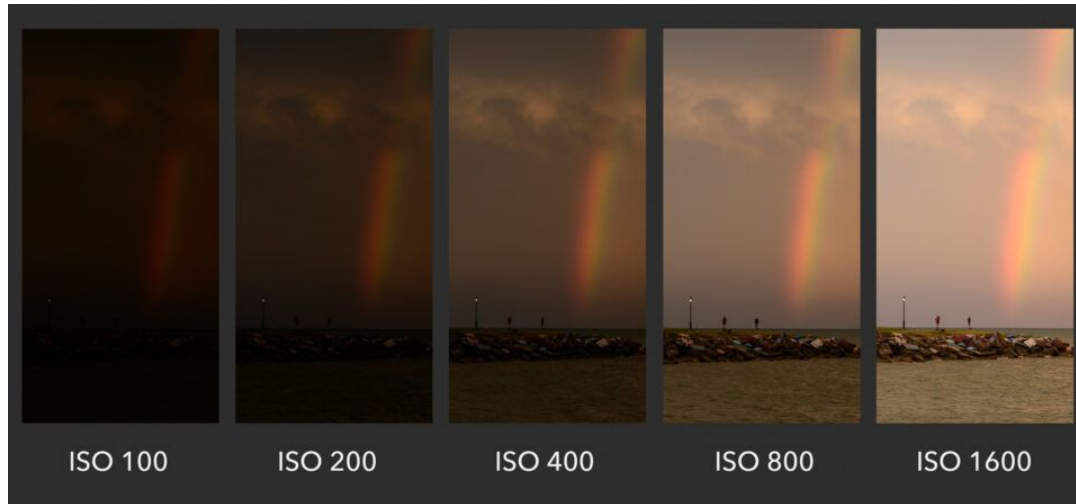
ISO

- Combination of two film standards ASA and DIN in 1974
 - International Organization for Standardization
 - Film sensitivity
 - A function/mapping of input exposure and output photo brightness

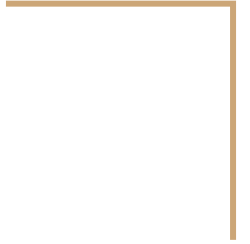
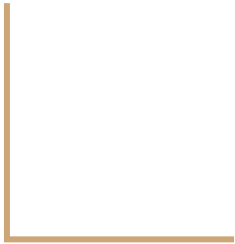


ISO

- Common ISO Values (ISO speeds)
 - ISO 100 (low ISO), 200, 400, 800, 1600. 3200. 6400 (high ISO)
 - $ISO(k) = 100 * 2^{(k-1)}$

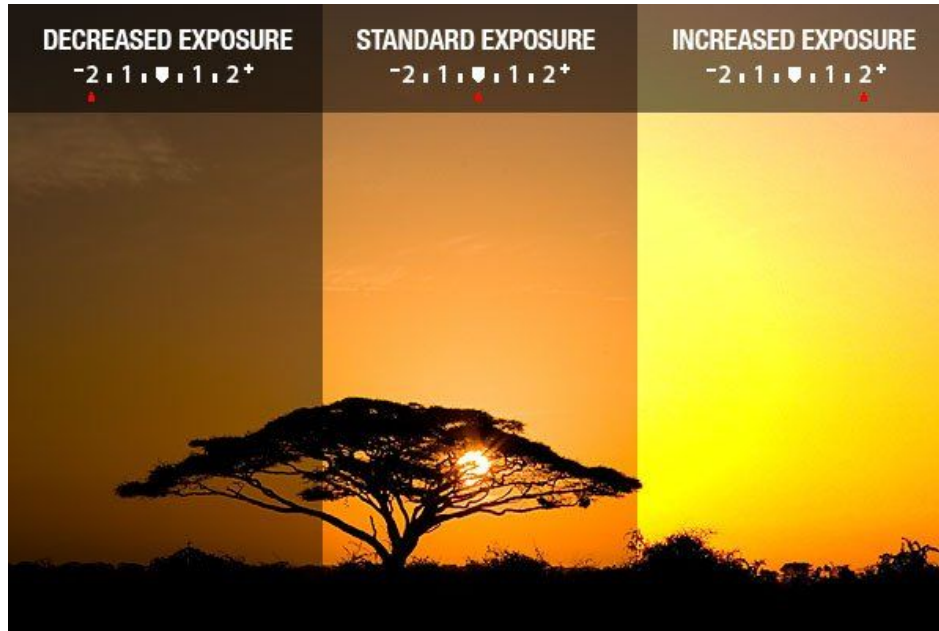


Parameter Combinations



Exposure

- $EV = \log_2 (100 * \text{aperture}^2 / (\text{ISO} * \text{time}))$

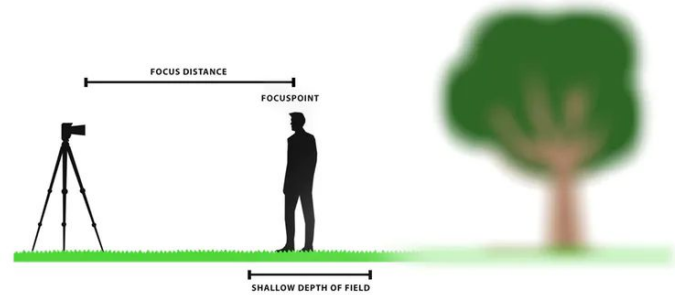


Exposure

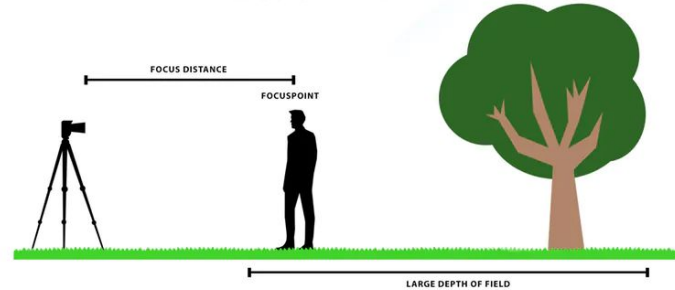
- Multiple controls are useful
 - Light over a wider range
 - Affect how the photograph looks



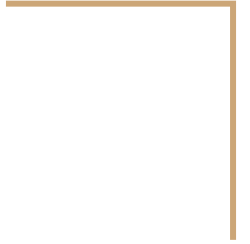
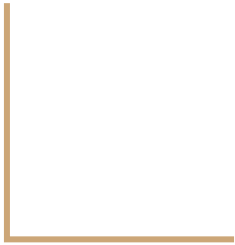
SHALLOW DEPTH OF FIELD :
MORE BACKGROUND BLUR



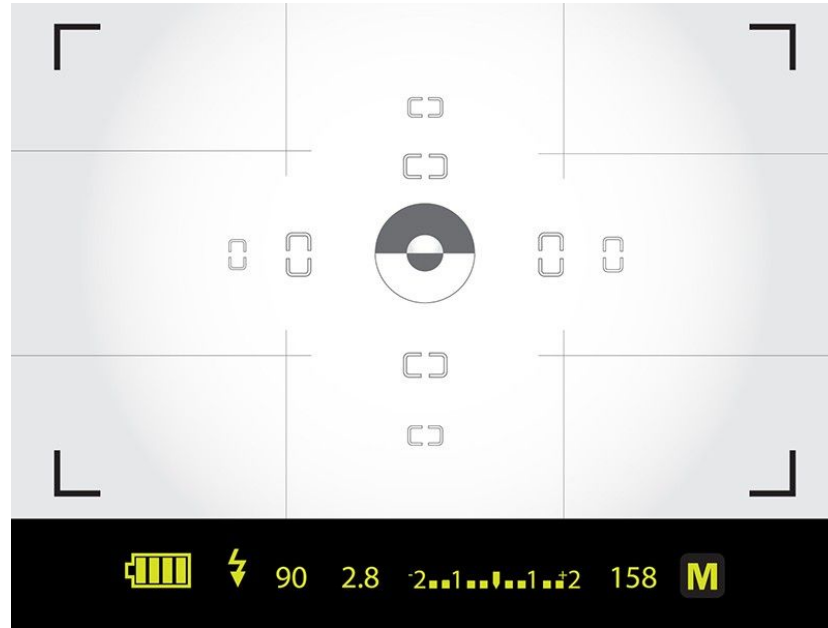
LARGE DEPTH OF FIELD :
LESS (OR NO) BACKGROUND BLUR



Photographic Composition



Rule of third



Rule of third



Rule of third

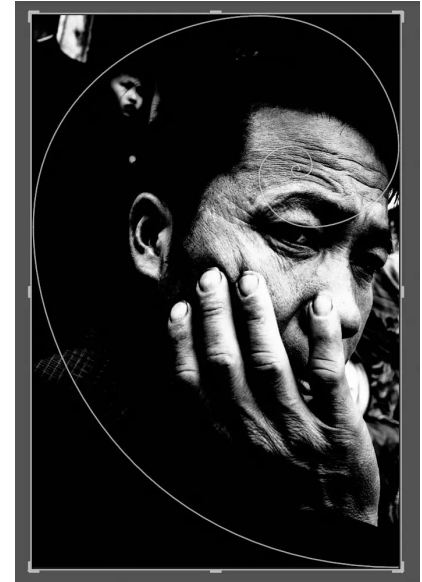
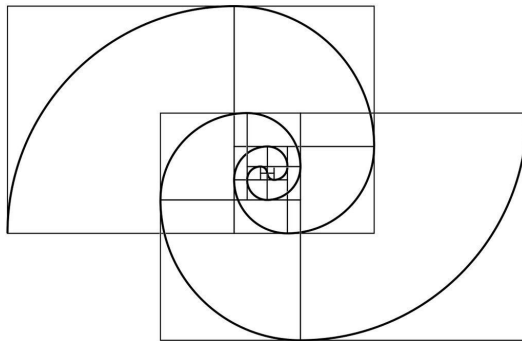
- An imprecise imitation of the Golden Ratio / Fibonacci Sequence

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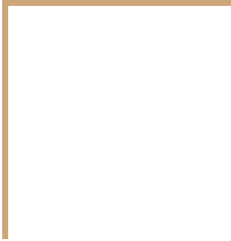
Fibonacci Sequence

- 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987, 1597, 2584, 4181, 6765, 10946, 17711, 28657, 46368, 75025, 121393, 196418, 317811
- ...
- Dates more than 750 years
- developed by Leonardo Pisano Bogollo in Italy





Sapa, 2017



Q&A

Thanks for listening

