A trend is a direction in which something is developing; in medical specialties this can be viewed as the phase before something becomes evidence-based medicine. Early adopters are those that start using a technology as soon as it becomes available, i.e., individuals that are sensitive to trends. Within the medical field, orthopedics has a long track record of being an early adopter.

Unfortunately, discriminating between positive and negative trends can be difficult; while the anterolateral approach for hip fractures (Enocson et al. 2009) has become evidence-based medicine, other trends such as resurfacing arthroplasties (Reito et al. 2017) and primary surgery for clavicle fractures (Ban et al. 2016) have failed. As increasing amount of innovation occurs in the digital space, it is important that we transfer the lessons from surgical trends to these innovations.

**Augmented reality**

In this issue of Acta Orthopaedica, Gregory et al. (2018) show us a glimpse of how we may perform surgery a few years down the road. Their article explores the use of mixed reality (also known as augmented reality) for surgery, a technology in which a computer-generated image is superimposed on top of the visual field. This is different from its sibling, virtual reality (VR), where the user is completely immersed in the computer-generated reality. Earliest mentions of augmented reality in PubMed go back to the mid-1990s (Lavallée et al. 1995), but we have only recently gained the technology that can live up to the original visions.

While Gregory et al.’s paper shows the first stumbling steps, it feels quite plausible that this could be just as common as cordless power tools in the years to come. The field where augmented reality probably has the strongest foothold is neurosurgery (Kersten-Oertel et al. 2013), but unfortunately the evidence of whether outcomes actually improve is scarce (Meola et al. 2017). It will be interesting to see if augmented reality will become a trend—at the moment the jury is still out; it is even uncertain whether they have assembled.

**Computer-assisted surgery**

Computer-assisted surgery (CAS) has, contrary to augmented reality, been both widely implemented and tested, especially for knee surgery. By mapping CT/MRI scans to the actual bone the system can navigate for the surgeon, thereby allowing improved implant positioning and smaller incisions (Dutton et al. 2008). An interesting randomized controlled trial from Petursson et al. (2017) showed no benefit in regard to RSA migration patterns, i.e. no signs of improved implant survival despite better positioning. Recently, they published patient reported outcomes from the same RCT where CAS patients were better on some subscales (Petursson et al. 2018), this should though be viewed with caution as knee function was a secondary outcome and the subscales were never mentioned in the ClinicalTrials.gov registration. Large registry cohorts have, though, not been able to clearly demonstrate the benefits (Roberts et al. 2015, Dyrhovden et al. 2016) and there are reports of falling utilization rates (Gholson et al. 2017).

Some believe that patient-specific guides will succeed CAS. By skipping the cumbersome mapping of the CT/MRI to the bone structure, you get patient specific 3D-printed saw guides that can both reduce the surgery time and improve accuracy. Unfortunately, this has also failed to translate into any tangible patient benefits (Chareancholvanich et al. 2013, Victor et al. 2014, Leeuwen et al. 2018). The trend is certainly looking grim for these types of technologies.

**Robot-assisted surgery**

One interesting development is the development of robot-assisted orthopedic surgery. At the moment we are still far from fully autonomous robots, but simply assisting the human could be an efficient way of providing accuracy (Marchand et al. 2018). The long history of robotic surgery publications (Kwoh et al. 1988, Bach et al. 2002) suggests that the trend has some difficulty catching on. A quick glance at other surgical fields shows that the robot trend has certainly made a huge impact; the Da Vinci surgical system continues to grow year on year (Peters et al. 2018).

**Artificial intelligence**

One of the strongest general tech-trends recently is the revival of neural networks, also known as deep learning, a form of artificial intelligence (AI). Through my work in applying AI for interpreting radiographs (Olczak et al. 2017) I am certainly biased, but I believe there is great potential in the technology. For instance, Chung et al. (2018) recently showed how it could be used for classifying humerus fractures, providing hope for solving the low classification reproducibility (Audigé et al. 2004). It is hoped it could also make the classifications more clinically relevant (Shehovych et al. 2016). There is also interesting work for classifying knee osteoarthritis (Tiulpin et al. 2018), the authors of which have released their dataset for anyone to experiment with (open data).
Artificial intelligence is, however, not limited to image interpretations. The technology is about finding structure in data; it is similar to regular statistics but does this on an entirely different scale. It is already being implemented for augmented reality (Pollefeys 2017) and can in theory enhance anything that analyzes patterns. At the same time, there are indications that clinical applications struggle to deliver (Ross and Swetlitz 2017). The struggles suggest that we still have a lot to learn and, based on my own experience, it takes time to appreciate the full complexity. For instance, an orthopedic surgeon is well aware that a fracture is not a question of yes/no, but has almost infinite subtle interpretations.

Final thoughts

We know that predicting the next big thing is hard (Denrell and Fang 2010), but at the same time it is interesting to survey the area and think of what direction we want the future to take. There are even some who believe that we are the ones who shape the future. Most of the things mentioned in this paper will require great efforts and a great number of people; fortunately, it has never been easier to participate in this endeavor.

Max Gordon
Department of Clinical Sciences at Danderyd Hospital
Karolinska Institute, Stockholm, Sweden
Email: max@gforge.se

Audigé L, Bhandari M, Kellam J. How reliable are reliability studies of fracture classifications? A systematic review of their methodologies. Acta Orthop 2017; 88(6): 576-83.

Bach C M, Winter P, Nogler M, Göbel G, Wimmer C, Ogon M. No functional impairment after Robodoc total hip arthroplasty. Acta Orthop Scand 2002; 73(4): 386-91.

Ban I, Nowak J, Virtanen K, Troelsen A. Overtreatment of displaced midshaid clavicle fractures. Acta Orthop 2016; 87(6): 541-5.

Chareancholvanich K, Narkbunnam R, Pornrattanamanewong C. A prospective randomised controlled study of patient-specific cutting guides compared with conventional instrumentation in total knee replacement. Bone Joint J 2013; 95-B(3): 354-9.

Chung S W, Han S S, Lee J W, Oh K-S, Kim N R, Yoon J P, Kim J Y, Moon S H, Kwon J, Lee H-J, Noh Y-M, Kim Y. Automated detection and classification of the proximal humerus fracture by using deep learning algorithm. Acta Orthop 2018; 89(4): 468-73.

Denrell J, Fang C. Predicting the next big thing: success as a signal of poor reality (Pollefeys 2017), but at the same time it is interesting to survey the area and think of what direction we want the future to take.

Marchand R C, Dodhi N, Khlopas A, Sultan A A, Higuera CA, Stearns K L, Mont M A. Coronal correction for severe deformity using robotic-assisted total knee arthroplasty. J Knee Surg 2018; 31(01): 2-5.

Meola A, Cutole F, Carbone M, Cagnazzo F, Ferrari M, Ferrari V. Augmented reality in neurosurgery: a systematic review. Neurosurg Rev 2017; 40(4): 537-48.

Olczak J, Fahlberg N, Maki A, Razavias A S, Jilert A, Stark A, Sköldenberg O, Gordon M. Artificial intelligence for analyzing orthopedic trauma radiographs. Acta Orthop 2017; 88(6): 581-6.

Peters B S, Armijo P R, Krause C, Choudhury S A, Oleynikov D. Review of emerging surgical robotic technology. Surg Endosc 2018; 32(4): 1636-55.

Pettersson G, Fenstad A M, Göthisen O, Dyhovden G S, Hallan G, Røhrl S M, Aamdot A, Furnes O. Computer-assisted compared with conventional total knee replacement: A multicenter parallel-group randomized controlled trial. J Bone Joint Surg 2018; 100(15): 1265-74.

Petersson G, Fenstad A M, Göthisen O, Dyhovden G S, Hallan G, Røhrl S M, Aamdot A, Furnes O. Similar migration in computer-assisted and conventional total knee arthroplasty. Acta Orthop 2017; 88(2): 166-72.

Pollefeys M. Second version of Hololens HPU will incorporate AI coprocessor for implementing DNNs. Microsoft Res Blog. 2017. https://www.microsoft.com/en-us/research/blog/second-version-hololens-hpu-will-incorporate-ai-coprocessor-implementing-dnn/

Reito A, Lehtovirta L, Lainiala O, Mäkelä I, Eskelinen A. Lack of evidence: the anti-stepwise introduction of metal-on-metal hip replacements. Acta Orthop 2017; 88(5): 478-83.

Roberts T D, Clatworthy M G, Frampton C M, Young S W. Does computer assisted navigation improve functional outcomes and implant survivability after total knee arthroplasty? J Arthroplasty 2015; 30(9, Suppl.): 59-63.

Ross C, Swetlitz I. IBM pitched Watson as a revolution in cancer care. It’s nowhere close. STAT News. 2017. https://www.statnews.com/2017/09/05/watson-ibm-cancer/

Shehovych A, Salar O, Meyer C, Ford D. Adult distal radius fractures classification systems: essential clinical knowledge or abstract memory testing? Ann R Coll Surg Eng 2016; 98(8): 525-31.

Tulipin A, Thevenot J, Rahu E, Lehenkari P, Saarakkala S. Automatic knee osteoarthritis diagnosis from plain radiographs: a deep learning-based approach. Sci Rep 2018; 8(1): 1727.

Victor J, Dujardin J, Vandenneucker H, Arnou N, Bellemans J. Patient-specific guides do not improve accuracy in total knee arthroplasty: a prospective randomized controlled trial. Clin Orthop Relat Res 2014; 472(1): 263-71.

Enedson A, Hedbeck C-J, Tidermark J, Pettersson H, Ponzer S, Lapidus L J. Dislocation of total hip replacement in patients with fractures of the femoral neck: a prospective cohort study of 713 consecutive hips. Acta Orthop 2009; 80(2): 184-9.

Gholson J J, Duchman K R, Otero J E, Pugely A J, Gao Y, Callaghan J J. Computer navigated total knee arthroplasty: rates of adoption and early complications. J Arthroplasty 2017; 32(7): 2113-19.

Gregory T M, Gregory J, Sledge J, Allard R, Mir O. Surgery guided by mixed reality: presentation of a proof of concept. Acta Orthop 2018; 89(5): 480-483.

Kersten-Oertel M, Jamin P, Collins D L. The state of the art of visualization in mixed reality image guided surgery. Comput Med Imaging Graph 2013; 37(2): 98-112.

Kwok Y S, Hou J, Jonckheere E A, Hayati S. A robot with improved absolute positioning accuracy for CT guided stereotactic brain surgery. IEEE Trans Biomed Eng 1988; 35(2): 153-60.