MLADEN JOVANOVIĆ

STRENGTH TRAINING MANUAL

The Agile Periodization Approach

Volume I

Strength Training Manual

The Agile Periodization Approach
Volume One

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Preface to the Volume One

When I started writing the Strength Training Manual, I wanted it to be a simple and short book with heuristics and reference tables. As I began to write, I soon realized that the readers will have hard time understanding how to actually apply those heuristics and tables, as well as understand the whys behind them. Additionally, writing is not a simple act of dumping material on paper for me, but rather an act of exploration and discovery. Therefore, as I wrote, new things emerged and I wanted to play with them, attack them from multiple perspectives to see how robust they are. In the end, this made the Strength Training Manual much larger and much slower to write than I originally intended.

The reasons why the Strength Training Manual e-book comes in volumes are as follows. First, I can split it in chunks, which, for those who embark on any writing adventure, is much more manageable. Second, I wanted this to be available to the readers as soon as possible, so that I can collect the feedback and improve the text for the potential paperback/hardback edition. Third, reading 600-page e-book is much harder than reading 200-something e-book. Fourth, the profit. E-book version of the Strength Training Manual published in volumes is available for free for the Complementary Training members, which makes it an additional benefit of the membership. In a nutshell, publishing in volumes seemed like a good idea and a solution. Only time will tell if I was right or wrong.

In this Volume One, first four chapters are published, plus the exercise table from the Appendix. This Volume is heavier on the philosophy and the Agile Periodization behind my strength training planning, although chapters 3 and 4 are much more practical and provide multiple useful tables and heuristics.

As always, I am looking forward to your critiques and feedback. Please do not hesitate to contact me if you have any questions or spot any kind of bullshit.

Mladen Jovanović

1 Introduction

As a strength and conditioning coach, I have always collected and referenced numerous tables, heuristics and guidelines (such as various rep max tables, Prilepin table, exercise max ratios to name a few) that helped me create strength training programs. Unfortunately, these were usually spread all over the place: numerous books and papers, countless Excel sheets and PowerPoint presentations. Every time I wanted to quickly find something to reference and possibly to compare, it was a major pain in the arse finding it. So I decided to put them all together in one place, where I can easily find them and use them, possibly have it at arms reach in the gym.

Thus, I decided to create this manual. But please note that this manual is not an in-depth how-to book, but a simple collection of useful tables and heuristics that you can use as a starting point when designing your strength training programs. Having said this, it is important to quickly go through some of the rationale and warnings before diving into the material. It is a bit philosophical, but please bear with me for the next few pages.

Precision versus Significance

"As complexity rises, precise statements lose meaning and meaningful statements lose precision" – Lofti Zadeh

The material in this manual is WRONG. It is not precise. It will vary, sometimes a lot, between exercises, individuals, and genders (all 457 of them). This should be expected since day-to-day motivation and readiness to train, improvement rates, testing errors, among others, are not constant and predictable, but rather represent sources of uncertainty, often experienced when working with athletes or dealing with any kind of performance enhancement. It is therefore up to you to update it with the information you possess and gain through training iterations. Figure 1.1 below depicts perfectly the difference between precision and significance, and the aim of this manual.

Precision and Significance in the Real World

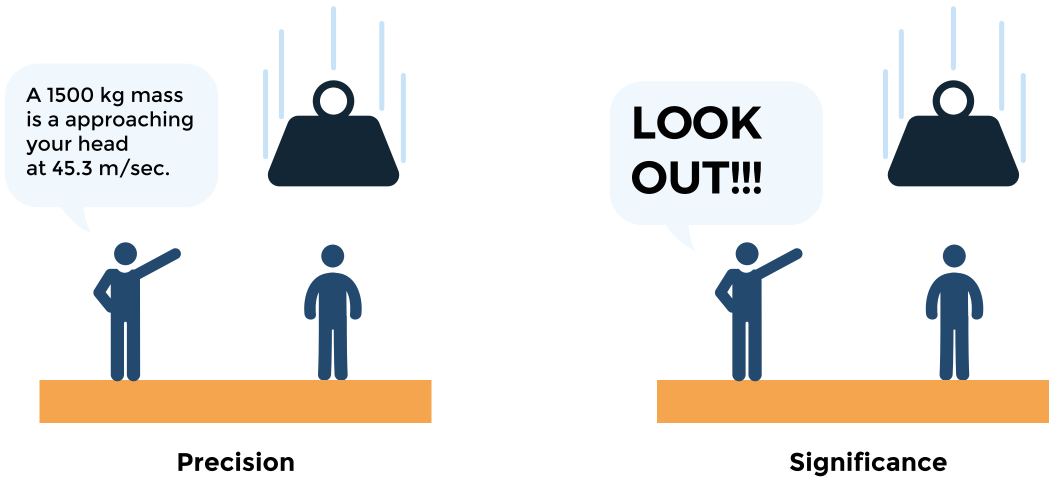


Figure 1.1. Difference between precision and significance. Image modified based on image in Fuzzy Logic Toolbox™ User's Guide (MathWorks, 2019)

Generalizations, *Priors*, and Bayesian updating

Not sure if there is anything else that pisses me off more than hearing someone say: "You cannot generalize!". Yeah right, I will approach every phenomenon in the Universe as unique and genuine. Not sure we have the brain power for that - that's why we try to reduce the amount of information by generalizing. There is no science without generalization. That's why we have generalizations, laws, archetypes, stereotypes.

But smart people are not slaves to generalizations - they start with generalizations, but quickly *update* them with new information to improve their insights. For example, one can say that females are generally weaker than males (yeah, sexist generalization), which means two things: (1) average female is weaker than the average male, and (2) randomly selected female will be very likely to be weaker than randomly selected male in the population. Of course, we also need to take into account *how much* weaker, but without making this a statistic treatise about magnitudes of effects, one cannot claim that *all* females are weaker than *all* males. Even if we start with this generalization before working with a new female individual client or athlete and *assume* generalization is true and we apply it to this individual as well (let's call this *prior* belief), we need to update this prior belief with observations and experience while working with this individual, who might be a future or current world class powerlifter (and probably stronger than 90% of males).

This means that we need to update our prior beliefs (e.g. generalizations, or heuristics) with our own observations in the process called *Bayesian updating* to gain insights which will educate our decision making.

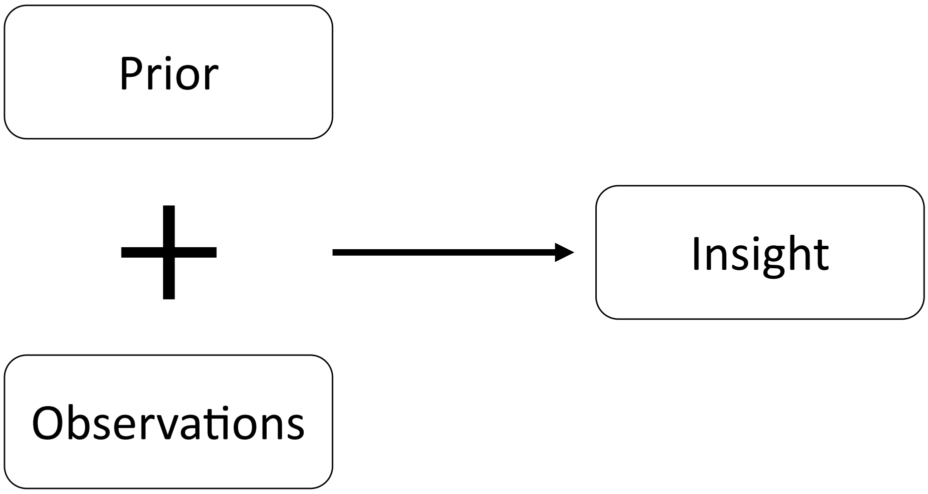


Figure 1.2. Bayesian updating, simplified

This manual is full of generalizations. Hence, you need to look at them as a starting point, which you should update with your own observations, experience, experimentations, and intuition. Just don't be a dumbfuck and blindly believe and adopt everything that has been written. Again, use it as a starting point (*prior*).

Large and Small Worlds

The real world is very complex and uncertain. To help in orienting ourselves in it, we create maps and models. These are representations of reality, or representations of the real world. In the outstanding statistics book "Statistical Rethinking" (McElreath, 2015), author uses an analogy, originally coined by Leonard Savage (Savage, 1972; Binmore, 2011; Volz & Gigerenzer, 2012; Gigerenzer, Hertwig & Pachur, 2015a), that differentiates between *Large World* and *Small Worlds*:

> *"The small world is the self-contained, logical world of the model. Within the small world, all possibilities are nominated. There are no pure surprises, like*

the existence of a huge continent between Europe and Asia. Within the small world of the model, it is important to be able to verify the model's logic, making sure that it performs as expected under favorable assumptions. Bayesian models have some advantages in this regard, as they have reasonable claims to optimality: No alternative model could make better use of the information in the data and support better decisions, assuming the small world is an accurate description of the real world.

The large world is the broader context in which one deploys a model. In the large world, there may be events that were not imagined in the small world. Moreover, the model is always an incomplete representation of the large world and so will make mistakes, even if all kinds of events have been properly nominated. The logical consistency of a model in the small world is no guarantee that it will be optimal in the large world. But it is certainly a warm comfort."[1]

Everything written in this manual represents Small Worlds - self-contained models of assumptions about how things work or should work. Although they are all wrong, some of them are useful[2] (to quote George Box), especially as a starting point in your orientation, experimentation, and deployment to the Large World. It is important to remember the distinction between the two. I embrace the *integrative pluralism* (Mitchell, 2002, 2012) in a way that there are multiple models (Page, 2018) that we should use to explain, predict and plan intervention in the Large World.

Different prediction errors and accompanying costs

Since all models are wrong, but some are useful, we need to make sure they don't come with harmful errors and potential costs. We can make different types of errors, and they come at different costs. Let's take a simplistic model of predicting 1RM (one-repetition maximum, or maximal weight one can lift with a proper technique):

Table 1.1 represents a common scenario for predicting 1RM. The top row contains two TRUE values (150kg and 180kg) and on the side, we have two predictions. The grey diagonal represents correct predictions, while red diagonal represents erroneous predictions. Type I is undershooting (predicting 150kg when the real value is 180kg),

1 Excerpt taken from "Statistical Rethinking" (McElreath, 2015), page 19

2 "All models are wrong, but some are useful" is aphorism that is generally attributed to the statistician George Box. Nassim Nicholas Taleb expanded this aphorism to "All models are wrong, many are useful, some are deadly"

and Type II is overshooting (predicting 180kg when the real value is 150kg). Does making these two errors come with different costs if the predicted 1RM is implemented into the training program? Hell yes!

Predicted 1RM	Real 1RM: 150 kg	Real 1RM: 180 kg
150kg	Correct	Error I (undershooting)
180kg	Error II (overshooting)	Correct

Table 1.1. Different types of prediction error

It must be noted that undershooting a lot is still safer than overshooting a little. This is because when you undershoot, you can still perform training sessions and easily update, while if you overshoot, you will *hit the wall* quite quickly, and potentially injure someone or create expectation stress and/or heavy soreness. Plus, in my own experience, it is easier to ask for more from an athlete, than less. Furthermore, imagine that your program calls for 3 sets of 5 reps with 100kg, and your athlete feels great and performs 8 reps in the last set instead of the situation where your program calls for 3 sets of 5 with 110kg and the athlete struggles to finish it, or might even need to strip the weights down. Performing better than it has been written in the training program is always motivational (first situation), whereas the opposite can be very discouraging (second situation). Collectively, this approach represents protection from the *downside* (i.e. injury) which can further allow us to *invest in the upside (i.e. strength training adaptation*). But more about this in the next chapter.

The problem is that we cannot get rid of errors - we can balance them out by accepting higher Type I error while minimizing Type II error, or *vice versa*. In this manual I accepted the fact that when making errors (and I do make them), I want them to be Type I errors, or undershooting errors since they come up with much less cost that can easily be fixed through few training iterations. Because of that, you might notice that some percentages in this manual are quite low. Therefore, I suggest you take a similar philosophy when deciding about percentages and every other guideline in this manual: lean on the side of conservatism and safety first.

Classification, Categorization and Fuzzy borders

As it is the case with generalization, classifications and categorizations (which I consider synonyms here and use interchangeably) are aiming to reduce the number of dimensions and numbers of particular phenomena at hand (with the aim of easier orientation and action). This eventually means that items in one bracket or class might differ, while items from different brackets or classes might be similar. Besides, there are multiple approaches to classifying phenomena which might have different depths or levels of precision (see Figure 1.3). To paraphrase Jordan B. Peterson: "Categories are constructed in relationship to their functional significance", meaning there are no objective or unbiased approaches to categorization and classification, and they depend on how we aim to use those categorizations[3]. For example, powerlifter might classify strength training means, methods, qualities, and objectives differently than Olympic weightlifter or a soccer player. This is because they experience different phenomena and demand a different *forum for action*. But if you ask your average lab coat to perform *unbiased* and objective classification, he or she will usually perform it as a *place of things* type of classification.

Categorization is not an exercise in futility, but rather helps us make better decisions (more educated and faster decisions via information reduction and simplification). This simplification has some similarities with *heuristics* (fast and frugal rules of thumb that help to avoid overfitting in a complex and uncertain world). Hence, categories should have *functional significance*. In other words, you want to *use* those categories somehow. Therefore, one should stop categorizing once there is no functional significance.

That said, categories should be in the lowest possible "compression" (lowest resolution) that still conveys enough pragmatic information. Since there are numerous ways to categorize certain items (see Kant's *thing in itself*[4]), the way we approach categorization and what we see, depends on what we plan using it for (see Figure 1.3). I might be wrong, but this reminds me of both *phenomenology*[5] (things as they manifest

3 Also check essentialism versus nominalism, realism versus instrumentalism/constructivism and how they are integrated with pragmatist-realist position (Borsboom, Mellenbergh & van Heerden, 2003; Guyon, Falissard & Kop, 2017)

4 From Wikipedia ("Thing-in-itself," 2019): "The thing-in-itself (German: Ding an sich) is a concept introduced by Immanuel Kant. Things-in-themselves would be objects as they are, independent of observation"

5 From Stanford Encyclopedia of Philosophy (Smith, 2018): "Literally, phenomenology is the study of "phenomena": appearances of things, or things as they appear in our experience, or the ways we experience things, thus the meanings things have in our experience. Phenomenology studies conscious experience as experienced from the subjective or first-person point of view."

to us) and *pragmatism*[6] (practical application), although they are radically opposed philosophical positions (together with *analytic* philosophy, which can be considered your average lab coat *objective* and *unbiased* approach to classification). It is beyond this manual (and my current knowledge) to discuss these topics, but in my opinion, philosophy is very much alive, and it needs to be taken into account especially with the recent rise of *scientism*[7] in sport science and performance.

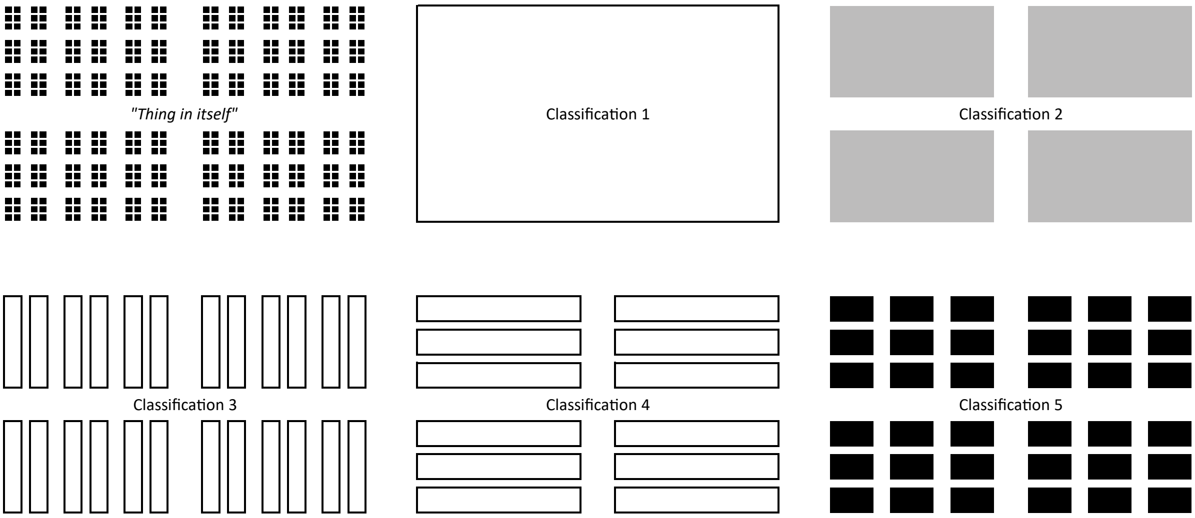


Figure 1.3. There is no bias-free, objective way to classify phenomena. Classification depends on what you plan to use it for[8]

Place of Things vs Forum for Action

Classification thus serves a dual purpose: *place of things* and *forum for action*. By term *place of things,* I refer to simply classify phenomena relative to some *objective* criteria (this is usually physiological, anatomical or biomechanical criteria), or using an *analytical* approach. On the other hand, the *forum for action* refers to a classification based on how we intend to use these classes in planning, action, and intervening. In this manual, I am leaning more toward *forum for action* approach in classifying phenomena, mostly as strength and conditioning coach of team sports athletes, rather than powerlifting or a weightlifting coach. This doesn't mean that powerlifting and weightlifting coaches cannot use this manual (at the end of the day, we have common

6 From Stanford Encyclopedia of Philosophy (Legg & Hookway, 2019): "Pragmatism is a philosophical tradition that – very broadly – understands knowing the world as inseparable from agency within it."

7 Belief or stance that all things can be reduced to science (Boudry & Pigliucci, 2017)

8 Thing-in-itself: "What do you see? Depends on what do you want to use it for". Modified based on the image from Maps of Meaning 5: Story and Meta-story course by Jordan B. Peterson (Peterson, 2017)

physiology, anatomy, psychology, and experience shared phenomena in training), but that they might classify things a bit differently because their forum for action differs than the forum for action of the non-strength-sport athletes.

It is also important to mention that class membership is not a TRUE/FALSE state (although it does simplify things a lot), but rather fuzzy (or continuous) membership. For example, is split squat double leg or single leg movement? For simplicity (Small World model) it is easier to assume it belongs only to one class or category, but in real life (Large World) we know it is not that easy to make a hard border between classes (thus, it can be 60% double leg, and 40% single leg, or what have you). One helpful approach, that helps me at least in minimizing how much I break my own balls over categorization, is to ask "How do I plan using this classification and for whom?". Also, remember that you do not need to be very precise, but rather meaningful and significant in helping yourself orienting from the forum for action perspective (see Figure 1.1).

Qualities, Ontology, Phenomenology, Complexity, Causality

Most, if not all, coaching education material regarding planning and periodization comes with highly biased classification using *objective* physiological and biomechanical approaches (*place of things*; analytical approach (Loland, 1992; Jovanovic, 2018)). These fields have a monopoly on defining *ontology*[9] ("What exists out there") of qualities and methods: maximal strength, explosive strength, VO2max, anaerobic capacity, you name it. Some individuals tend to wave around with this *scientific method*, as something *objective* and *unbiased*, but they are just value signaling, because they are using a *scientific approach*, and you, the little dungeon dweller, are not. But unfortunately, there is no *objective* or *unbiased* approach, and you, the dungeon dweller, might engage phenomena classification as you experience it (phenomenology) and you should not be embarrassed about your *subjectivity*. Yes, you should understand anatomy, physiology and biomechanics, but they should not hold the monopoly over how you classify the phenomena of importance to you. They are necessary, but not sufficient knowledge.

Since these fields define what is real (ontology), it is natural to follow up with an approach that assumes these qualities as the building blocks of *periodized* training

9 From Wikipedia ("Ontology," 2019): "Ontology is the philosophical study of being. More broadly, it studies concepts that directly relate to being, in particular becoming, existence, reality, as well as the basic categories of being and their relations. Traditionally listed as a part of the major branch of philosophy known as metaphysics, ontology often deals with questions concerning what entities exist or may be said to exist and how such entities may be grouped, related within a hierarchy, and subdivided according to similarities and differences."

programs. Beyond this, we assume very simplistic causal models (Small World models of what causes what), where we further assume there is some magic training method, or intensity zone, that drives adaptation of the qualities we need to address. For example, we might claim that reps >90% improve maximal strength and that reps with 65% done fast improve explosiveness. This is bullshit. Even worse than this is the Load Velocity curve with associated qualities and intensity zones.

Unfortunately, or luckily, things are not that simple. Yes, we can use these as Small World models, representations and heuristics (which they are), rather than the factual state of the world (ontology). First, different individuals will manifest different phenomena and will demand different quality identification as a forum for action. For example, what is holding back a world-class powerlifter in the bench press of 200kg might be lockout strength or bottom strength (and these are phenomenological qualities). Thus, one might approach intervention with these qualities in mind. This will not be the case for your average soccer player since his bench press performance is not the ultimate goal, but rather one aspect of what we might consider important for him (i.e. horizontal pressing). Biomechanically speaking, they are identical (place of things), but phenomenologically, they are very much different, especially in defining the qualities from the forum for action perspective and deciding about intervention to improve them.

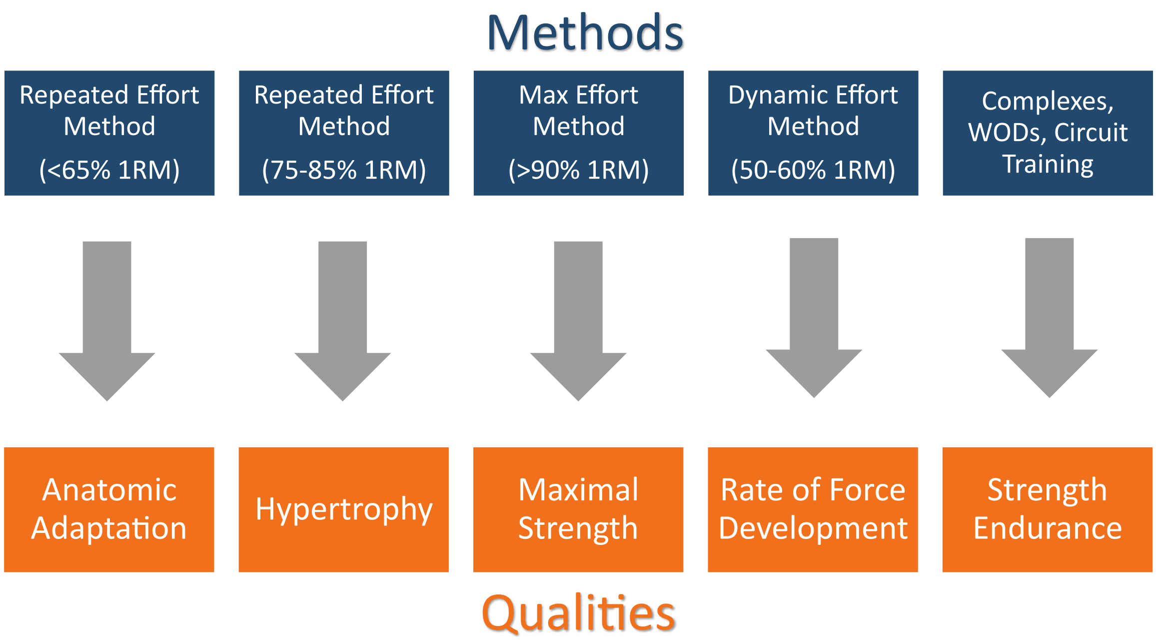


Figure 1.4. An overly simplistic causal model of methods and qualities

Second, assuming there is an associated training method or intensity zone that magically hits identified quality is a pipe dream. The causal network is very complex and at the end of the day, we do need to realize and accept the fact that we are experimenting using a case-by-case approach. There are still useful *priors* we can rely on (e.g. scientific studies, best practices, *old school* methods) as a starting point in our experimentation and updating process, but at the end of the day, we are experimenting, and following some Russian lab coat's program is a warm comfort of certainty assumptions.

Philosophical stance(s) and influential persons

Someone more versed in philosophy than myself currently, can probably put me in certain philosophical stance brackets (i.e. *classify me*). My current reasoning, besides being *complementarist*[10] is that of *integrative pluralist* (Mitchell, 2002, 2012), *pragmatist-realist* (Maul, 2013; Guyon, Falissard & Kop, 2017) and *phenomenologist*. I am highly influenced by works of Robert Pirsig and his *Metaphysics of Quality*[11] (Pirsig, 1991, 2006), Jordan Peterson (Peterson, 1999; Peterson, Doidge & Van Sciver, 2018), Nassim Taleb (Taleb, 2004, 2010, 2012, 2018), and Gerd Gigerenzer (Gigerenzer, 2015; Gigerenzer, Hertwig & Pachur, 2015a). These philosophical stances and personas are highly influential on my approach to training (and life in general) and that will be quite visible in the chapters to come. For that reason, I find it important to pinpoint to the sources. I do think, especially with the recent rise of *scientism* (Boudry & Pigliucci, 2017), particularly in our domain of sport performance and science, that philosophy is more than needed. This introductory chapter and the following on the Agile Periodization are very much philosophical and are covering mine philosophical stances.

What is covered in this manual?

It was important to vent the above out before presenting the rest of the material. I take the *percent-based approach* to strength training since I find it a great *prior* for being implemented concurrently with any other approach (velocity based, RPE based

10 Complementary Training is the name of my blog (www.complementarytraining.net) that I started in 2010, with the aim of reconciling opposing concepts in training using the complementary approach (Kelso & Engstrøm, 2008).

11 You will probably read the word Quality numerous times in this manual

approach, open sets and so forth), and because it can give a *ballpark* of where weights should be. When I was working with soccer athletes, I first tried to implement open sets (only prescribing reps) and to *teach them how to fish* by allowing them to progress and select weights themselves by keeping a training log (which was usually forgotten or slipped under treadmill). This failed miserably, since they didn't give many fucks regarding strength training. They wanted to get it done and play *rondo*. Therefore, I decided to calculate the weights and the number of repetitions they needed to lift. You know - being a Hitler and master of puppets. However, after that, I realized how all these formulas and tables differ for a given individual, exercise, on a daily basis.

I needed something that is prescriptive enough to avoid *fuckarounditis* ("Tell me how much I need to be lifting" and to make sure progressive overload happens over time), but also flexible enough to take into account errors and uncertainties, individual differences, and rates of improvement. That is how this manual was born.

This manual starts with Chapter 2 on Agile Periodization (Jovanovic, 2018), which provides a rough outline of the concept, particularly *iterative planning* component, and how it is applied to strength training planning, objectives classification, and goals setting. Chapter 3 discusses strength training movements classification, as well as the ratios between their maximum (which can be quite useful in estimating max for novel exercise, at least until one gains more observation regarding the exercise in question and update this model). Chapter 4 discusses 1RM estimation (particularly *estimation through iteration* idea), rep max tables and how they can be useful. Chapter 5 discusses the planning of the strength training phase and set and rep schemes. Chapter 6 covers the review and retrospective of the strength phase (which I titled *Rinse and Repeat*). Appendix consists of multiple chapters including case studies, as well as full list of exercises, the most important tables and all set and rep schemes discussed in the book.

As already stated, the objective of this strength training manual is not to go into theoretical nitty-gritty details, but to provide all the useful tables, formulas and heuristics at one place.

2 Agile Periodization and Philosophy of Training

Agile Periodization is a planning framework that relies on decision making in uncertainty, rather than ideology, physiological and biomechanical constructs, and industrial age mechanistic approach to planning (Jovanovic, 2018). Contemporary planning strategies are based on predictive responses and linear reductionist analysis, which is ill-suited for dealing with the uncertain and complex domain, such as human adaptation and performance (Kiely, 2009, 2010a,b, 2011, 2012, 2018; Loturco & Nakamura, 2016). The word *agile* comes from IT domain, where they figured out that industrial age approach to project management (i.e., *waterfall*) doesn't work very well in highly changing and unpredictable environment of the software industry and markets (Rubin, 2012; Stellman & Greene, 2014; Sutherland, 2014; Layton & Ostermiller, 2017; Layton & Morrow, 2018).

Iterative Planning

Iterative planning consists of iterative processes of (1) *planning*, (2) *development*, and (3) *review and retrospective*. These can be applied on different time scales, and here I selected three as well: (1) *release*, (2) *phase*, and (3) *sprint* (see Figure 2.1). Sprint can be considered one *microcycle*, the phase can be considered *mesocycle*, and the release can be regarded as one *macrocycle*, for those familiar with more contemporary periodization terms (Bompa & Buzzichelli, 2015, 2019).

Why did I choose different names? To act smart? First of all, different frameworks demand different language. Second of all, planning in this framework, as opposed in contemporary planning strategies, is iterative rather than detailed up-front. Taking all of that into account, it is essential to use the terminology which will better represent the iterative planning approach and differentiate it from more common planning strategies as well.

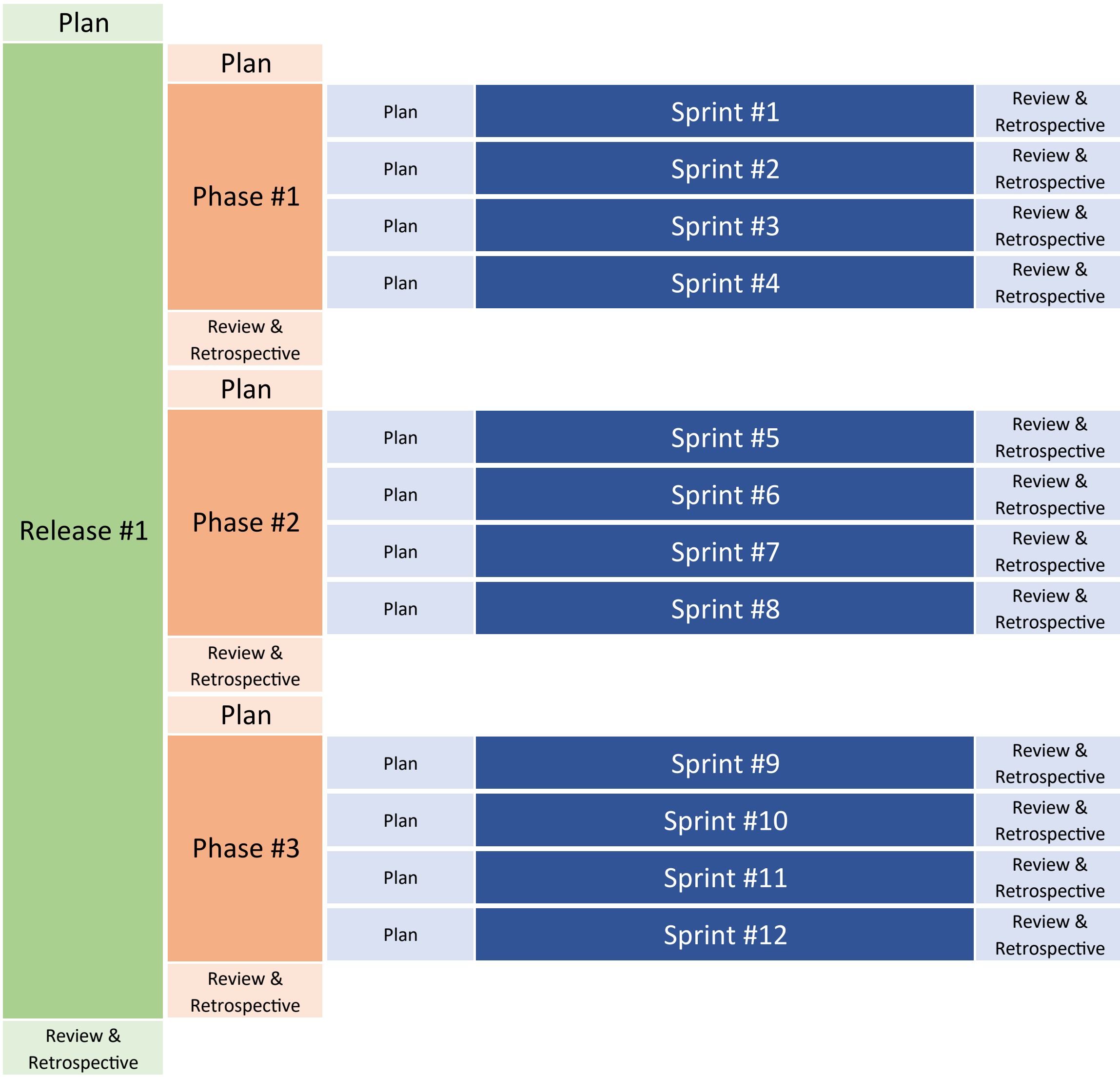


Figure 2.1. Iterative Planning consists of three time-frames: release, phase and sprint, each having a planning component, development component, and review & retrospective component (which are needed to update the knowledge for the next iteration)

(which can be considered performance potential). The path of those before you can give you some direction, not exact scripts (see Figure 1.1, priors and Bayesian updating in previous chapter). Which brings me to evidence-based practices

Evidence-based mumbo jumbo

Waving evidence-based flag is a simple virtue signaling for the lost lab coats. Citing and referencing studies and meta-studies done on grade motivated student-athletes while bitching on the *old school* as something terrible, and you unscientific practitioner, with the aim of providing evidence for the intervention, is a *fragilista* and *intellectual-yet-idiot* (to use Nassim Taleb's terminology (Taleb, 2004, 2010, 2012, 2018)) wet dream.

In my opinion, these sources of knowledge represent only one aspect of *prior* information (from the *known* domain, see Figure 2.12) we can use to start experimenting with. I have represented this in Figure 2.13

Figure 2.13 represent more complex Figure 1.2 on Bayesian updating. I have tried to combine the famous Deming PDCA (plan-do-check-adjust) ("PDCA," 2019) loop with the iterative aspect of updating prior information with the experiment (intervention). Is/Ought gap represents the embedded and inescapable uncertainty of how interventions will work. This is especially the case in a complex domain such as human performance and adaptation. Equally to evidence-based (using scientific studies and meta-analysis), the data-driven approach should be treated as only one source of prior information in decision making and should probably change the name to 'data-informed'. These two are not fail-safe, predictable, certainty strategies - they are necessary to be considered, but far from sufficient in guarantying wanted outcomes. It is the same story with pre-planned periodization schemes - if those fancy blocks seem to be working, then most if not all athletes would reach personal best, or at least seasonal best, at the major competition. Yet, that number is not very optimistic (Loturco & Nakamura, 2016). Well, if performance goals are tough to reach in individual sports, then team sports are even more notorious, uncertain and unpredictable. So, just because you are using 'evidence-based', 'data-driven' or 'Eastern European periodization' approaches, at the end of the day, you are still experimenting and gambling against unpredictable complex systems and environments. They do provide warm comfort though. If put at the right place, these strategies represent one source of prior knowledge, that needs to be updated through iterations and experimentation. This is the idea that Agile Periodization embraces and focus on wholeheartedly.

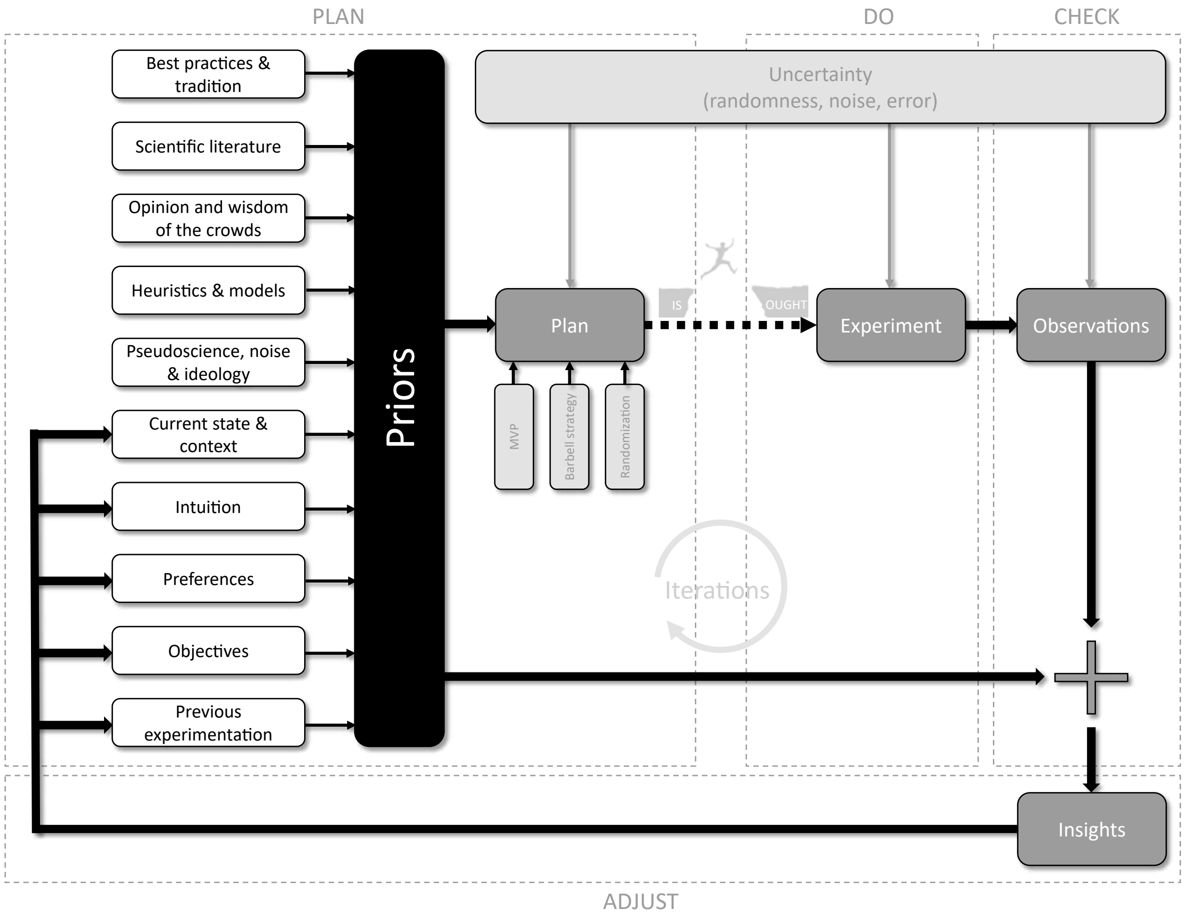


Figure 2.13. The evidence-based approach of using studies and meta-studies is just one component of the prior that needs to be updated with the iterative intervention and experiment for a particular individual and a group

Certainty, Risk, and Uncertainty

Similar to the already discussed direct versus oblique decisions and problem solving, decision making differs in predictable versus unpredictable environments (Gigerenzer, 2004, 2008, 2015; Gigerenzer & Gaissmaier, 2011; Neth & Gigerenzer, 2015; Gigerenzer, Hertwig & Pachur, 2015b,b). What needs to be done is to differentiate the worlds of *certainty, risk, and uncertainty* (see Table 2.2).

Realm	Type of Problem	Type of inference	Appropriate Tool
Certainty	All options and consequences are known for certain (known knowns)	Deductive inference	Logic
Risk	All options and consequences are known, and their probabilities can be reliably estimated (known unknowns)	Inductive inference	Probability theory, statistics
Uncertainty	Ill-posed or ill-defned problems (unknown unknowns)	Heuristic inference	Heuristics, ecological rationality

Table 2.2. Three Realms of Rationality: Certainty, Risk, and Uncertainty. Modified based on (Neth & Gigerenzer, 2015)

Dave Snowden with his Cynefin framework (Brougham, 2015; Berger & Johnston, 2016) differentiates between certainty (obvious), risk (complicated), uncertainty (complex) with the additional domain of chaos (Figure 2.14):

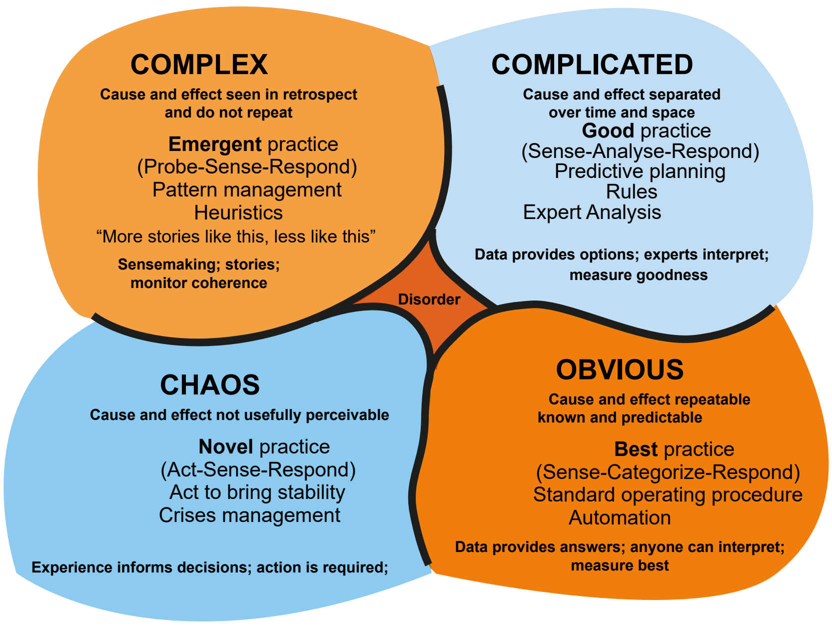


Figure 2.14. Dave Snowden’s Cynefin Framework. Image modified based on work by Dave Snowden (Brougham, 2015; Berger & Johnston, 2016; Fernandez, 2016).

The takeaway point is that different domains demand different decision making. The question is to which domain sports performance belongs to? Well, if you consult contemporary planning strategies that were highly influenced by Taylorism and industrial age approach to management, they belong to Complicated domain (or risk domain). In this domain, probabilities of events are known, and with certain mathematical tools (like expected utility formulas), one can calculate the *optimal* choice. But, to paraphrase Nassim Taleb: “*Life is not a casino!*”.

In my opinion and experience, our domain is a Complex domain. We just cannot oversee and nominate all the potential outcomes, their probabilities, and costs.

Let me quote the description of excellent free course "Introduction to Dynamical Systems and Chaos" from David Feldman (Feldman, 2017):

> *"Deterministic dynamical systems can behave randomly. This property, known as sensitive dependence or the butterfly effect, places strong limits on our ability to predict some phenomena.*
>
> *Disordered behavior can be stable. Non-periodic systems with the butterfly effect can have stable average properties.* ***So, the average or statistical properties of a system can be predictable, even if its details are not.***
>
> *Complex behavior can arise from simple rules. Simple dynamical systems do not necessarily lead to simple results. In particular, we will see that simple rules can produce patterns and structures of surprising complexity."*

The bold emphasis is mine and it is related to the already stated idea that we can predict the average effects and directions of intervention, but we cannot predict the details and exact values. For this reason, we combine the *prior* knowledge and beliefs with iterative experimentation through MVP.

Please remember the Small Worlds versus Large Worlds from the previous chapter, wherein Small Worlds we are able to nominate all the outcomes and probabilities, but they are simplifications of the Large Worlds. This process is useful, but let's not forget the distinction. This puts all these "optimal loads", "optimal progression", "optimal sequencing" approaches on its heads. They are interesting and useful priors we can consider but trying to find 'optimality' in complex domain is flawed and based on predictable and stable assumptions and behaviors of the system and its environment. As outlined in Table 2.2 and Figure 2.14, Complexity (or uncertainty on Table 2.2) domain demands the use of probing, heuristics and *satisficing* (good enough) approaches.

Optimal versus Robust

The whole analytical (physiology/biomechanics) approach utilized in contemporary planning (as seen in the top-down approach) is based on the predictable behavior of the system, in which optimal decisions can be estimated. There is an optimal training load distribution, there is optimal intensity zone for developing certain qualities, there are optimal days for high loads and so forth. This is, of course, the property of the Small World, where all outcomes can be nominated and their probabilities calculated, hence optimal decision can be estimated. But this optimality revolves on the assumptions that things are stable and predictable, and they usually are not. Figure 2.15 depicts an example of how optimal day to perform speed work in team sport fails miserably when faced with the unforeseen event (for example head coach not giving a shit about your speed work):

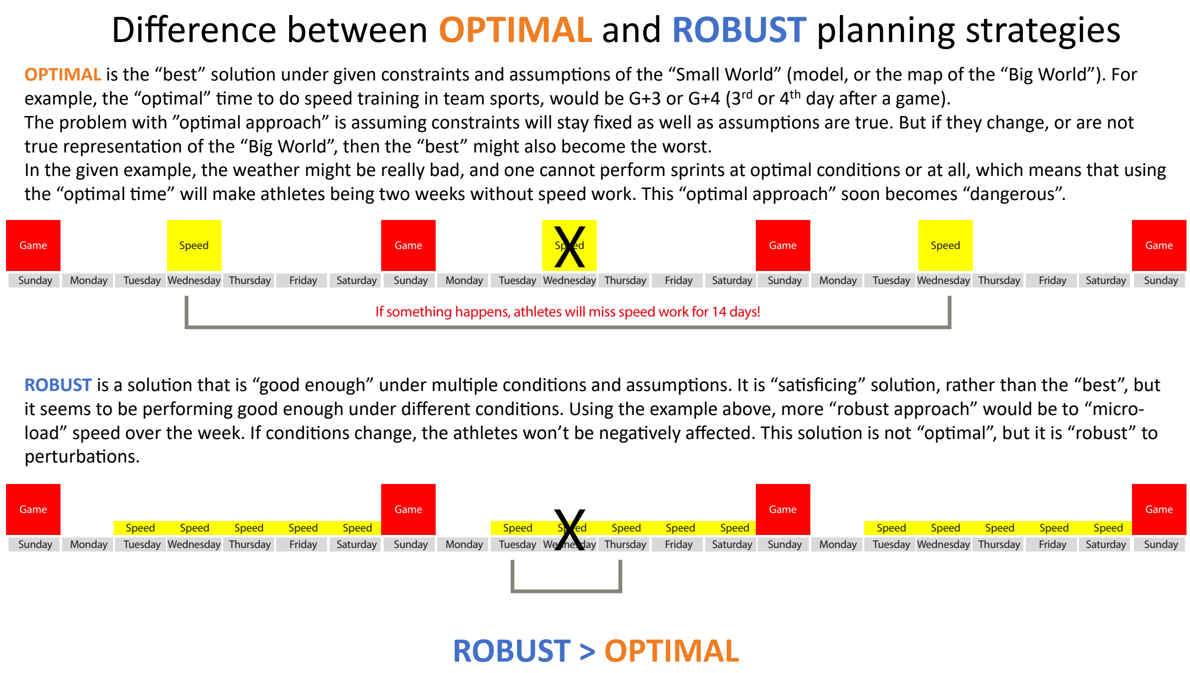


Figure 2.15. Difference between optimal and robust planning on the example of speed work in team sports

To quote Gerd Gigerenzer: "When faced with significant irreducible uncertainty, the robustness of the approach is more relevant to its future performance than its optimality." And this cannot be emphasized enough in the Complex domain. So rather than trying to figure out the 'optimal' scenario (from physiological and biomechanical perspectives), try to find the most robust scenario that will be *satisficing* (good enough) when assumptions break (Jovanovic, 2018; Jovanovic & Jukic, 2019). The concept of MVP revolves around providing the most robust plan one can rely on when the shit hits the fan. This is also the basis of the bottom-up approach to planning. Certain solutions might not be 'optimal' from physiological perspectives, but they will be more robust to logistical issues (such as missing sessions in Figure 2.15).

be utilized for strength specialists, potentially as sub-categories of the SPE and GE categories in the Bondarchuk categorization model.

Grinding vs. Ballistic

Grinding movements are *slow*, controlled, compound movements (e.g., squats, deadlift, bench press) with constant tension, while **Ballistic** movements are *fast* and explosive (e.g., jump squats, hang cleans) with a burst of tension followed by relaxation, and they usually involve a flight of the body or the implement (e.g., barbell or a medicine ball). Additional categories involve **Control** movements (mostly for Vanilla Training, e.g., local and global stabilizers, but also has a lot similarity with *complex* movements category later in the chapter which demands symmetry and stabilization) and **Other** (that annoying category for exercises you do not know where they belong to). As with any categorization, it is hard to draw a fine line between categories since there are some similarities between them. Here, Figure 3.4 illustrates one possible classification of the

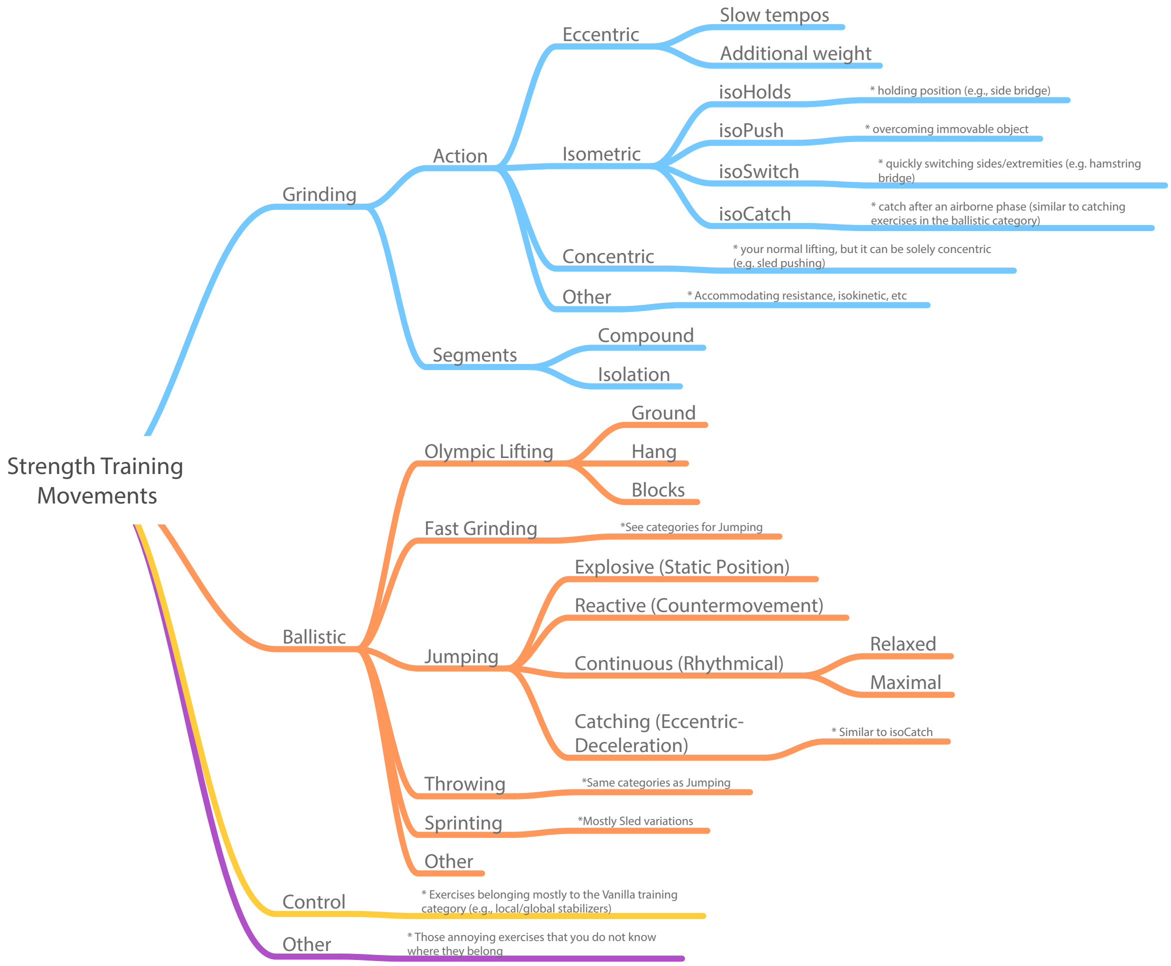


Figure 3.4. Categorization of movements based on their type

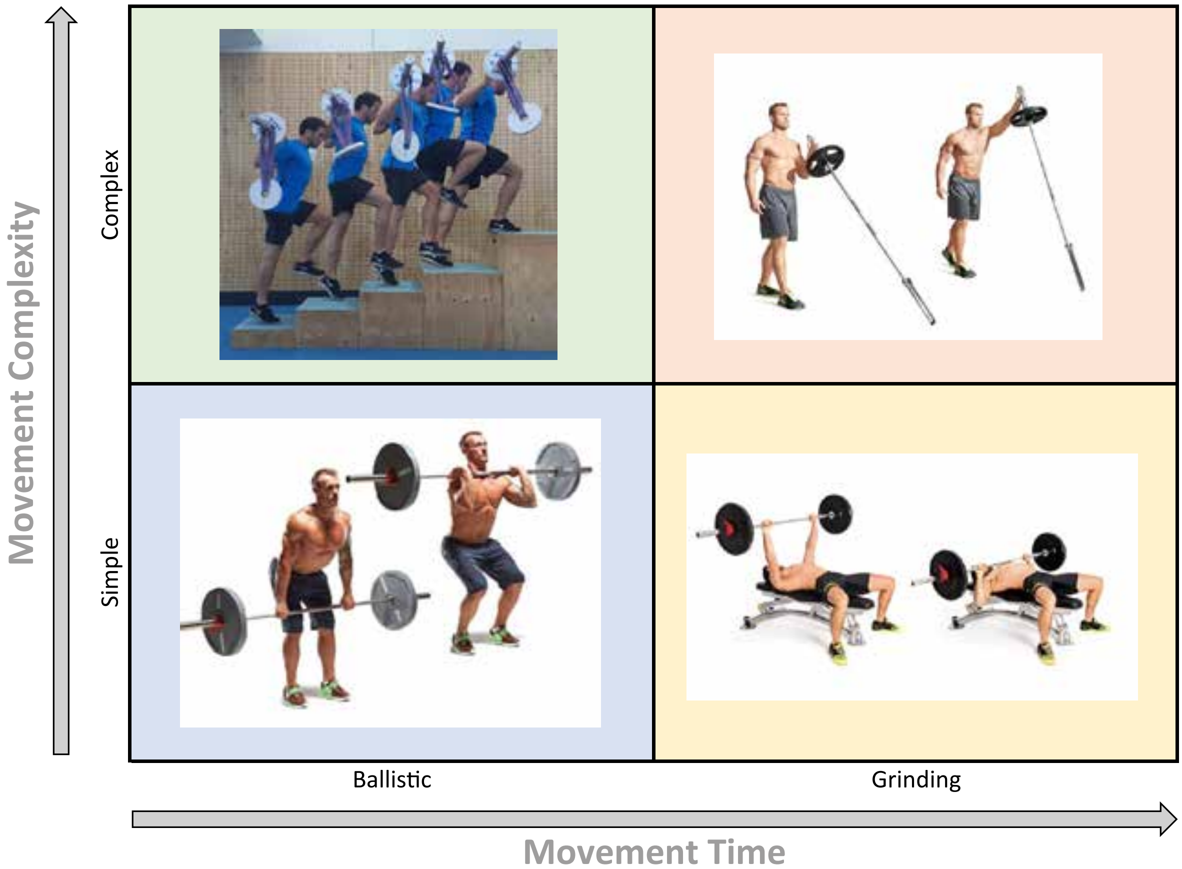


Figure 3.7. Example of TCQ exercises

Exercises from all quadrants can be represented in the training program, in a higher or lower degree, depending on the objectives, needs, and context. TCQ allow a *place for things*, particularly when someone starts bombarding you with fancy Instagram exercises. Now you have a drawer to put them in, and use them if and when needed.

Fundamental movement patterns

Not sure who figured out this categorization thing first, but I guess that Ian King (King, 2002) was one of the first to write about it. Different coaches utilized different classifications, of which I am the most thankful to Dan John (John & Tsatsouline, 2011; John, 2013) (who added loaded carries which I am more than grateful for), Michael Boyle (Boyle, Verstegen & Cosgrove, 2010; Boyle, 2016) (mainly for his view on single leg movements), and Joe Kenn (Kenn, 2003) (whose book I consider one of the most important books written for generalist strength training). Figure 3.8 contains my current classification of the fundamental movement patterns in the lowest resolution:

The functional units represent archetypal *bottom-up planning* approach, where one starts with the constraints of the equipment, rather than top-down of what needs to be done for the next 6 months. One approach to exercise selection is depicted in Figure 3.26, where two circuits are performed on the same functional unit (e.g., 20min for the first circuit and 20 min for the second).

	Circuit A	Circuit B
Squat Rack Station	Split Squat	Bench Press
Mobility Station	Lat Stretch	Stretch
DB Station	KB Press	SL RDL
Core Station	Roll-out	Palloff Press

Figure 3.26. Exercises selection based on the equipment and functional unit constraints

Proper organization will maintain the flow between multiple athletes and avoid any potential bottlenecks. Sometimes you do need to see it in action in order to pinpoint potential issues with the equipment and the flow. If you are a single coach, or there is a insufficient number of coaches, you need to be very selective with *coaching intensive exercises* and limit it to one per circuit,and hopefully located very close between the groups. In examples here, you will probably stick to coaching Split Squat at the squat rack station. If you have multiple exercises that you need to be present at, you will be having a hard time coaching and you will eventually have to decide what is of a greater importance at the moment.

You also need to pay close attention to minimize athletes asking you stuff while you are coaching. For example, athlete interrupts you while you are coaching Split Squat to ask you how much they need to lift and for how many reps on the KB Press. For this reason, particularly for coaching groups, I prefer to use a percent-based approach and give some flexibility to athletes (see Chapter 5), rather than give them full freedom. Workout card can be personalized and given to athletes (unless you have soccer athletes who keep losing their workout cards), or printed somewhere centrally on a bigger paper or using some type of a projector or touch screen with athletes and exercises enlisted. These strategies will be covered in more detail in Chapter 5.

1RM relationships

Since I am a proponent of percent-based approach (as a general framework, or as a starting point of implementation of the other methodologies), how does one know 1RMs (or one-repetition-maximums) for exercises? Next chapter will deal with 1RMs in detail, mainly how they are estimated for the *main movements* (see Figure 3.15), which is another reason why they are considered to be *main*. But how does one know 1RMs for all the other exercises? For example, if I know someone's bench press 1RM, how can I prescribe DB Bench Press?

Before expanding, it is important to state my opinion regarding 1RMs. 1RMs are not goals in itself - just because I am using 1RMs to prescribe training, doesn't mean the objective of training is solely to increase 1RMs. Thus, 1RMs serve more of a *prescriptive* role, rather than *descriptive*. Next chapter will expand more on these concepts, but it was important to state them to prevent readers from jumping to conclusions so easily. As you will see, sometimes testing 1RMs is not necessary, and definitely, it is not needed for all *assistance* movements.

Having said this, how does one estimate 1RMs of all assistance movements?

Dan Baker (Baker, 2015) was one of the first to my knowledge to suggest the following table (Figure 3.27)

Upper Body Press		Upper Body Pull		Lower Body Squat and Hinge	
Bench Press	100%	Supinated Pull-Up	100%	Full Squat	100%
Decline Press	105%	Pronated Pull-Up	95%	Front Squat	80%
Incline Press	80%	Supinated Pull-Down	95%	Overhead Squat	70%
Narrow Grip BP	90%	Pronated Pull-Down	85%	Lunge	40%
Close Grip BP	80%	Wide Grip Front PLD	80%	Step-Up	40%
DB Bench Press	each 33%	Wide Behind Neck PLD	75%	1-leg Squats	40%
Push Press	75%	Seated Row	75%	Lateral Lunge	25%
Military Press	55%	Bench Pull	65%	Romanian DL	75%
Press Behind Neck	55%	Upright Row	50%	Power Shrug	85%
DB Overhead Press	17.5%	1-arm DB Row	each 33%	Clean Pull	85%

Figure 3.27. Dan Baker's 1RMs relationship table (Baker, 2015)

For example, if you know your or your athlete's back squat 1RM, let's say 150kg, then you can expect that he or she is able to lift approximately 75% of 150kg in the Romanian Deadlift (or RDL), which is 110kg. If one lifts 120kg in the bench press, his 1RM in the dumbbell bench press is approximately 33% of 120kg, or 40kg (each hand). Of course, this varies for every individual. The point is not being precise, but having some prior that we can update (see Chapter 1).

It is easy to jump to the conclusion, that there is something wrong with someone lifting 150kg in the back squat, but not being able to lift 110kg in the RDL. But that is not the purpose of this table - the aim is, when the new exercise is introduced, one can develop a MVP (minimum viable product) and start with that. It is not to identify weaknesses (e.g., comparing clean to front squat, although useful sometimes; see GUT and *substance* - *form* complementary pair, where front squat is a potential one should realize or manifest in the clean), but to have a rough gauge to help prescribe weights and reps.

From Chapter 1 you remember that we always make prediction mistakes, but I want to make sure that those are Type I errors (undershooting). For this reason, we usually don't use 1RMs, but EDMs (Every Day Maximum), which is approximately 80-90% of 1RM. This makes predictions conservative and most likely undershooting the real 1RMs (which is better than overshooting, since you can always increase the weight, plus one feels much better being able to do MORE rather than LESS of what is being prescribed). But again, the precise prediction is not the goal - the goal is a *forum for action*, or having something *good enough* for you to start implementing (without losing time testing and finding the perfect estimate) and iterating. Next chapter will go deeper into *estimation through iteration* approach to 1RM estimation.

For this reason, Dan Baker table is extremely useful for the first iteration, when one knows 1RMs/EDMs of the main moves but doesn't know 1RMs for all other assistance exercises.

Searching the web (Boyle, 2011; Millette, 2014; Shute, 2015; Thibaudeau, 2015; "Olympic Weightlifting Calculator," 2017; Waxman, 2017) and from my personal experience, I managed to create the following 1RM tables for upper body, lower body and combined. Missing values were input using the script I wrote in the R language (RStudio Team, 2016; R Core Team, 2018). First, I filled in the *known* relationships, and then I let the iterative algorithm to find the missing values. Perfect? Hell no, but a good starting point. Just don't be a stupid and try to predict 1RM in the hang clean from barbell curls. That being said, try to stick to the same movement pattern for the most reliable prediction.

Upper Body

Figure 3.28 contains relationship matrix for the upper body push and pull movements. Ideally, you want to stick within movement pattern when it comes to prediction, although combining the two is possible, but be conservative.

Let's say that one wants to predict military press from known bench press. Finding military press on the rows and bench press on the columns indicate that the relationship is around 55%.

Military Press = 0.55 x Bench Press

So, if your bench press is 120kg, military press is around 66kg. Again, this is a starting rough estimate, which will differ from person to person.

For exercises where you are lifting your bodyweight (BW), such as dips and pull-up variations, one needs to take BW into account. For example, if you weight 85kg and lift 40kg in the pull-up for 1 rep (1RM), then your 1RM in the pull-up is *85kg + 40kg*, which is equal 125kg. As you will read in the next chapter, one should use 125kg (total system 1RM) when prescribing strength training using a percent-based system, rather than 40kg (only external load).

	Bench Press	Decline Bench Press	Incline Bench Press	Dips	Close Grip BP	Floor Press	DB Bench Press	Push Press	Millitary Press	DB Overhead Press	Chin-Up	Pull-Up	Supinated Pull Down	Pronated Pull Down	Wide Grip Front PD	Wide Grip Behind Neck PD	Seated Row	Bench Pull	Upright Row	Single Arm DB Row	Preacher Curl
Bench Press	100%	95%	125%	85%	125%	110%	285%	135%	180%	500%	95%	100%	100%	110%	120%	125%	125%	145%	190%	270%	250%
Decline Bench Press	105%	100%	130%	90%	130%	115%	300%	145%	185%	525%	100%	105%	105%	115%	125%	130%	130%	150%	200%	285%	260%
Incline Bench Press	80%	75%	100%	65%	100%	90%	230%	110%	140%	400%	75%	80%	80%	90%	95%	100%	100%	115%	150%	215%	200%
Dips	120%	115%	150%	100%	150%	130%	340%	160%	210%	595%	110%	120%	120%	130%	140%	150%	150%	170%	225%	320%	300%
Close Grip BP	80%	75%	100%	65%	100%	90%	230%	110%	140%	400%	75%	80%	80%	90%	95%	100%	100%	115%	150%	215%	200%
Floor Press	90%	85%	115%	75%	115%	100%	255%	120%	160%	450%	85%	90%	90%	100%	105%	115%	115%	130%	170%	240%	225%
DB Bench Press	35%	35%	45%	30%	45%	40%	100%	50%	60%	175%	35%	35%	35%	40%	40%	45%	45%	50%	65%	95%	85%
Push Press	75%	70%	90%	60%	90%	80%	210%	100%	125%	365%	70%	75%	75%	80%	85%	90%	90%	105%	140%	200%	185%
Millitary Press	55%	55%	70%	45%	70%	60%	160%	80%	100%	280%	55%	55%	55%	60%	65%	70%	70%	80%	105%	150%	140%
DB Overhead Press	20%	20%	25%	15%	25%	20%	55%	25%	35%	100%	20%	20%	20%	20%	25%	25%	25%	30%	40%	55%	50%
Chin-Up	105%	100%	135%	90%	135%	120%	305%	145%	190%	530%	100%	105%	105%	120%	125%	135%	135%	155%	200%	285%	265%
Pull-Up	100%	95%	125%	85%	125%	110%	290%	135%	180%	505%	95%	100%	100%	110%	120%	125%	125%	145%	190%	270%	250%
Supinated Pull Down	100%	95%	125%	85%	125%	110%	290%	135%	180%	505%	95%	100%	100%	110%	120%	125%	125%	145%	190%	270%	250%
Pronated Pull Down	90%	85%	115%	75%	115%	100%	260%	125%	160%	450%	85%	90%	90%	100%	105%	115%	115%	130%	170%	245%	225%
Wide Grip Front PD	85%	80%	105%	70%	105%	95%	245%	115%	150%	425%	80%	85%	85%	95%	100%	105%	105%	120%	160%	230%	210%
Wide Grip Behind Neck PD	80%	75%	100%	65%	100%	90%	225%	110%	140%	400%	75%	80%	80%	90%	95%	100%	100%	115%	150%	215%	200%
Seated Row	80%	75%	100%	65%	100%	90%	225%	110%	140%	400%	75%	80%	80%	90%	95%	100%	100%	115%	150%	215%	200%
Bench Pull	70%	65%	85%	60%	85%	75%	200%	95%	125%	350%	65%	70%	70%	75%	80%	85%	85%	100%	130%	185%	175%
Upright Row	55%	50%	65%	45%	65%	60%	150%	70%	95%	265%	50%	55%	55%	60%	60%	65%	65%	75%	100%	145%	135%
Single Arm DB Row	35%	35%	45%	30%	45%	40%	105%	50%	65%	185%	35%	35%	35%	40%	45%	45%	45%	55%	70%	100%	95%
Preacher Curl	40%	40%	50%	35%	50%	45%	115%	55%	70%	200%	40%	40%	40%	45%	45%	50%	50%	60%	75%	110%	100%

Figure 3.28. Upper body exercises 1RM relationships

Let's say you want to predict dips 1RM from known pull-ups 1RM. From the upper body relationship matrix, dips are 120% of pull-ups, so:

Dips = 1.2 x Pull-Up

Dips = 1.2 x 125kg

Dips = 150kg

According to this formula, 1RM in dips is 150kg. Deducting BW, one gets *150kg - 85kg*, or 65kg, which represents external load attached on the dip belt. If some of these predictions seem too high, you should always lean on the side of conservatism.

What if you have multiple known exercises and want to predict the unknown one? For example, you might know bench press, military press, and pull-ups, but you want to predict incline bench press.

1RM = 20 + 100

1RM = 120kg

The beauty of Epley's equation is in its simplicity. And it is very easy to remember. There are numerous uses of this simple equation, as you will soon see.

Load-Exertion Table

Combining load-max reps table with RIR as a metric of proximity to failure (exertion), we get the next very usable table that is helpful in prescribing and analyzing training programs (Table 4.3). This table represent one of the cornerstones of the percent-based approach described in this manual.

% 1RM	Exertion / Reps in Reserve (RIR)												
	Max reps	1 rep short	2 reps short	3 reps short	4 reps short	5 reps short	6 reps short	7 reps short	8 reps short	9 reps short	10 reps short	11 reps short	12 reps short
100%	1												
94%	2	1											
91%	3	2	1										
88%	4	3	2	1									
86%	5	4	3	2	1								
83%	6	5	4	3	2	1							
81%	7	6	5	4	3	2	1						
79%	8	7	6	5	4	3	2	1					
77%	9	8	7	6	5	4	3	2	1				
75%	10	9	8	7	6	5	4	3	2	1			
73%	11	10	9	8	7	6	5	4	3	2	1		
71%	12	11	10	9	8	7	6	5	4	3	2	1	
70%	13	12	11	10	9	8	7	6	5	4	3	2	1
68%	14	13	12	11	10	9	8	7	6	5	4	3	2
67%	15	14	13	12	11	10	9	8	7	6	5	4	3
65%	16	15	14	13	12	11	10	9	8	7	6	5	4
64%	17	16	15	14	13	12	11	10	9	8	7	6	5
63%	18	17	16	15	14	13	12	11	10	9	8	7	6
61%	19	18	17	16	15	14	13	12	11	10	9	8	7
60%	20	19	18	17	16	15	14	13	12	11	10	9	8

# Reps	Exertion / Reps in Reserve (RIR)												
	Max reps	1 rep short	2 reps short	3 reps short	4 reps short	5 reps short	6 reps short	7 reps short	8 reps short	9 reps short	10 reps short	11 reps short	12 reps short
1	100%	94%	91%	88%	86%	83%	81%	79%	77%	75%	73%	71%	70%
2	94%	91%	88%	86%	83%	81%	79%	77%	75%	73%	71%	70%	68%
3	91%	88%	86%	83%	81%	79%	77%	75%	73%	71%	70%	68%	67%
4	88%	86%	83%	81%	79%	77%	75%	73%	71%	70%	68%	67%	65%
5	86%	83%	81%	79%	77%	75%	73%	71%	70%	68%	67%	65%	64%
6	83%	81%	79%	77%	75%	73%	71%	70%	68%	67%	65%	64%	63%
7	81%	79%	77%	75%	73%	71%	70%	68%	67%	65%	64%	63%	61%
8	79%	77%	75%	73%	71%	70%	68%	67%	65%	64%	63%	61%	60%
9	77%	75%	73%	71%	70%	68%	67%	65%	64%	63%	61%	60%	59%
10	75%	73%	71%	70%	68%	67%	65%	64%	63%	61%	60%	59%	58%
11	73%	71%	70%	68%	67%	65%	64%	63%	61%	60%	59%	58%	57%
12	71%	70%	68%	67%	65%	64%	63%	61%	60%	59%	58%	57%	56%
13	70%	68%	67%	65%	64%	63%	61%	60%	59%	58%	57%	56%	55%
14	68%	67%	65%	64%	63%	61%	60%	59%	58%	57%	56%	55%	54%
15	67%	65%	64%	63%	61%	60%	59%	58%	57%	56%	55%	54%	53%
16	65%	64%	63%	61%	60%	59%	58%	57%	56%	55%	54%	53%	52%
17	64%	63%	61%	60%	59%	58%	57%	56%	55%	54%	53%	52%	51%
18	63%	61%	60%	59%	58%	57%	56%	55%	54%	53%	52%	51%	50%
19	61%	60%	59%	58%	57%	56%	55%	54%	53%	52%	51%	50%	49%
20	60%	59%	58%	57%	56%	55%	54%	53%	52%	51%	50%	49%	48%

Table 4.3. Load-Exertion Table

The above two tables (Table 4.3) are identical, they are just organized in a different way to help find either a number of reps that needs to be performed, or percentage that needs to be used. Here are two examples:

training and try to estimate EDM rather than TM. In the case you are not sure what is your EDM, deduct 10-20% from your TM.

How to estimate 1RM or EDM?

Having covered the important distinctions in 1RMs, there are multiple ways to establish it:

1. True 1RM test
2. Reps to (technical) failure
3. Velocity based estimates
4. Estimation through iteration

True 1RM test

True 1RM test is about "finding" the weight you can successfully lift for 1 repetition, and it represents "gold standard" in estimating "strength levels" in non-laboratory environment (and we are not interested in those environments anyway). 1RM testing is a reliable and safe method, although not very time efficient, especially if done for multiple exercises and with a bunch of athletes.

There are numerous protocols for 1RM testing, and the goal is to find your 1RM without causing too much fatigue with too many "warm-up" sets and maximum attempts. The simple protocol might be the following:

1. Use 50% of estimated 1RM and perform 5 reps. Rest 1-3min
2. Use 75% of estimated 1RM and perform 3 reps. Rest 1-3min
3. Use 90% of estimated 1RM and perform 1 rep (if you believe your athletes that estimated or reported 1RM are honest and not overblown). Rest 2-4min
4. Athletes now increase the weight and begin finding their 1RM. A series of single attempts should be completed until a 1RM is achieved.
5. Rest periods should remain at 3-5 minutes between each single attempt and load increments typically range between 2.5-5%.In general, 1RMs should be achieved within 3-5 attempts. If failing to lift certain weight, athletes can decrease the load for 2.5-5% and try few more times.

As explained before, the key is to find 1RM by increasing and decreasing weights of the single attempts, but not exceeding 5 total tries. If multiple 1RMs are performed (i.e. for back squat and bench press) then longer rest period is advised (e.g., 5-10min) between exercises. Here is the hypothetical example of a 1RM test for the bench press:

1. While talking to the athlete, he mentions he could lift approximately 140kg on the bench press. Since we understand that athletes are irrational lying scumbags, we are going to test it, but we are going to use athletes reported values for initial weights and increments.
2. We decided to test the strict bench press with 2-sec hold at the chest. The athletes complains (well, duh).
3. After a warmup and a few sets with 20 & 40kg, we begin the test
4. Initial weight set to 50% of reported 1RM (140kg), which is 70kg. Athlete performs 5 reps with a 2 sec pause at the chest
5. Take 3min off, complaining he never lifted with pause
6. Second set is done with 75% of reported 1RM (140kg), which is 105kg. Athlete performs 3 reps with a 2 sec pause at the chest. Last rep was shaky. You decide to skip the 90% set because he might have been lying about his 1RM.
7. Take 3min off. Athlete asks to play 8 Miles by Eminem, you say "Fuck that shit!" and go and play Spring by Vivaldi.
8. Athlete decides to increase for 10kg, which is 115kg. Performs one perfect rep
9. Take 3min off. Complains about Vivaldi.
10. Decide to increase for extra 10kg, which is 125kg. Performs one grindy rep.
11. Take 3min off. Asks again to play Eminem. You agree to play "Ride Of The Valkyries" by Richard Wagner. That gives him little "oomph" while staying within limits of EDM.
12. Wants to increase for extra 10kg. You roll your eyes (him not seeing it). 135kg. Failed
13. Take 3min off. Athlete blames you and your music choice (and the fucking 2-sec pause at the chest).
14. Decided to reduce to 130kg. Slow lift but within technical requirements
15. Take 3min off.
16. Decided to go for 132.5kg. Failed.
17. No need to micro-load this stuff with 130.63kg. We accept 130kg to be his 1RM (EDM, assuming Wagner didn't cause too much arousal).

The above example shows the typical 1RM testing. We managed to find 1RM using 5 sets (excluding two warm-ups). Another constraint might be giving time limit (after warm-up sets) rather than limiting to 3-5 sets. For example, "Lads, you have 20minutes to find your 1RM. Timer starts.... NOW!". And accept the highest technically sound rep as 1RM. It is up to the athletes to select weight and rest periods. This approach might work better with athletes already familiar with 1RMs, but not so with beginners (or soccer players) who need more constraints and guidance in 1RM testing.

The key is not finding the perfect protocol, but rather sticking to the same protocol over time.

Reps to (technical) failure

Another method to assess 1RM is using reps to failure technique. Rather than trying to find 1RM, we want to find 2-5RM (maximum weight that can be lifted for 2-5 reps ideally) and then use either conversion table or formulas to establish 1RM (see Table 4.2).

The protocol is much simpler and quicker than 1RM.

1. Use 50% of estimated 1RM and perform 5 reps. Rest 1-3min
2. Use 75% of estimated 1RM and perform 3 reps. Rest 1-3min
3. Use 80-90% of estimated 1RM and perform maximal number of reps (while staying within technical requirements of the exercise).
4. If an athlete is 'calm' then we are estimating EDM, if he wants to hear Eminem, screams, slaps himself, then TM is estimated. Know the difference.

For example, athlete performed maximum 5 reps with 150kg in the back squat.

1RM = (150kg x 5reps x 0.0333) + 150kg

1RM = 25 + 150

1RM = 175kg

So according to Epley formula, 1RM of our athlete will be around 175kg. Another option would be to use Load-Max Reps table (see Table 4.2).

The beauty of using reps to technical failure method is that it can be "embedded" into a workout (which is one of the ideas of the Agile Periodization). Rather than doing true 1RM test, one can just perform reps to technical failure at the end of the prescribed sets. Here is an example:

Set 1: 150kg x 3

Set 2: 150kg x 3

Set 3: 150kg x 3+

During the last prescribed set (denoted as a *PLUS* set), athlete is trying to perform as much reps as possible. Usually, these should be capped at around 10 reps. Using this as "embedded" testing, one can estimate 1RMs (or changes in the same) during the workout. More on this in Chapter 6.

One can also create individualized rep max tables, but that is feasible only when working with individual strength athletes (i.e., strength-specialists), rather than team sport players (i.e., strength-generalists). It comes back to the *satisficing* concept - something that is not perfect, but very usable, or good enough. Besides, individualized rep max table will hold true only for a single lift, so planning other lifts cannot utilize that knowledge. This is fine if your sport is powerlifting, so you really want to nail down three exercises (bench press, squat and deadlift), but if you are team sport athlete pursuing strength training as a means to an end, then having individualized rep max tables for a few exercises would not be very practical - one would still need to use *heuristics* when prescribing training for other exercises.

Velocity based estimates

Using velocity to estimate 1RM has been a novel technique that still needs validation (Jovanovic & Flanagan, 2014). To perform this method, one needs LPT (linear position transducer) such as GymAware or PUSH2. The LPT device connects to a barbell via retractable cable and measures velocity of movements. If we plot velocity of the reps versus load we get straight line that we can use to estimate 1RM. Figure 4.3 depicts concentric *mean velocity* (MV) across loads during 1RM deadlift testing for three athletes. Each rep is done with the maximal intent to lift as fast as possible (which is crucial assumption and requirement).

Comparing individuals

"Hey bro, how much you bench?"

How do we decide who is stronger? Person who lifts the most for 1 rep (1RM), who lifts more reps (e.g. pull-ups), or who lifts the fastest (e.g. clean)? As you will see, the answer is not clear cut (again pluralism).

Let's compare four athletes in the back squat (Table 4.19):

	Bodyweight (kg)	1RM (kg)
Athlete 1	75	140
Athlete 2	100	170
Athlete 3	80	120
Athlete 4	90	135

Table 4.19. Four athletes with different bodyweight and 1RMs in the back squat. Who is the strongest?

Which one of the four athletes is the strongest? Athlete 2 lifts biggest weight in the back squat - 170kg, but he is also the heaviest. So we need to take into account bodyweight[31].

Comparing individuals is very complex topic and there is no clear cut solution to it. For the sake of example, I will compare a few techniques that you might use when comparing individuals.

Simple ratio (relative strength)

The simplest approach we can do is to divide 1RM with the bodyweight. Similar to pull-up vs. squat example, we can use only external 1RM or total system 1RM (Table 4.20)

				Relative	
	Bodyweight (kg)	1RM (kg)	Total System 1RM (kg)	External	Total
Athlete 1	75	140	208	1.87	2.77
Athlete 2	100	170	260	1.70	2.60
Athlete 3	80	120	192	1.50	2.40
Athlete 4	90	135	216	1.50	2.40

Table 4.20. Using external and total body simple ratio (dividing with bodyweight)

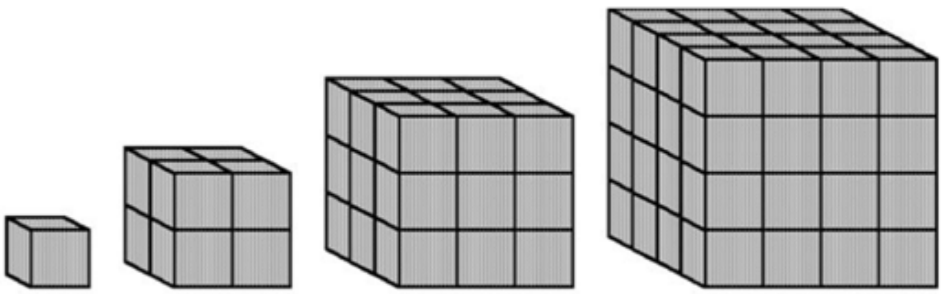
31 We could also take into account height, limb lengths, experience, drug use and so forth with the aim of creating "equal playing" field. Essentially the number of variables we need to control for is pretty much unlimited, so I leave this pipe dream for the "progressives" and SJWs

Using relative strength approach, we can clearly see that the Athlete 1 has the highest level of relative strength. As with the conclusion of using total vs. external in estimating 1RM, I suggest here as well to use total system when comparing bodyweight movements (e.g. pull-ups, push-ups, etc) and external load when comparing barbell movements (e.g. bench press, back squat).

This is a very common approach when comparing individuals, unfortunately it is biased towards lighter weight individuals, because strength doesn't increase linearly with bodyweight (all things being equal). For that reason we need to use *allometric scaling* (Folland, Mccauley & Williams, 2008).

Allometric scaling

Let's represent a muscle (or the force generator) with a cube with the side length *L*



Length	**1**	**2**	**3**	**4**
Surface	**1**	**4**	**9**	**16**
Volume	**1**	**8**	**27**	**64**
Surface / Volume	**1**	**0.50**	**0.33**	**0.25**

Figure 4.8. Small World model of the muscle using cube with side lengths L.

The surface of the cube (one side surface) is proportional to the cross-sectional area of the muscle, and hence directly proportional to the maximal strength. The volume of the cube is proportional to the weight of the muscle.

As can be seen, the ratio of surface to volume, or strength to weight, is not linear, because weight increase much quicker than surface area. That's why simple strength ratio is biased against heavier individuals.

Even if you do not plan using this approach, providing time constraints (and making it transparent by using a big timer on the wall) can get team athletes more productive. For example, you might have a super set (A1. Back Squat, A2. Pull-Ups, A3. Abs Roll-out, A4. Hip stretch) and to keep a group of athletes punctual (especially if the next group is coming in), you might also state that they have 15-20minutes to finish the prescribed sets. This works like a charm. Just put the timer on the wall and let them see it.

In the following Table there are all modifications listed for the easier summary (simplified).

Original prescription	**3** x **5** **@70%**
Open Sets	**3** x **5**
Rep Zone	**3** x **4-6** **@70%**
Load Zone	**3** x **5** **@65-75%**
Combined	**3** x **4-6** **@65-75%**
Subjective	**3** x **4-6** **@70%** w/**3RIR**
VBT	**3** sets **@75%** u/**0.3m/s**
Time & Rep constraints	In **10min** perform **15-20**reps **@70%**

Table 4.23. Set and rep scheme modifications. See text for further examples

Prediction and monitoring

Before jumping to the strength training planning in Chapter 5, it is important to introduce few load (dose)[33] monitoring metrics that are commonly used, as well as to introduce few novel ones. As you will soon see, all these represent Small Worlds - or a models with assumptions that attempt to represent Large World with a simple number. Nothing wrong with this of course. What is problematic is forgetting the distinction and trying to *optimize* the whole training based on few numerical aggregates. If you check the Figure 2.13 in Chapter 2, you can see that these data represent only one source of insight when making decision. Thus, they are needed and important, but just don't forget that they represent aggregated summary of simplified Large World. It is very easy to fall for the Small World narrative of trying to optimize one metric to maximize training effects. The true story is that we do not know what variable drives (is associated or is causal) the training effects. Similarly, in a *Kuhnian* sense (Dienes, 2008), we do need to

33 Here, the term 'load' differs from the term load as part of intensity trinity (weight on the bar, %1RM). Here the load is the "the dose" or "stress" and it is also multicomponent, consisting of volume, intensity and density components.

collect these studies and various models to push the scientific revolution forward, but the goal is not to become Intellectual Yet Idiot (IYI, to paraphrase Nassim Taleb) that sells this as objective 'evidence-based' approach. There is much more we do not know and that we do not capture with simple metrics.

Chapter 5 will expand more on the topic and the concept of *load* from a conceptual perspective, but in this chapter I will cover the most common metrics used to track the strength training load.

Table 4.24 contains 3 sets (8 reps at 73%, 6 reps at 79%, and 4 reps at 86%) with athlete subjective rating of exertion (RIR). I have provided few summary metrics that I will explain below.

Set	Reps	1RM	%1RM	Load	RIR	NL	aRI	Tonnage	Impulse	INOL	pred1RM	prox1RM
1	8	150	73%	110	4	8	73%	876	5.84	0.30	153	92%
2	6	150	79%	119	2	6	79%	711	4.74	0.29	150	95%
3	4	150	86%	129	0	4	86%	516	3.44	0.29	146	97%
						18	79%	2103	14.02	0.87	153	95%
							78%					

Table 4.24. Common training load summary metrics

Each set is summarized, and then at the bottom the workout summary is provided. Here are the columns

Set - Indicate the order of the set.

Reps - Indicate how many reps has been planned/performed (here the assumption is that number of reps planned is equal to number of reps performed).

1RM - Represents athletes 1RM of the exercise (or EDM) used to estimate load.

%1RM - Percentage of the 1RM used.

Load - Calculated weight that needs to be lifted using athlete 1RM and %1RM of the program (Load = 1RM x %1RM).

RIR - Reps-In-Reserve. This is a subjective rating that athlete gives after the completion of the set.

The above variables represent the usual planning parameters (with the exception of RIR, that can be planned in advance and that can help in selecting the %1RM and reps, but it can also be subjective rating given by the athlete at the end of each set). The variable below are the aggregates or the summaries of each set.

NL- represent number of lifts (or reps). The summary at the bottom of the table represents simple sum

aRI- represents average relative intensity (%1RM) of the set. The summary at the bottom of the table can be calculated in two ways. First option (first number; 79%) is the simple average of three sets (*(73% + 79% + 86%) / 3 = 79%*). But we can also calculate it using reps, since each set contributed different number of reps to a grand summary. This is done using the *weighted average* where set percentage is multiplied by number of reps, and finally divided by NL. This is indicated by the second number (78%) and it is calculated the following way: *(8 x 73% + 6 x 79% + 4 x 86%) / (8 + 6 + 4)*. As you will soon see, and I suggest you create an Excel workbook and play with the numbers, this is equal to *Impulse / NL*. With this very simple example, one can see the "Small World" model at hand - we immediately have the assumptions in the simple aggregate. You can also use average load metric, where instead of %1RM you use average weight.

Tonnage- Tonnage is a very common metric and it represents *Reps x Load*. The summary at the bottom of the table is a simple sum of tonnage of each set. Tonnage corresponds to *mechanical work*, but without the distance component.

Impulse- Impulse is relative tonnage. Imagine doing 3x5 @75% for bench press (1RM = 100kg) and deadlift (1RM = 200kg). Tonnage will be double for the deadlift since the higher absolute load used. Impulse is there to fix this issue and allow comparison between different exercises and individuals possible. Impulse is calculated by multiplying *Reps x %1RM* for each set, and the summary at the bottom of the table is the simple sum. A simpler way to calculate impulse is to use *Tonnage / 1RM*. Thus, impulse also tells you how many times you lifted your 1RM.

INOL- Intensity of Lift, is the metric created by Hristo Hristov (Hristov, 2005) to improve training prescription using the Prilepin Table. INOL is calculated by the following equation for every set: *NL / (100 - 100 x %1RM)*. For example, set one (8 reps @73%) has INOL equal to 8 / (100 - 73), or 8 / 27, which is equal to 0.3. The summary at the bottom of the table is the simple sum of each set INOL. Hristov suggested the following training guidelines using INOL metric:

Workout INOL Guidelines (per exercise)

INOL	Suggestion
< 0.4	Too few reps, not enough stimulus?
0.4 - 1	Fresh, quite doable and optimal if you are not accumulating fatigue
1 - 2	Tough, but good for loading phases
> 2	Brutal

Weekly INOL Guidelines (per exercise)

INOL	Suggestion
< 2	Easy, doable, good to do after more tiring weeks and prepeaking
2 - 3	Tough but doable, good for loading phases between
3 - 4	Brutal, lots of fatigue, good for a limited time and shock microcycles
> 4	Are you out of your mind?

Table 4.25. Hristo Hristov guidelines for using INOL metric (Hristov, 2005)

All the above load metrics can be reported per intensity (%1RM) *bracket* rather than solely with the grand total. For example, one might be interested how many reps are done in the 80-90% range, what is the impulse in that range and so forth. It is always easy to get fancier with load metrics (for example you might calculate the work done using distances that barbell travel, or density using time to complete, which can be useful metric for some type of training, such as *Mongoose Persistence* or EDT - Escalatory Density Training (Staley, 2005)), but the objective is to be as simple as possible and get few actionable metrics. Having said this, I will contradict myself and introduce some novel metrics in a few paragraphs. To further understand why is this needed, consider the following examples.

The two metrics that are left are my *invention* and are more related to 1RM prediction and the estimate of proximity to 1RM than load:

pred1RM-Predicted 1RM is the equation already introduced. It is used to predict 1RM from load used, number of reps done and athlete RIR subjective rating:

1RM = (Weight x (Reps + RIR) x 0.0333) + Weight

This is a tool to *track* (embedded testing) effects - what is potentially happening to 1RM, without directly testing it (either with a true test, or with reps-to-failure). Please note that this prediction is based on Epley's formula and *subjective* rating given by the athlete. For this reason it should be supplemented with something more *demonstrable*, such as *plus set*. Other options might involve predicted 1RM from load-velocity relationship (using 2-3 warm-up sets, e.g., 40-60-80%) and the known v1RM (velocity at 1RM) which can be personalized or group averaged. The goal here is not *perfect* prediction, but a gauge into trends over time that can supplement decision making after a training sprint or a phase.

Appendix: Exercise List

Name	Category	Pattern	Variant	%	Related to	%BW Used	Equipment Used	Note
Clean (Blocks)	Ballistic	Olympic	Blocks	95%	Clean	0%	Barbell	
Clean High Pull (Blocks)	Ballistic	Olympic	Blocks	75%	Clean	0%	Barbell	
Clean Pull (Blocks)	Ballistic	Olympic	Blocks	105%	Clean	0%	Barbell	
Snatch (Blocks)	Ballistic	Olympic	Blocks	95%	Snatch	0%	Barbell	
Snatch High Pull (Blocks)	Ballistic	Olympic	Blocks	75%	Snatch	0%	Barbell	
Snatch Pull (Blocks)	Ballistic	Olympic	Blocks	105%	Snatch	0%	Barbell	
Clean	Ballistic	Olympic	Ground	100%	Clean	0%	Barbell	
Clean High Pull	Ballistic	Olympic	Ground	80%	Clean	0%	Barbell	
Clean Pull	Ballistic	Olympic	Ground	110%	Clean	0%	Barbell	
Power Clean	Ballistic	Olympic	Ground	85%	Clean	0%	Barbell	
Split Clean	Ballistic	Olympic	Ground	90%	Clean	0%	Barbell	
Clean & Jerk	Ballistic	Olympic	Ground	100%	Clean and Jerk	0%	Barbell	
Power Snatch	Ballistic	Olympic	Ground	85%	Snatch	0%	Barbell	
Snatch	Ballistic	Olympic	Ground	100%	Snatch	0%	Barbell	
Snatch Balance	Ballistic	Olympic	Ground	80%	Snatch	0%	Barbell	
Snatch High Pull	Ballistic	Olympic	Ground	80%	Snatch	0%	Barbell	
Snatch Pull	Ballistic	Olympic	Ground	110%	Snatch	0%	Barbell	
Split Snatch	Ballistic	Olympic	Ground	90%	Snatch	0%	Barbell	
Clean (Hang)	Ballistic	Olympic	Hang	95%	Clean	0%	Barbell	
Clean (Muscle)	Ballistic	Olympic	Hang	60%	Clean	0%	Barbell	
Clean High Pull (Hang)	Ballistic	Olympic	Hang	75%	Clean	0%	Barbell	
Clean Pull (Hang)	Ballistic	Olympic	Hang	105%	Clean	0%	Barbell	
Power Clean (Hang)	Ballistic	Olympic	Hang	80%	Clean	0%	Barbell	
Power Snatch (Hang)	Ballistic	Olympic	Hang	80%	Snatch	0%	Barbell	
Snatch (Hang)	Ballistic	Olympic	Hang	95%	Snatch	0%	Barbell	
Snatch (Muscle)	Ballistic	Olympic	Hang	60%	Snatch	0%	Barbell	
Snatch High Pull (Hang)	Ballistic	Olympic	Hang	75%	Snatch	0%	Barbell	
Snatch Pull (Hang)	Ballistic	Olympic	Hang	105%	Snatch	0%	Barbell	
Rack Pull	Grinding	Hinge	Blocks	110%	Deadlift	0%	Barbell	
Deadlift	Grinding	Hinge	Double Leg	100%	Deadlift	0%	Barbell	
Snatch Grip Deadlift	Grinding	Hinge	Double Leg	75%	Deadlift	0%	Barbell	
Sumo Deadlift	Grinding	Hinge	Double Leg	100%	Deadlift	0%	Barbell	From 95-105%
Bridge (Straight Leg Ball)	Grinding	Hinge	Double Leg		None	0%	Fitness Ball	
Bridge (Straight Leg)	Grinding	Hinge	Double Leg		None	0%	Bodyweight	
Bridge Drop Downs (Ball)	Grinding	Hinge	Double Leg		None	0%	Fitness Ball	
Bridge Lift and Curl (Ball)	Grinding	Hinge	Double Leg		None	0%	Fitness Ball	
Bridge Lift and Curl (Slide Board)	Grinding	Hinge	Double Leg		None	0%	Slideboard	
Glute Bridge (Ball)	Grinding	Hinge	Double Leg		None	0%	Fitness Ball	
Glute Bridge (Elevated Feet)	Grinding	Hinge	Double Leg		None	0%	Bodyweight	
Glute Ham Raise (GHR)	Grinding	Hinge	Double Leg		None	0%	Machine	
Hip Thrust (Ball)	Grinding	Hinge	Double Leg		None	0%	Fitness Ball	
Hyper 45 degree	Grinding	Hinge	Double Leg		None	0%	Machine	
Hyper 90 degree	Grinding	Hinge	Double Leg		None	0%	Machine	
Nordic Curl	Grinding	Hinge	Double Leg		None	0%	Bodyweight	
Pull Through	Grinding	Hinge	Double Leg		None	0%	Machine	
Reverse Hyper	Grinding	Hinge	Double Leg		None	0%	Machine	
Sumo Pull Through	Grinding	Hinge	Double Leg		None	0%	Machine	
DB Romanian Deadlift	Grinding	Hinge	Double Leg	35%	Squat	0%	Dumbells	* Each dumbell
Glute Bridge (Floor)	Grinding	Hinge	Double Leg	105%	Squat	0%	Barbell	>105%
Good Morning	Grinding	Hinge	Double Leg	50%	Squat	0%	Barbell	
Hip Thrust (Bench)	Grinding	Hinge	Double Leg	100%	Squat	0%	Bodyweight	
Romanian Deadlift	Grinding	Hinge	Double Leg	75%	Squat	0%	Barbell	
Sumo Good Morning	Grinding	Hinge	Double Leg	40%	Squat	0%	Barbell	
Sumo Romanian Deadlift	Grinding	Hinge	Double Leg	65%	Squat	0%	Barbell	
Trap Bar Romania Deadlift	Grinding	Hinge	Double Leg	75%	Squat	0%	Trap Bar	
Zercher Romanian Deadlift	Grinding	Hinge	Double Leg	70%	Squat	0%	Barbell	
Bridge 1-Leg (Straight Leg Ball)	Grinding	Hinge	Single Leg		None	0%	Fitness Ball	
Bridge 1-Leg (Straight Leg)	Grinding	Hinge	Single Leg		None	0%	Bodyweight	
Bridge Drop Downs (Slide Board)	Grinding	Hinge	Single Leg		None	0%	Slideboard	
Bridge Drop Downs 1-Leg (Ball)	Grinding	Hinge	Single Leg		None	0%	Fitness Ball	
Bridge Drop Downs 1-Leg (Slide Board)	Grinding	Hinge	Single Leg		None	0%	Slideboard	
Bridge Lift and Curl 1-Leg (Ball)	Grinding	Hinge	Single Leg		None	0%	Fitness Ball	
Bridge Lift and Curl 1-Leg (Slide Board)	Grinding	Hinge	Single Leg		None	0%	Slideboard	
Glute Bridge 1-Leg (Ball)	Grinding	Hinge	Single Leg		None	0%	Fitness Ball	
Glute Bridge 1-Leg (Elevated Feet)	Grinding	Hinge	Single Leg		None	0%	Bodyweight	
Glute Bridge 1-Leg (Floor)	Grinding	Hinge	Single Leg		None	0%	Bodyweight	
Glute Bridge 1-Leg Alternating (Floor)	Grinding	Hinge	Single Leg		None	0%	Bodyweight	
Hip Thrust 1-Leg (Ball)	Grinding	Hinge	Single Leg		None	0%	Fitness Ball	
Hip Thrust 1-Leg (Bench)	Grinding	Hinge	Single Leg		None	0%	Bodyweight	
Hyper 45 degree 1-Leg	Grinding	Hinge	Single Leg		None	0%	Machine	
Hyper 90 degree 1-Leg	Grinding	Hinge	Single Leg		None	0%	Machine	
Lateral Bridge 1-Leg (Straight Leg Ball)	Grinding	Hinge	Single Leg		None	0%	Fitness Ball	
Lateral Bridge 1-Leg (Straight Leg)	Grinding	Hinge	Single Leg		None	0%	Bodyweight	
Reverse Hyper 1-Leg	Grinding	Hinge	Single Leg		None	0%	Machine	
DB Romanian Deadlift 1-Arm/1-Leg (Contralateral)	Grinding	Hinge	Single Leg	30%	Squat	0%	Dumbells	
DB Romanian Deadlift 1-Arm/1-Leg (Ipsilateral)	Grinding	Hinge	Single Leg	25%	Squat	0%	Dumbells	
DB Romanian Deadlift 2-Arm/1-Leg	Grinding	Hinge	Single Leg	20%	Squat	0%	Dumbells	* Each dumbell
Good Morning 1-Leg	Grinding	Hinge	Single Leg	30%	Squat	0%	Barbell	
Plate Good Morning 1-Leg (Overhead)	Grinding	Hinge	Single Leg	10%	Squat	0%	Plates	
Romanian Deadlift 1-Leg	Grinding	Hinge	Single Leg	45%	Squat	0%	Barbell	
Barbell Curls	Grinding	Pull	Accessory	35%	Pull-up	0%	Barbell	
DB Curls	Grinding	Pull	Accessory	20%	Pull-up	0%	Dumbells	* Each dumbell
Rings Inverted Row 1-Arm	Grinding	Pull	Horizontal		None	0%	Gymnastic rings	
1-Arm/1-Leg Row (Contralateral)	Grinding	Pull	Horizontal	25%	Pull-Up	0%	Dumbells	
1-Arm/1-Leg Row (Ipsilateral)	Grinding	Pull	Horizontal	25%	Pull-Up	0%	Dumbells	
Bench Pull	Grinding	Pull	Horizontal	70%	Pull-Up	0%	Barbell	
Bent Over Row	Grinding	Pull	Horizontal	65%	Pull-Up	0%	Barbell	

About

Mladen Jovanović is a Serbian Strength and Conditioning Coach and Sport Scientist. Mladen was involved in the physical preparation of professional, amateur and recreational athletes of various ages in sports, such as basketball, soccer, volleyball, martial arts, tennis and Australian rules football. In 2010, Mladen started the Complementary Training website and in 2017, developed the scheduling and monitoring application, AthleteSR. He is currently pursuing his PhD at the Faculty of Sports and Physical Education in Belgrade, Serbia.

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