**Effects of Photographic Elements on Apparent Age**

**Lighting**

* Improper lighting is by far the biggest issue that comes to causing notably large errors in facial recognition age estimation.
* Certain angles of lighting, particularly lighting that is directly overhead, can cause facial features such as wrinkles or even more prominent facial structure to be accentuated by small shadows that cause someone to look older.
  + When analyzing photos with a notably large error in estimation on an individual basis, this was a common issue.
* Improper lighting that causes large shadows to fall across a portion of the subjects face can skew error in estimation heavily in both directions, but more often than not towards positive error.
  + This was confirmed by analyzing photos individually to be a common issue.
* Uneven lighting, i.e. one side of the face being darker than the other due to the primary light source not being placed in front of the subject, has a notable effect upon error in estimation in both directions for both softwares.

**Logo**

* Inclusion of the logo across a face in a single-subject image or in a cropped photo does notably affect error in estimation by skewing it in the positive direction. Severity of error increase depends on how much of the face is being obscured by the logo, and seemingly tends to be more severe when the lower half of the face is obscured.
* Our hypothesis is that logos have an effect on the facial recognition software similar to shadows falling across faces, though intricacy of logos may affect the software in a way similar to how glasses do (See Misc.).

**Angle**

* When a subject’s face is turned just enough such that one side of their nose is no longer visible, estimations for both softwares tends to go into notably positive errors, generally at least ten years more than the actual age. Severity of error increased as the head was turned further away from the camera.

**Blur/Noise**

* While believed to be a source of significant error prior to analyzing the Python data, blur, exposure, and noise had no significant effect on error for either Amazon or Microsoft regardless of year in which the photo is taken.
  + This is heavily backed up by all the CEO/politician analysis.
  + Unsure of what exactly constituted as ‘blur’ and ‘noise’ by Amazon and Microsoft facial recognition software, though they had no correlation with error in age estimation regardless.
* Issues of blur and noise affecting error in estimation tend to be more prominent when the cause of both stems from jpeg degradation, causing images to become pixelated and detail to be obscured and even lost.

**Black and White**

* A photo being in black and white as opposed to color often has little effect on error in estimation such that it is often an insignificant factor.
* BW photos are often more affected by possible graininess depending on what year the photo was taken, causing the issue of error with BW photos to be on an individual basis rather than for all BW photos.

**Professional v ‘Action Shot’**

* Professional portrait photos, such as those of politicians, often have few overall photographic issues, though are often at the mercy of how lighting is decided to be set up. The most common issue of lighting when it comes to these photos is that lighting is set at an overhead angle, just close enough to be directly above the subject such the light accentuates minor facial features, causing them to both appear and be estimated as older than they actually are.
  + Portrait photos may best be used as a ‘control group’ for age estimations as they may be able to provide us with the most accurate physical age appearance.
* Professional photos that aren’t portraits or are possibly used for advertisements are not consistently dependable as the lighting in them is often from a side, causing one side of the face to be more lit up than the other, or one side of the face to be darker than the other. This often leads to issues of software estimations having a positive error.
* Both of these types of professional photos are often at the mercy of possible digital editing to make the subject look more presentable, though this is often less of an issue when it comes to portrait photos.
* The reliability of ‘action shots’ is entirely unpredictable due to the uncontrollable factors of lighting, angle, facial expressions, etc. Their quality is entirely reliant on the perception of the photo collector. Even when the subject is staged such that the photo is taken as a portrait or that the subject is intentionally facing the camera, lighting is a consistent issue.

**Expression**

* While expression is a considerable factor almost entirely unique to action shots, since action shots make up the vast majority of our photo archive, it is a very considerable issue that cannot be avoided.
* More often than not, subjects will not simply be smiling or have a neutral expression, but are often talking or appear animated. As such, certain facial features, generally wrinkles and smile lines, are accentuated and can cause the subject to be estimated to be older than they actually are.
* While this is more often an issue with photos of politicians rather than CEOs, photos in which the subject appears stressed, frowning, has their brow furrowed, etc. are particularly worrying as they can cause the subject to be estimated to be older than they actually are. Seeing as this is often a case for politicians, particularly congressman and senators, overall age estimations may be positively skewed simply are likely heavily affected by this, which may place its severity as a factor affecting age estimations among the tier of lighting.
* While not necessarily an expression, a subject’s photo being taken in the midst of talking likely has an additional role in causing a positive error.

**Glasses**

* We believe glasses tend to be picked up by the software as shadows accentuating features, leading to the subject being estimated as older than they really are. However, we are not able to accurately assess just how much of an error glasses add.
  + This was confirmed by analyzing photos individually to be a common issue.
  + This is arguably the most consistent factor causing additional error for both CEOs and politicians, primarily those in congress or senate, as they tend to be at an age in which seeing aides are entirely necessary.