

Self-Study Tips

Shih-Chin Weng
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I graduated in Computer Science in the early 2000s.

When I took a Databases class, NoSQL didn't exist.

When I took a Computer Graphics class, OpenGL didn't support shaders.

When I took a Computer Security class, no one knew about botnets yet.

When I took an Artificial Intelligence class, deep learning didn't exist.

When I took a Programming Languages class, reactive programming wasn't a "thing".

When I took a Distributed Systems class, there was no Big Data or cloud computing.

When I took an Operating Systems class, hypervisors didn't exist (in PCs at least).

When I took a Networking class, there was no wifi in my laptop or internet in my phone.

Learn the fundamentals. The rest will change anyway.|



Hisham @hisham_hm · 13 Dec 2015

I felt like saying this.



6.5K



5.6K



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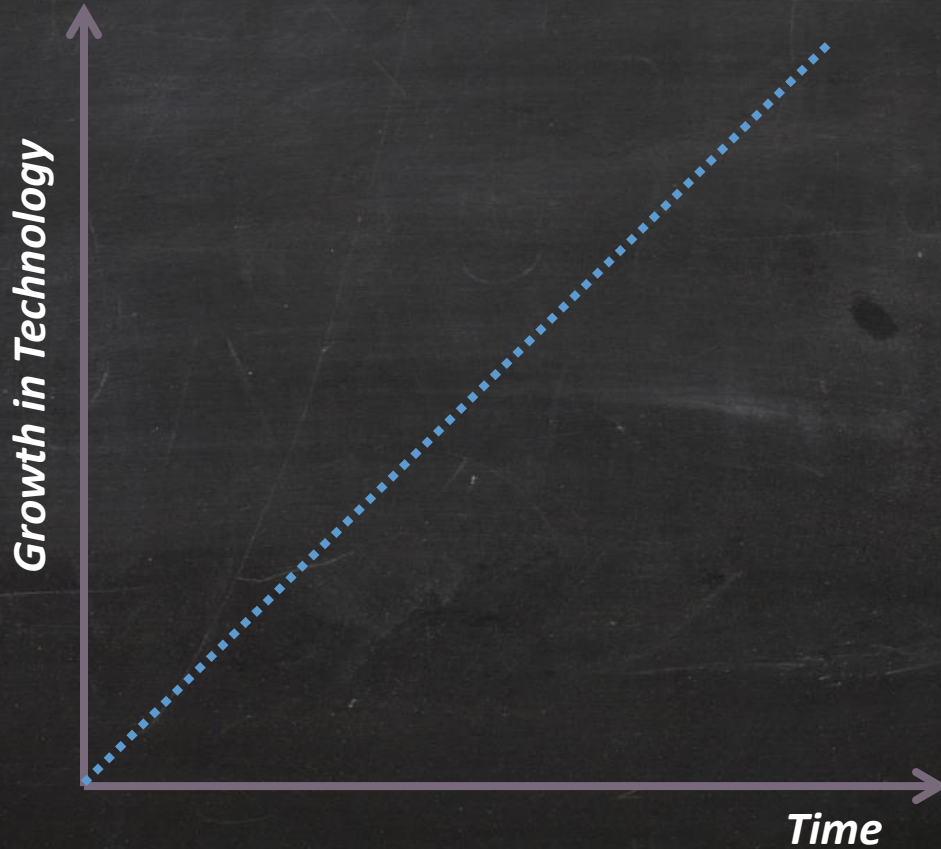
5.6K



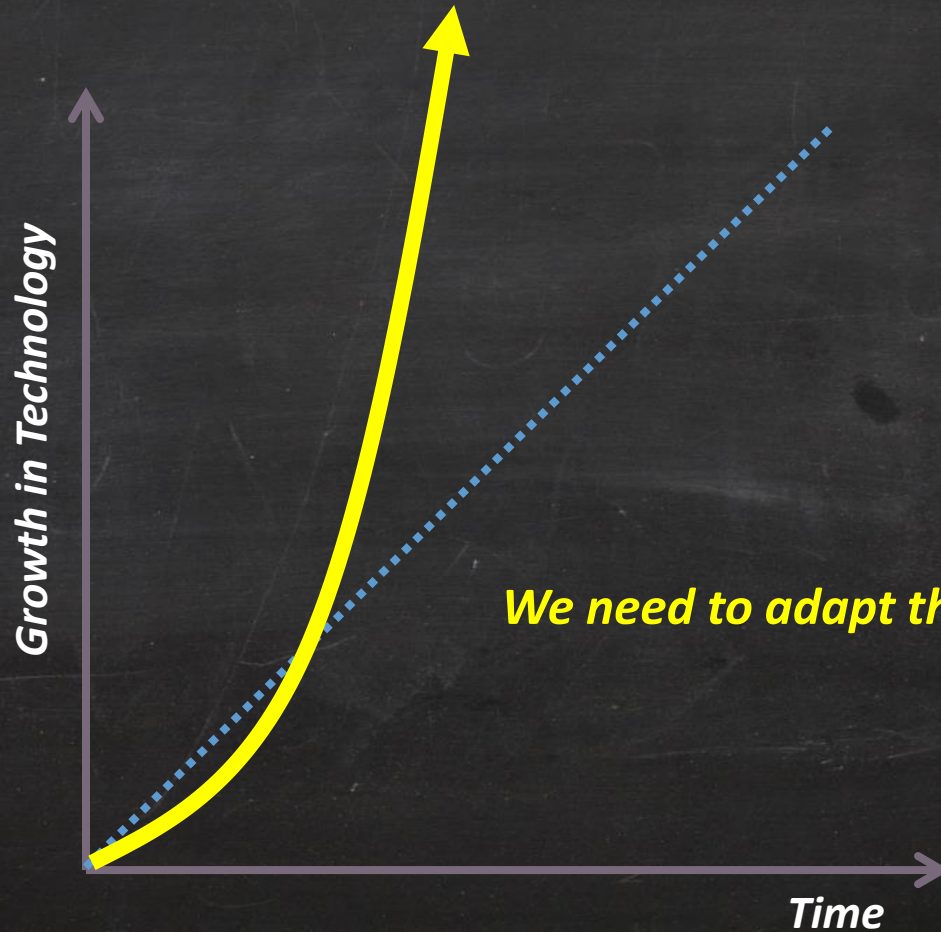
My Personal Experience

- Before I entered an animation studio 9 years ago, I didn't know anything about
 - Computer animation pipeline
 - Maya, Nuke
 - Mental ray / Arnold / RenderMan
 - MEL, Python, CMake, PowerShell
 - TBB, CUDA, etc.
- As a developer in a small team, I've to learn most of these things from absent teachers

We Are Living in an Era of **Exponential** Change!



We Are Living in an Era of **Exponential** Change!



We need to adapt the rapid changes!

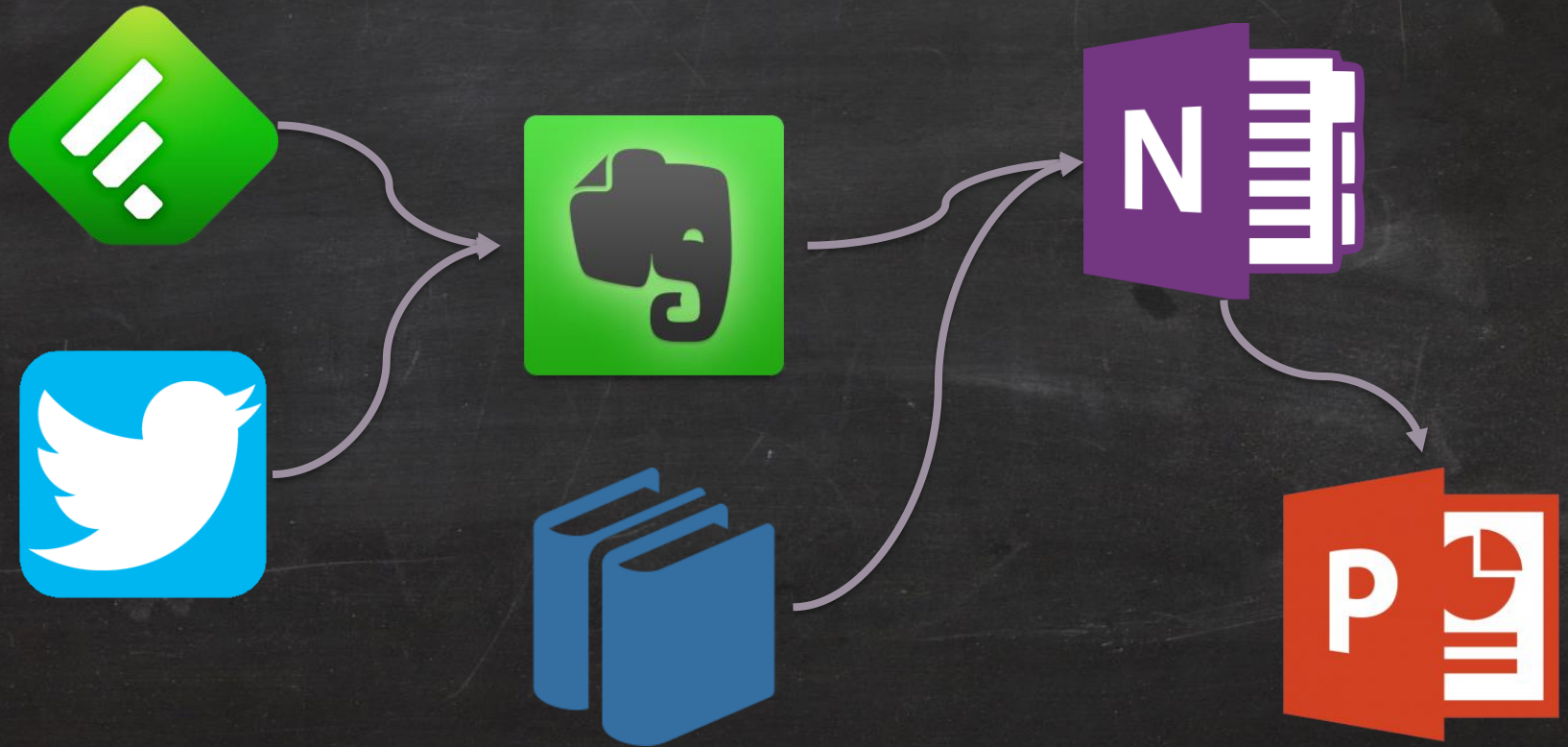
Fundamental Skills for Self-Study

- Information retrieval
- **Active reading**
- Effective note-taking
- Time-management
- Critical thinking

*There are too **MUCH** information!*

How could we learn new things more effectively?

My Information Distillation Workflow



Feedly



Graphics Programmi... 2

- Around the Corner 1
- GPU Pro 1
- 15 more sources

Research 9

- (Li-Yi Wei) Confes... 1
- Physics-Based A... 4
- Real-Time Rende... 4
- 18 more sources

Production 10

- Cinefex Blog 1
- fxguide 4**
- The Art of VFX 5
- 7 more sources


SciTech 10


- CASE PRESS
- Computer Graphi...
- Inside
- New on MIT Tech...
- PanSci 泛科學
- PanX 泛科技
- Road to VR


Fxguide


4 unread articles — 4K readers — #vfx #cg #3d

MAR 31

 **A Glimpse at Animal Logic**
Animal Logic technically walks through the design of their Glimpse renderer. One renderer, everywhere in the company, at every level of production.
400+👍 by Mike Seymour / 4d

 **fxpodcast #300: Haarm-Pieter Duiker**
Mike talks down with Haarm-Pieter Duiker, who has worked on amazing projects from the Light Stage 1 to the Matrix films, ...from ACEScg and to the latest EPIC Games GDC demo.
5👍 by Ian Failes / 4d

 **fxinsider's summer movie preview**
Our fxinsider guide to the big - no, the huge, USA summer movie releases and the VFX behind them.
33👍 by Ian Failes / 4d

 **Telling the story: the importance of invisible effects**
How invisible fx made the small budget films Race and Birth of a Nation possible.
32👍 by Ian Failes / 4d



Use Twitter in Different Ways

- Follow other graphics developers and researchers
- Follow academic/tech events like
 - SIGGRAPH, GDC, NVidia GTC, Microsoft Build, etc.
- Follow studios/companies/products like
 - Disney, Pixar, ILM, etc.
 - Unreal Engine, Unity, CryEngine, etc.
 - Hololens, Kinect, etc.



Use Twitter in Different Ways

- Follow other graphics developers and researchers
- Follow academic/tech events like
 - SIGGRAPH, GDC, etc.
- Follow **inspiration**
 - Disney, Pixar, etc.
 - Unreal Engine, Unity, CryEngine, etc.
 - Hololens, Kinect, etc.

Rule of Thumb
Follow the ones who inspire you!



Evernote

- Collect informative web pages & posts
 - [Real-Time Rendering](#), [fxguide](#), etc.
 - Course web-sites
 - [Courses in graphics](#) @Stanford
 - [Courses](#) @Cornell
 - Project pages of academic papers
 - Discussions from *StackOverflow* or other forums

A Glimpse of My Evernote

Work Chat

★ Shortcuts

Drag notes, notebooks or tags here for quick access

📄 Notes (1251)

📁 Notebooks

Life

Maya (25)

Production (36)

Programming (446)

Study

English (16)

Graphics (146)

Learning (11)

Math (69)

Physics (4)

Research (70)

Tips & Tricks (57)

Trash

🏷️ Tags

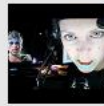
📶 Upgrade

Production ▾



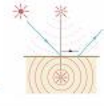
Hellblade: Diary 21 - Making a Virtual ...

3/24/2016 Hellblade: Diary 21 - Making a Virtual Human | Real-time performance capture <https://www.youtube.com/watch?v=...>



Skin Shader

3/11/2016 PBR, skin Deep skin from weta <http://www.fxguide.com/featured/prometheus-rebuilding-hallowed-vfx-space/> Until recent...



Animation basics: Homemade special ...

2/27/2016 Animation basics: Homemade special effects - TED-Ed 64,442 Views 1,788 Questions Answered Let's Begin... Animation...



Mery Rig - Free Maya Character Rig, Fe...

2/18/2016 Like 1.9K Tweet 50 87inShare 326 Mery Rig - Free Maya Character Rig, Female Character rig, Free Maya rigs Mery Project i...



Rouhollah Toghiani Portfolio

12/22/2015 Rouhollah Toghiani Portfolio <http://www.toghiani.com/index.html> Rouhollah Toghiani, 3d artist

RIO 2 Behind the Scenes

12/21/2015 RIO 2 Behind the Scenes <http://www.cgmeetup.net/home/rio-2-behind-the-scenes/> RIO 2 Behind the Scenes. Watch ...



CGTalk - 3D Portrait of Annasophia Ro...

11/29/2015 3D Portrait of Annasophia Robb, Hossein Diba (3D) 07-24-2014, 01:43 PM #1 HosseinDiba Frequenter Hossein Diba Istan...



🏷️ Production ▾ 🏠 Click to add tag...

Created: 3/24/2016 5:20 PM

URL: www.youtube.com... ▾

Hellblade: Diary 21 - Making a Virtual Human | Real-time performance capture

Hellblade: Diary 21 - Making a Virtual Human | Real-time performance capture

<https://www.youtube.com/watch?v=CmrXK4fNOEo>

[OfficialNinjaTheory](#)

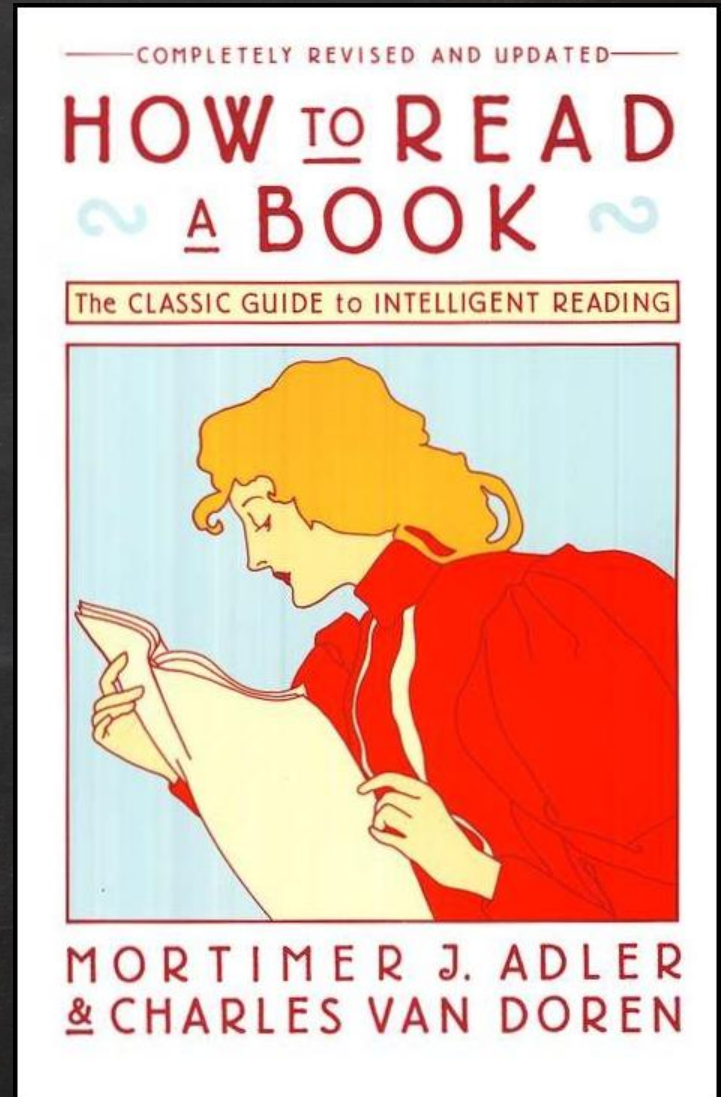
31,072 views

Published on Mar 17, 2016

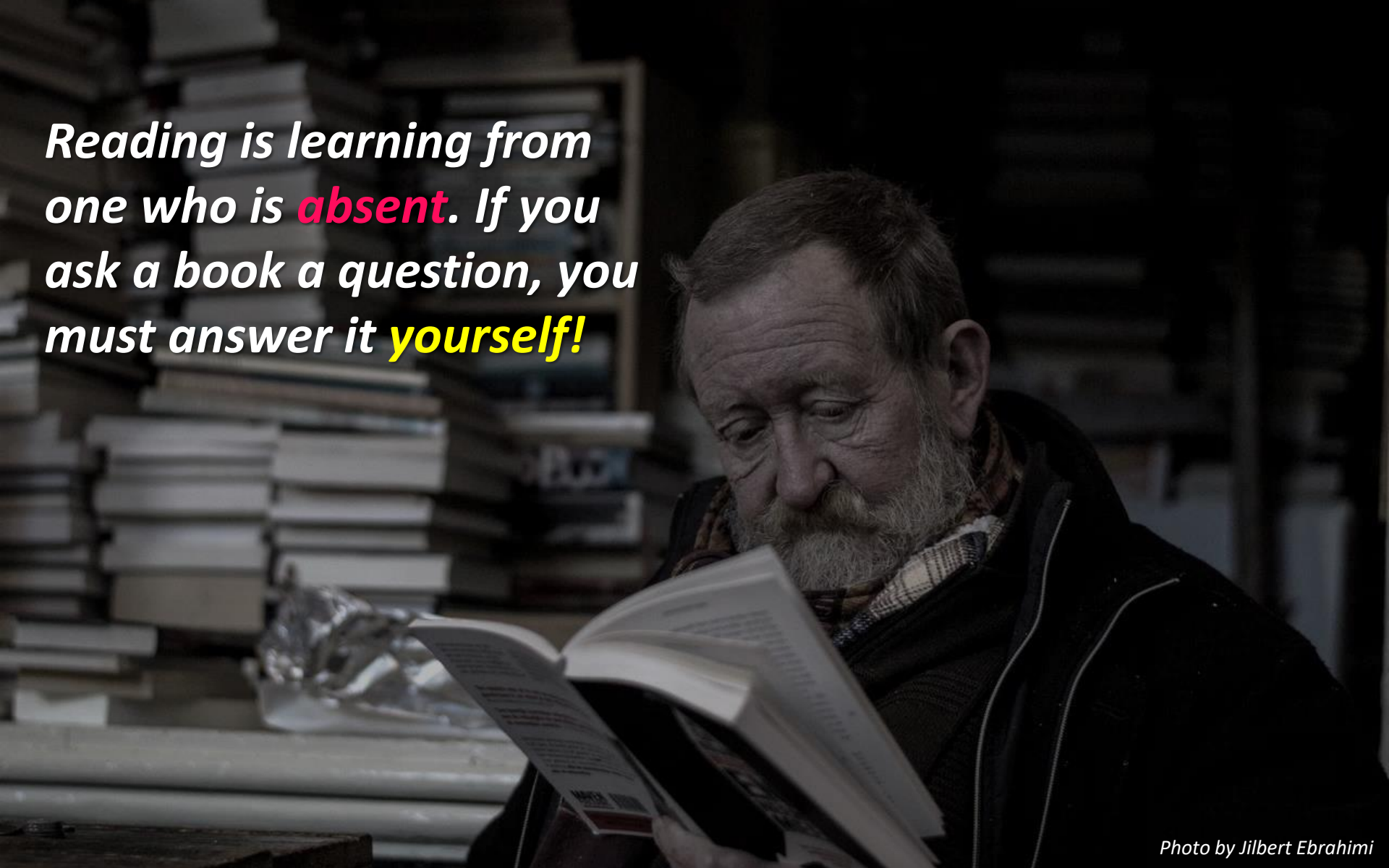


Our goal is “Reading for **Understanding!**”

Active Reading



*Reading is learning from
one who is **absent**. If you
ask a book a question, you
must answer it **yourself!***



Four Basic Questions During Active Reading

- What is the book all about?
- What is being said in detail, and how?
- Is the book true in whole or part?
- What is the significance?
 - Is it important for us to know that information?

Four Basic **Questions** During Active Reading

- What is the book all about?
- What is being said in detail, and how?
- Is the book true in what it says?
- Why does the author want us to know that information?

Wonder is the beginning of wisdom in learning.
Keep asking yourself questions!

The Levels of Reading

- 1. Elementary Reading*
- 2. Inspectional Reading*
- 3. Analytical Reading*
- 4. Syntopical Reading*

The Levels of Reading

Our Focus Today



2. Inspectional Reading

3. Analytical Reading

Inspectional Reading

- Systematic skimming or pre-reading in a **limited** time
 - It's **NOT** a casual or random browsing
- **Discover if the book requires a more careful reading**
- Looking for clues to a book's general theme or idea
 - Alter for anything that will make it clearer
 - Grasp the big picture first!

Practical Tips for Inspectional Reading

1. Look at the title page and its preface
2. Study the table of contents
3. Check the index
4. Read the publisher's blurb
5. Look at the chapters which is pivotal to its argument
6. Read a paragraph or two, sometimes several pages



Francis Bacon 1561-1626

*“Some books are to be tasted, others to be swallowed,
and some few to be **chewed and digested.**”*

A photograph of two hikers on a dirt trail in a forest. The hiker in the foreground is wearing a white shirt with red accents and dark shorts, and is captured in mid-stride. The hiker in the background is wearing a white shirt with red accents and dark leggings, also using trekking poles. The trail is rocky and surrounded by dense green foliage.

*In tackling a **difficult** book for the first time,
read it through **without ever stopping** to look up or
ponder the things you do not understand right away.*

A photograph of two hikers on a dirt trail in a forest. The hiker in the foreground is wearing a white shirt with red accents and dark shorts, using trekking poles. The hiker in the background is wearing a white shirt and dark pants, also using trekking poles. The trail is rocky and surrounded by dense green foliage.

*If you let yourself get stalled, you are lost!
You will miss the forest for the trees.*

*Do **NOT** try to understand every word or page of a
difficult book **the first time** through.*

The Idea of Growth Mindset

Carol Dweck:

The power of believing that you can improve

TEDxNorrkoping · 10:20 · Filmed Nov 2014

⋮ 40 subtitle languages ?

📄 View interactive transcript



Cf. [The Journey to a Growth Mindset by Prof. Carol Dweck](#)

[TED talk](#)

Different Mindsets

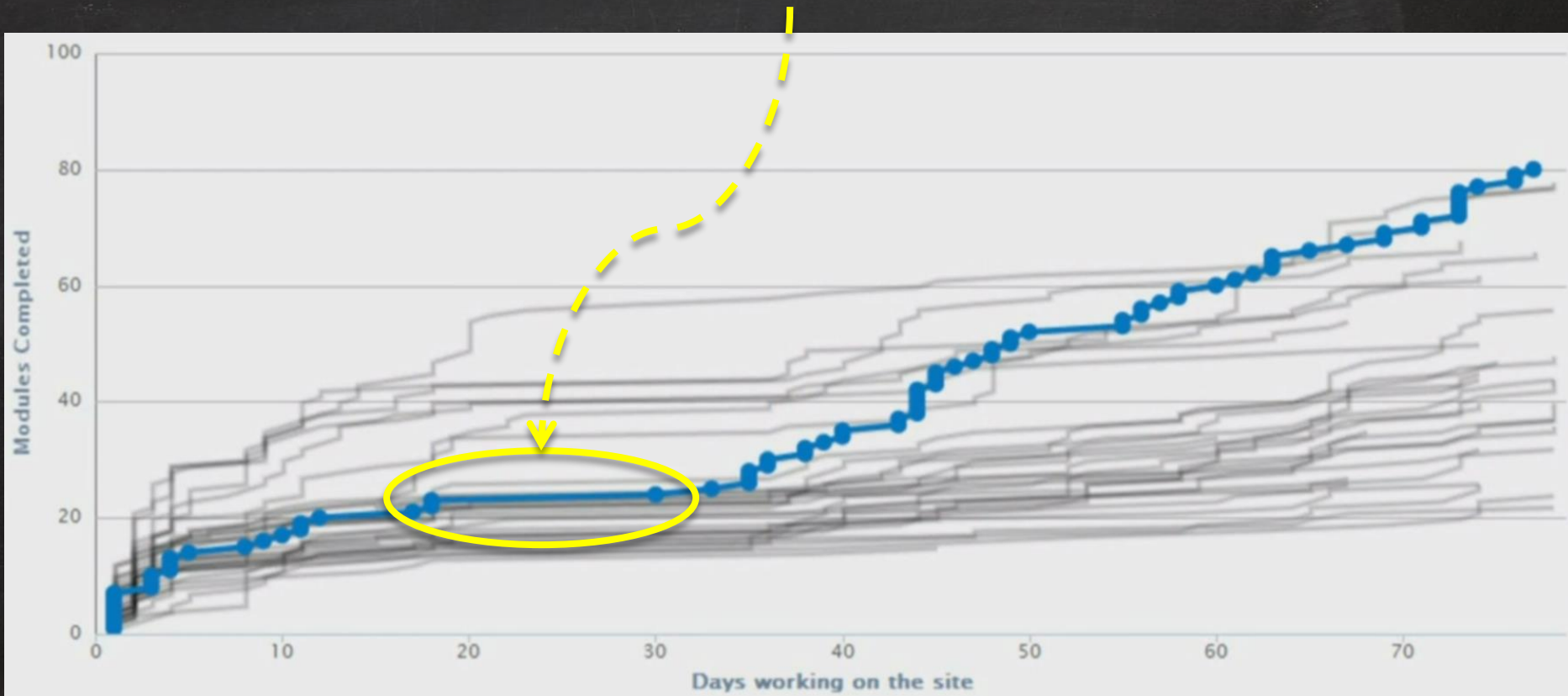
Fixed Mindset

- Never look dumb
- Don't work hard or seek help
- Run from difficulty

Growth Mindset

- Learn
- Work hard, use strategies, seek help to learn
- Learn from mistakes

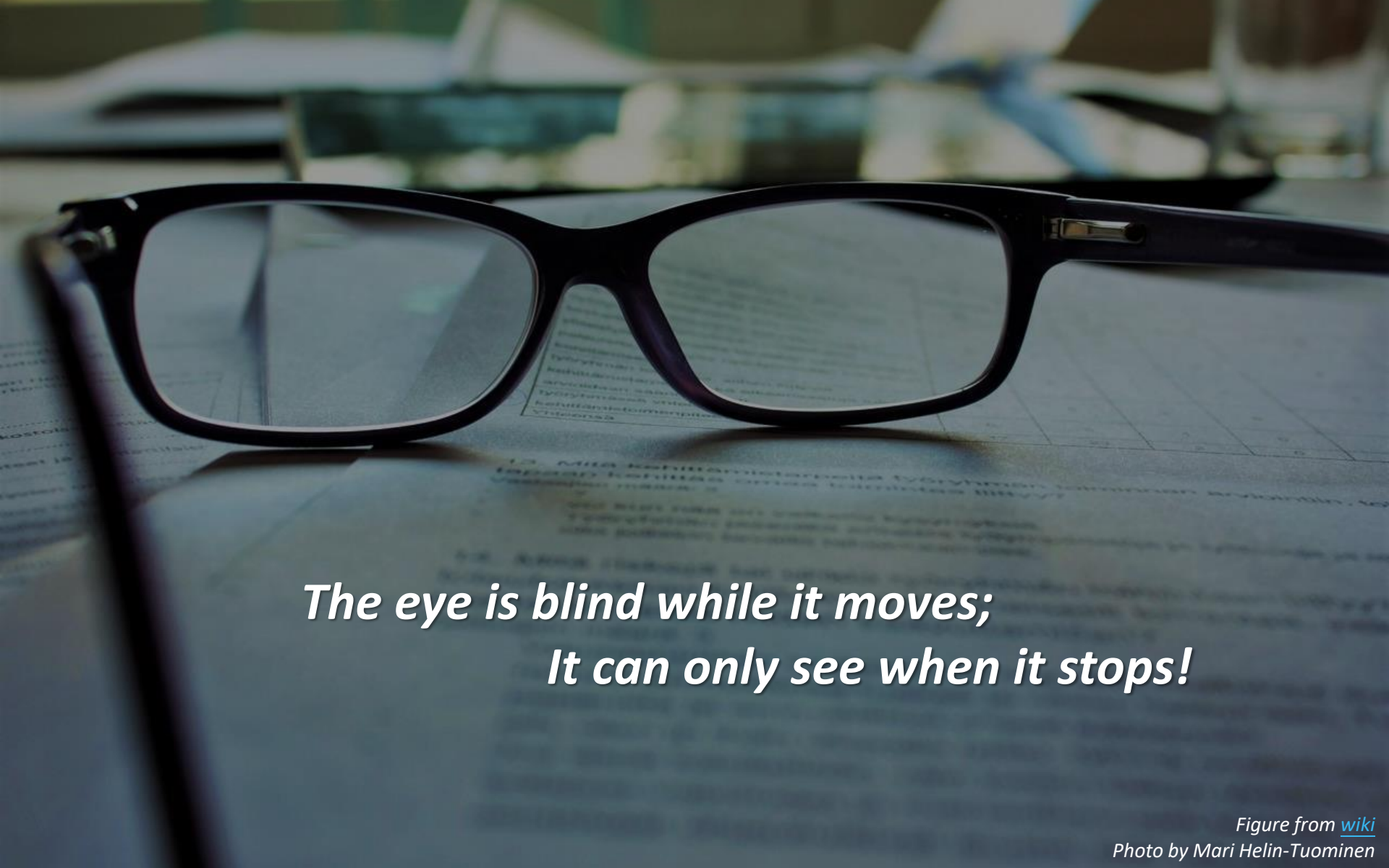
**Once you get through a concept,
you would learn the relevant materials more quickly!**



Screen capture from TED talk: [Salman Khan: Let's use video to reinvent education](#)

Reading at **Different** Speeds

- Every book should be read
 - no more **slowly** than it deserves and
 - no more **quickly** than you can read it with satisfaction and comprehension
- Eyes **fixate** as many as five or six times in each line reading...
 - Try to sweep a “pointer” (finger or pen) across a line
 - a little faster than it is comfortable for your eyes to move



*The eye is blind while it moves;
It can only see when it stops!*

fixation point

Around the fixation point only four to five letters are seen with 100% acuity.

Around the fixation point only four to five letters are seen with 100% acuity.



Acuity

*The eye is blind while it moves;
It can only see when it stops!*

Eye Tracking of Reading

DANS, KÖN OCH JAGPROJEKT

På jakt efter ungdomars kroppsspråk och den "synkretiska dansen", en sammansmältning av olika kulturers dans, har jag i mitt fältarbete under hösten rört mig på olika arenor inom skolans värld. Nordiska, afrikanska, syd- och östeuropeiska ungdomar gör sina röster hörda genom sång, musik, skrik, skratt och gestaltar känslor och uttryck med hjälp av kroppsspråk och dans.

Den individuella estetiken framträder i kläder, frisyrer och symboliska tecken som förstärker ungdomarnas "jagprojekt" där också den egna stilen i kroppsrörelserna spelar en betydande roll i identitetsprövningen. Uppehållsrummet fungerar som offentlig arena där ungdomarna spelar upp sina performance-liknande kroppsspråk

研究表明，漢字序順並不一定影響閱讀。
比如當你看完這句話后，才發現這里的字全是都亂的

[漢字順序並不影響閱讀?人眼一次能看六個字](#)

Aoccdrnig to a rscheearch at Cmabrigde Uinervtisy, it deosn't mttar in waht oredr the ltteers in a wrod are, the olny iprmoetnt tihng is taht the frist and lsat ltteer be at the rghit pclae.

The rset can be a total mse and you can sitll raed it wouthit porbelm. Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe.

<https://www.mrc-cbu.cam.ac.uk/personal/matt.davis/Cmabrigde/>

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We use our **Brain** to
understand the meanings,
NOT eyes!

Aoccdrnig to a rse
waht oredr the ltt
frist and lsat ltt

Isn't mttar in
hng is taht the

The rset can be a total mse and you can sitll raed it wouthit porbelm. Tihs
is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the
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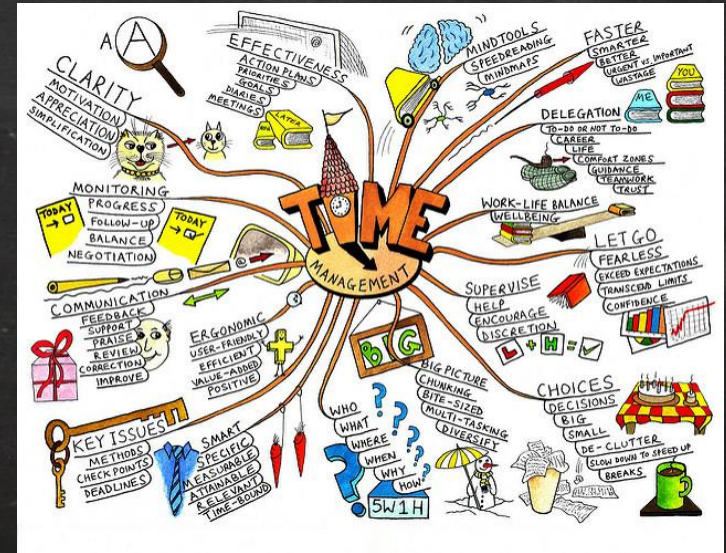
<https://www.mrc-cbu.cam.ac.uk/personal/matt.davis/Cmabrigde/>

Analytical Reading

- Before reading, you must know what kind of book you are reading!
 - Learn to read each kind of book in an appropriate manner
- Works at a book until it becomes your own
 - Preeminently for the sake of understanding
 - From knowing *what is the case* to *what to do about it if we wish to get somewhere*

Analytical Reading (Cont'd)

- Use a short paragraph to state the whole book
 - Find out what the author's problems were
 - Discover its theme or main points
- Show how the major points are organized into the unity of the whole
 - Mind-map might help



Analytical Reading (Cont'd)

- **Terms \neq Words**

- A term is the basic element of communicable knowledge
- It's a word used **un**ambiguously

- **Key words**

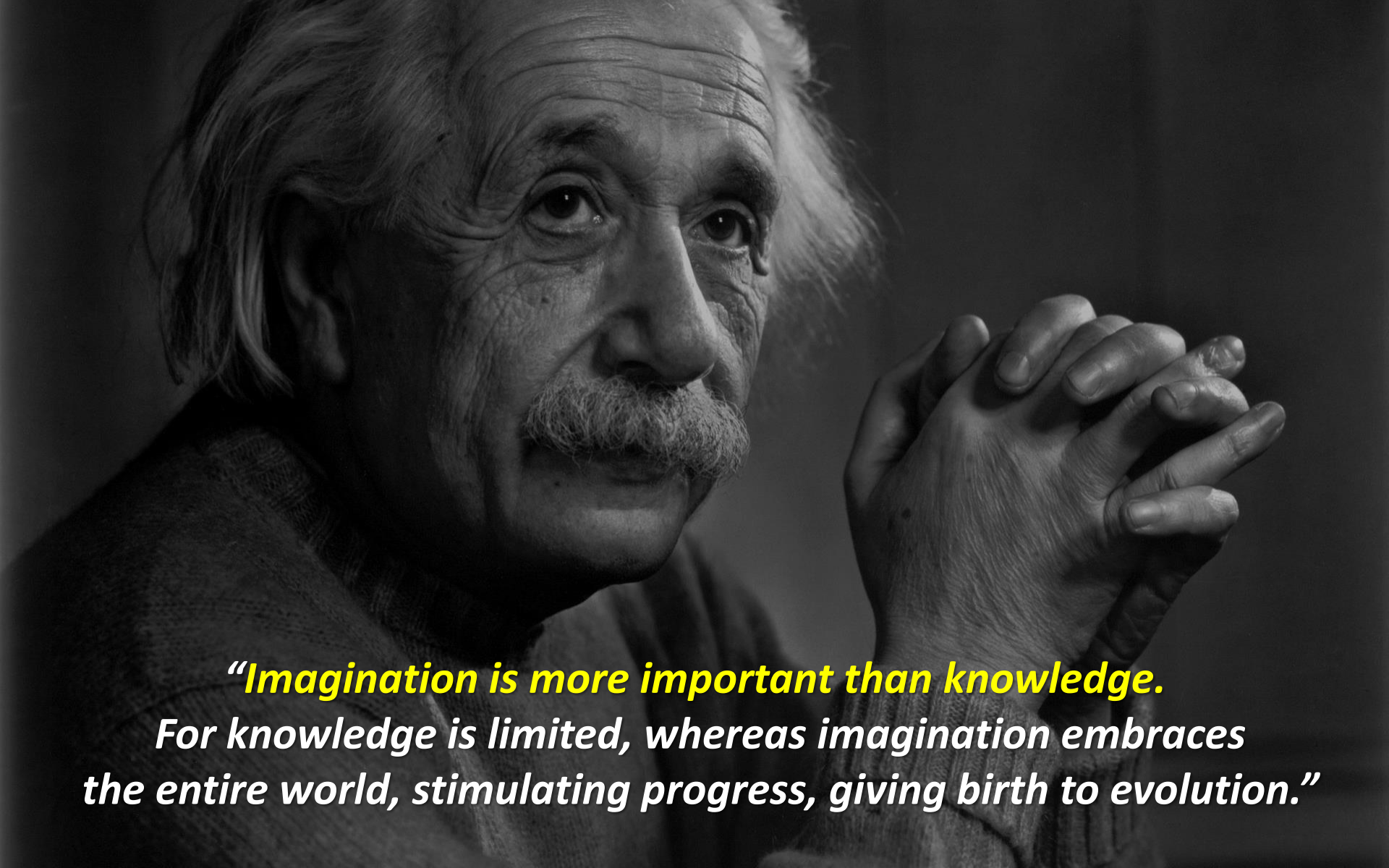
- You can't locate them without understanding the passage
- The most important ones are those **give you troubles**
- Discover the meaning of a word from the enclosing context you understand

Analytical Reading

- Classify the book according to kind and subject
- State what the whole book is about
- Enumerate its major parts in their order and relation
- Define the problem or problems the author is trying to solve

Analytical Reading

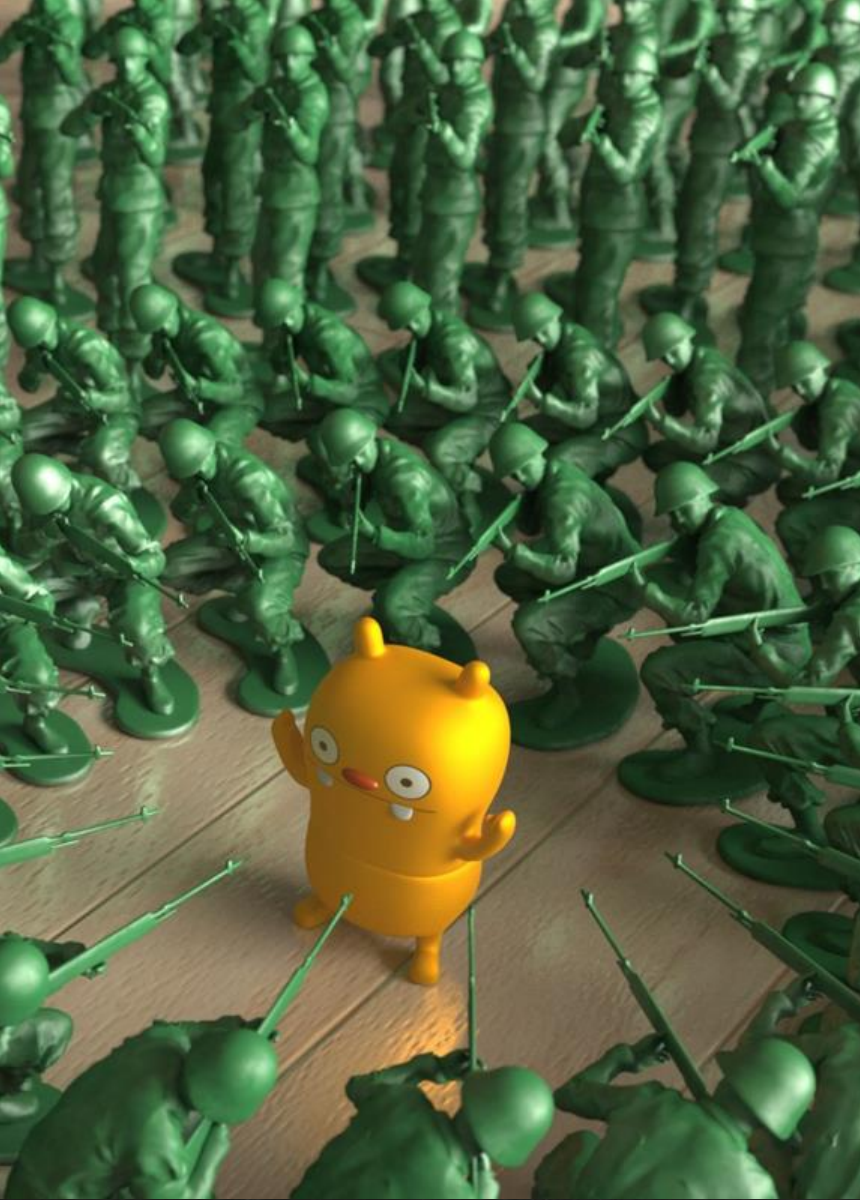
- Come to **terms** with the author
- Grasp the author's leading **propositions**
- Know the author's **arguments**
 - Construct them out of sequence of sentences
- Determine the problems and whether those problems are solved by the author or not



“Imagination is more important than knowledge.

For knowledge is limited, whereas imagination embraces the entire world, stimulating progress, giving birth to evolution.”

Active Reading for Graphics Engineers



Know Your Enemy!!

*Before diving into reading,
breakdown your problems
at hand first!*

Reading for Specific Purposes

- Grasp the big ideas of a new topic you didn't know
Ex. Physically-based rendering / simulation
- Get inspired from related works
Ex. Hair/fur shading models and implementations
- Study fundamental subjects
Ex. Numerical optimization, differential geometry, etc.

Grasp The Big Ideas of A New Topic

- Apply **inspectional reading** skills on
 - SIGGRAPH course notes
 - EUROGRAPHICS STARs (state-of-the-art reports)
 - survey papers or technical reports

Get Inspired from Related Works

- Use google scholar to find related papers in recent years then
 1. Watch the demo videos
 2. Read the abstract, introduction & results
 3. Find out the **assumptions**
 4. Study the core ideas

Study Fundamental Subjects

- Learn from worldwide universities
 - OCW: [MIT](#), [Udacity](#), [Coursera](#), etc.
 - Search for course websites
 - Check out course slides, textbooks or video recordings
- [Khan Academy](#)
 - This is extremely helpful to learn/review certain topics
- Reading classic textbooks which are highly recommended on Amazon

Study Fundamental Subjects (Cont'd)

- Find sometime to review the materials
- Note making is a crucial process or you will definitely forget what you've learned today in the future!
 - Life is too short, don't repeat yourself!
- Try to do few exercises in the textbooks if possible
 - This is not an easy task, especially when you don't have much time after your day-time job
 - Try to enroll in more math-related courses when you study at school

Research & Development

- Always check out these materials first
 - SIGGRAPH course notes & talks
 - Learn the invaluable experiences from other studios
 - EUROGRAPHICS STARs (state-of-the-art reports)
 - Technical papers published from industry
- Be aware of the **assumption** in those papers
 - Would it put additional burdens on our artists?
 - The precondition might not be true in our production environment

Research & Development (Cont'd)

- Assure that the algorithm is implementable in our development infrastructure
 - Maya nodes/commands
 - Mental Ray/Arnold shaders
 - NUKE operators
- Performance concerns
 - Time-consuming preprocessing might be unsuitable
 - It's not art-directable usually
 - Check the runtime environment
 - Re-estimate the performance with our own hardware specs.

Effective Note-Taking

Note Taking for Active Reading

- Don't use too many star or asterisk symbols
 - **Everything means NOTHING!**
 - Only emphasize the most important statements
- Use numbers to indicate how the author develops an argument
- Use "Cf." for comparison, cross reference
- Circling of key words or phases

Note Taking for Active Reading (Cont'd)

- Write down your question in a simple statement and **try to answer these questions during reading**
- Record the sequence of major points
 - What are the key points and their relationships
 - Do you agree them all or not?
 - It's useful to read other papers for the opinions about the paper you currently study

Note Taking for The Theme

- Paper notes are hard to
 - index and search
 - cross reference
 - extract the common ideas from different contexts
- I've tried several software to tackle problems above and I finally found OneNote is a perfect match for me



OneNote

- Extremely handy editing workflow
 - Type everywhere
 - Support math equation editing
 - Support cross references
- Sync everywhere
 - Desktop, laptop & cell phones
- It's [FREE!](#)

In Progress

- Physically Based Simulation
- Numerical Methods
- Numerical Optimization
- Digital Geometry Processing
- Motion
- Eigen
- IdeaBox
- Global Illumination
- Physically Based Shading
- Parallel Programming
- Julia
- git
- Realtime Rendering
- Work

Research

- Research Method
- Hair and Fur
- Animation
- Volume Rendering
- Digital Signal Processing
- Machine Learning
- Surface Reconstruction
- Performance Capture
- Vocation
- Cosmos VR

Graphics

Programming

- General Concept
- Memory Management
- System Programming
- Algorithms
- Architect
- Computation Tips
- Profiling

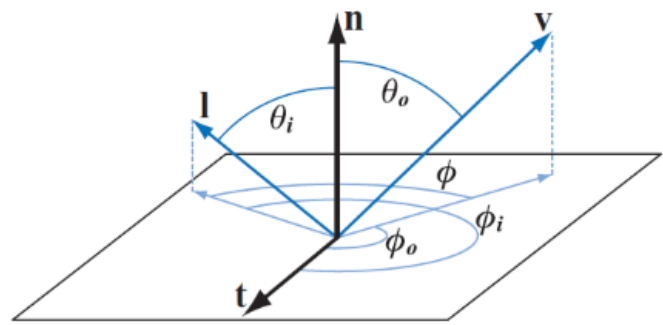
Add Page

- Contents
- Key Factors for PBR
- Task
- Layer Shading
- Surface Models
- Material Classification
- Light and Matter
- Fresnel Reflectance
- Refraction
- Scattering
- BRDF

- BRDF History
- BRDF Acquisition
- MERL 100
- BRDF Viewer
- Capturing Diffuse Albedo
- Fabric
- Microfacet Model
- Normal Distribution Function
- Geometry Function
- Shadowing-Masking
- Multiple Scattering Microfacet
- Digital Human
- Diffuse Reflectance Chart
- Eyeball
- Skin
- Human Skin Appearance
- Subsurface Scattering
- BSSRDF Importance Sampling
- Disney Principled BRDF
- Disney Principled BRDF in Arno

BRDF

2015年5月31日 下午 01:50



$$f(\theta_i, \phi_i, \theta_o, \phi_o) = f(\vec{\omega}_i, \vec{\omega}_o)$$

$$f(\vec{\omega}_i, \vec{\omega}_o) = \frac{dL_r(\vec{\omega}_o)}{dE_i(\vec{\omega}_i)} = \frac{dL_r(\vec{\omega}_o)}{L_i(\vec{\omega}_i) \cos \theta_i d\omega_i}$$

Properties

1. Helmholtz-reciprocity
The direction of the ray of light can be reversed: $f(\vec{\omega}_i, \vec{\omega}_o) = f(\vec{\omega}_o, \vec{\omega}_i)$
2. Positivity
 - o $f(\vec{\omega}_i, \vec{\omega}_o) \geq 0$
3. Energy conservation
 - o Total amount of outgoing energy must be **less than or equal to** the incoming energy
 - o $\int_{\Omega} f(\vec{\omega}_i, \vec{\omega}_o) \cos \theta d\vec{\omega}_i \leq 1$
 - adding all possible incoming directions

Lambert: constant value

- $n \cdot l$ is part of reflectance equation, **NOT** BRDF
- doesn't account for surface roughness

In most cases, microscopic roughness only affects specular:

In Progress

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Research

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- Digital Signal Processing
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- Performance Capture
- Vocation
- Cosmos VR

Graphics

Programming

- General Concept
- Memory Management
- System Programming
- Algorithms
- Architect
- Computation Tips

Physically Based Simulation

- Add Page
- Contents
- Differential Equation Basics
- Implicit Methods for ODEs
- Time Integration Method
- Classical Mechanics
- Constrained Dynamics
- Force-Based vs. Position-Based
- FEM
 - Tetrahedral Model
 - Elastic Deformation

Position-Based Dynamics

- Analysis of PBD
- Constrains in PBD
- Gauss's Principle of Least Constraint
- Wavelet Turbulence
- Elastic Rod
- Physically-Based Deformation
- Inverse Kinematics
- Rigid Body
- Collision Detection
 - Colliding Contact
 - Resting Contact
- Stabilization
- Mass-Spring
- Cloth
- Controllable Simulation

Big Ideas

- Solve position first (from constraints)
- Update velocity from position

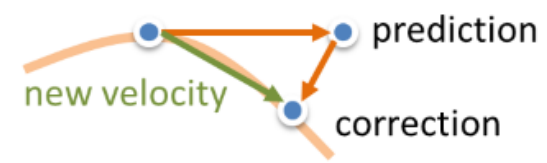
Framework

- Use explicit Euler integration step to estimate position p_i
- Project each constraint in a *Gauss-Seidel* type fashion
- Solve velocity similar to *Verlet* integration step
- Unconditionally stable!
- Stability doesn't depend on the time step size but on the shape of constraint functions

```

forall vertices i
    initialize  $x_i = x_i^0, v_i = v_i^0, w_i = 1/m_i$ 
endfor
loop
    forall vertices i do  $v_i \leftarrow v_i + \Delta t w_i f_{ext}(x_i)$ 
    dampVelocities( $v_1, \dots, v_N$ )
    forall vertices i do  $p_i \leftarrow x_i + \Delta t v_i$ 
    forall vertices i do generateCollisionConstraints( $x_i \rightarrow p_i$ )
    loop solverIterations times
        projectConstraints( $C_1, \dots, C_{M+M_{coll}}, p_1, \dots, p_N$ )
    endloop
    forall vertices i
         $v_i \leftarrow (p_i - x_i) / \Delta t$ 
         $x_i \leftarrow p_i$ 
    endfor
    velocityUpdate( $v_1, \dots, v_N$ ) // friction/resistution
endloop
    
```

Position Correction



Velocity Correction





PowerPoint

- Teaching is the best way to learn!
- If we can't find an easy way to explain something to someone, most of the time, we don't truly understand that topic
- Making slides help us
 - organize the sequence of points
 - develop our arguments in a proper order
 - figure out the points we didn't know very well

Fundamental Subjects in Graphics

- Parallel programming
 - Focus on algorithm pattern, not on specific technology
- Machine learning
 - More and more graphics applications need training
- Numerical optimization

References

- [*How to Read a Book*](#), by Mortimer J. Adler & Charles Van Doren.
- [*Advices*](#) from Prof. Li-Yi Wei.
- [*Being A Developer After 40*](#), Adrian Kosmaczewski.
- [*Learning How to Learn: Powerful mental tools to help you master tough subjects*](#), by Dr. Terrence Sejnowski & Dr. Barbara Oakley.

*Learning is more like hiking,
NOT car racing...*



A hiker with a large backpack stands on a rocky mountain peak, looking out over a vast, hazy mountain range at sunrise or sunset. The hiker is wearing a dark hooded jacket and shorts. The background features multiple layers of mountain ranges, with the nearest peaks in sharp focus and the distant ones fading into a soft, golden light. The overall mood is serene and adventurous.

Stay Hungry, Stay Foolish.

Photo by Danka & Peter