Blockchain Introduction

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Blockchain

- A blockchain is a decentralized ledger in which each set of entries references its predecessor
- A ledger is a chronological record of transactions
- Decentralized means distributed among multiple participants rather than maintained by one

A *stylized* illustration

- Law school transcript: A *ledger* of the courses you took and the grades you earned

Course	Grade
Tort Law	A
Tort Theory	B
Advanced Torts	B
Tortes and Cakes	C
How to Commit Torts	A

Your transcript today

- *Centralized* ledger
  - Controlled by the Registrar
  - Do you trust her? (Yes: She's awesome)

Course	Grade
Tort Law	A
Tort Theory	B
Advanced Torts	B
Tortes and Cakes	C
How to Commit Torts	A

Course	Grade
Tort Law	C
Tort Theory	C
Advanced Torts	C
Tortes and Cakes	C
How to Commit Torts	C

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Your transcript today

- Your copy is just a copy
  - Controlled by you
  - Will potential employers trust you?

Course	Grade
Tort Law	A
Tort Theory	B
Advanced Torts	B
Tortes and Cakes	C
How to Commit Torts	A

Course	Grade
Tort Law	A
Tort Theory	A
Advanced Torts	A
Tortes and Cakes	A
How to Commit Torts	A

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First solution

Course	Grade
Tort Law	A
Tort Theory	B
Advanced Torts	B
Tortes and Cakes	C
How to Commit Torts	A

Course	Output
Tort Law	4
Tort Theory	3
Advanced Torts	3
Tortes and Cakes	2
How to Commit Torts	4

Total: 16

Create a *function*:

- Takes your grade as an input (e.g., “A”)
- Gives a number as the output (e.g., “4”)

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First solution

Course	Grade
Tort Law	A
Tort Theory	B
Advanced Torts	B
Tortes and Cakes	C
How to Commit Torts	A

Course	Output
Tort Law	4
Tort Theory	3
Advanced Torts	3
Tortes and Cakes	2
How to Commit Torts	4

Total: 16

Course	Grade
Tort Law	A
Tort Theory	A
Advanced Torts	A
Tortes and Cakes	A
How to Commit Torts	A

Course	Output
Tort Law	4
Tort Theory	4
Advanced Torts	4
Tortes and Cakes	4
How to Commit Torts	4

Total: 20

Course	Grade
Tort Law	C
Tort Theory	C
Advanced Torts	C
Tortes and Cakes	C
How to Commit Torts	C

Course	Output
Tort Law	2
Tort Theory	2
Advanced Torts	2
Tortes and Cakes	2
How to Commit Torts	2

Total: 10

But what's the problem?

- Do you want the world to know your total?
- How do we trust that your total is correct?
- How do we trust that the path to your total is correct?

Course	Grade
Tort Law	A
Tort Theory	B
Advanced Torts	B
Tortes and Cakes	B
How to Commit Torts	B

Course	Output
Tort Law	4
Tort Theory	3
Advanced Torts	3
Tortes and Cakes	3
How to Commit Torts	3

Total: 16

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Second solution

Course	Grade
Tort Law	A
Tort Theory	B
Advanced Torts	B
Tortes and Cakes	C
How to Commit Torts	A

Course	Output
Tort Law	3d873f
Tort Theory	dk3KD5
Advanced Torts	dk3KD5
Tortes and Cakes	8v298a
How to Commit Torts	3d873f

Changing the grade changes the output!

Hash

A mathematical function!

- Takes your grade as an input (e.g., “A”)
- Gives a string as the output (e.g., “3d873f”)

We’ll discuss encryption later!

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Third solution

Course	Grade
Tort Law	A
Tort Theory	B
Advanced Torts	B
Tortes and Cakes	C
How to Commit Torts	A

Course	Output
Tort Law	3d873f
Tort Theory	dk3KD5
Advanced Torts	dk3KD5
Tortes and Cakes	8v298a
How to Commit Torts	3d873f

893D90

Hash

A mathematical function!

- Takes the *previous outputs* as an input
- Gives a *new* string as the output

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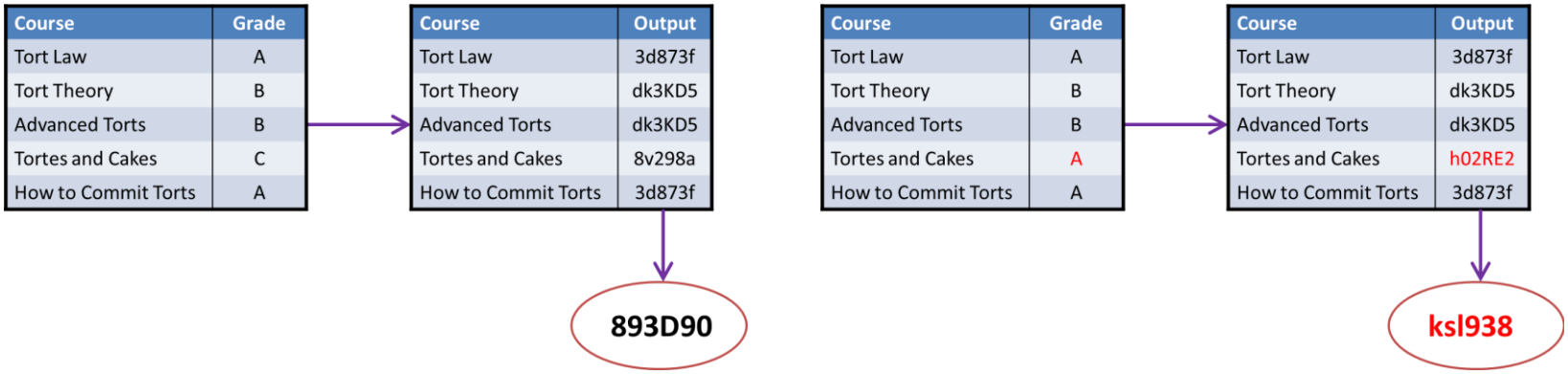
As a result

- Changing any grade changes the corresponding output
- Changing that output in turn changes any outputs that are based on it



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Third solution

- Hash *everything* (not just the grades)
  - Hash to 256 characters instead of 6 characters
  - There are **2^256** possible combinations (>100,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000)

- *Every* hashed output is now 256 characters
  - "Tort Law A" → 256 characters
  - Your entire exam answer → 256 characters
  - A file of law school blueprints → 256 characters

Refining our illustration (*still stylized!*)

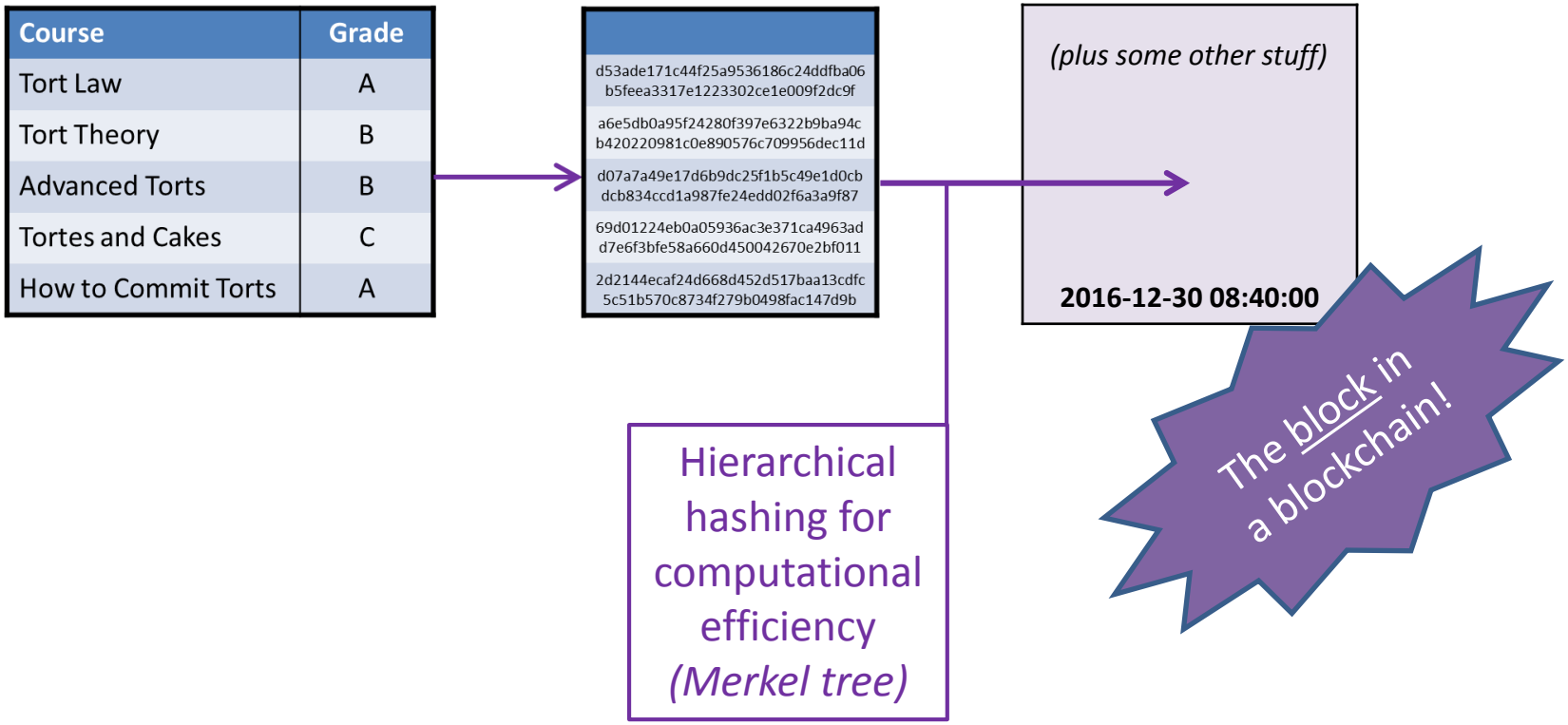
Course	Grade
Tort Law	A
Tort Theory	B
Advanced Torts	B
Tortes and Cakes	C
How to Commit Torts	A

Hash

d53ade171c44f25a9536186c24ddfba06b5feea3317e1223302ce1e009f2dc9f
a6e5db0a95f24280f397e6322b9ba94cb420220981c0e890576c709956dec11d
d07a7a49e17d6b9dc25f1b5c49e1d0cbdcb834ccd1a987fe24edd02f6a3a9f87
69d01224eb0a05936ac3e371ca4963add7e6f3bfe58a660d450042670e2bf011
2d2144ecaf24d668d452d517baa13cdfc5c51b570c8734f279b0498fac147d9b

(using SHA-256)

Refining our illustration



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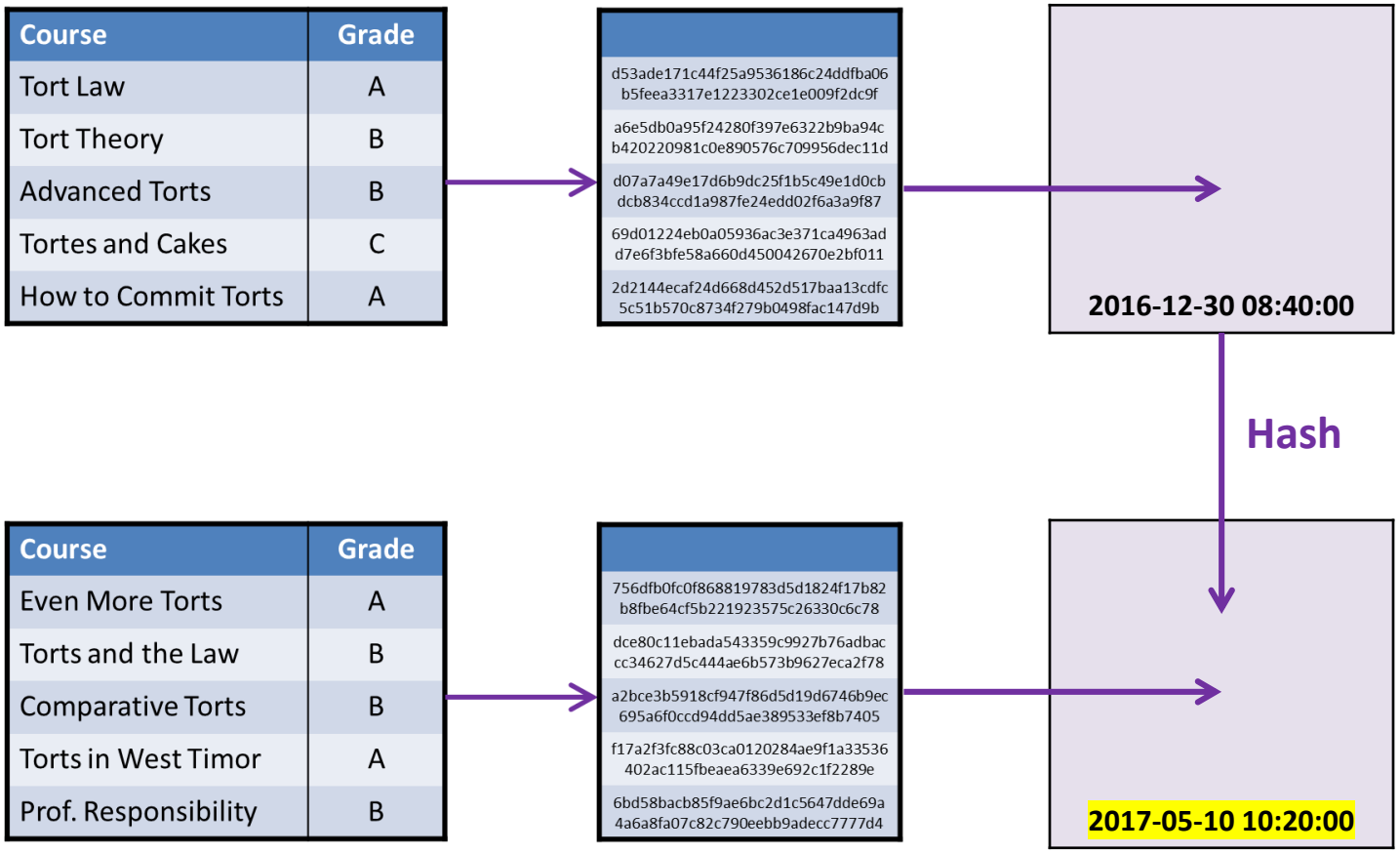
Refining our illustration



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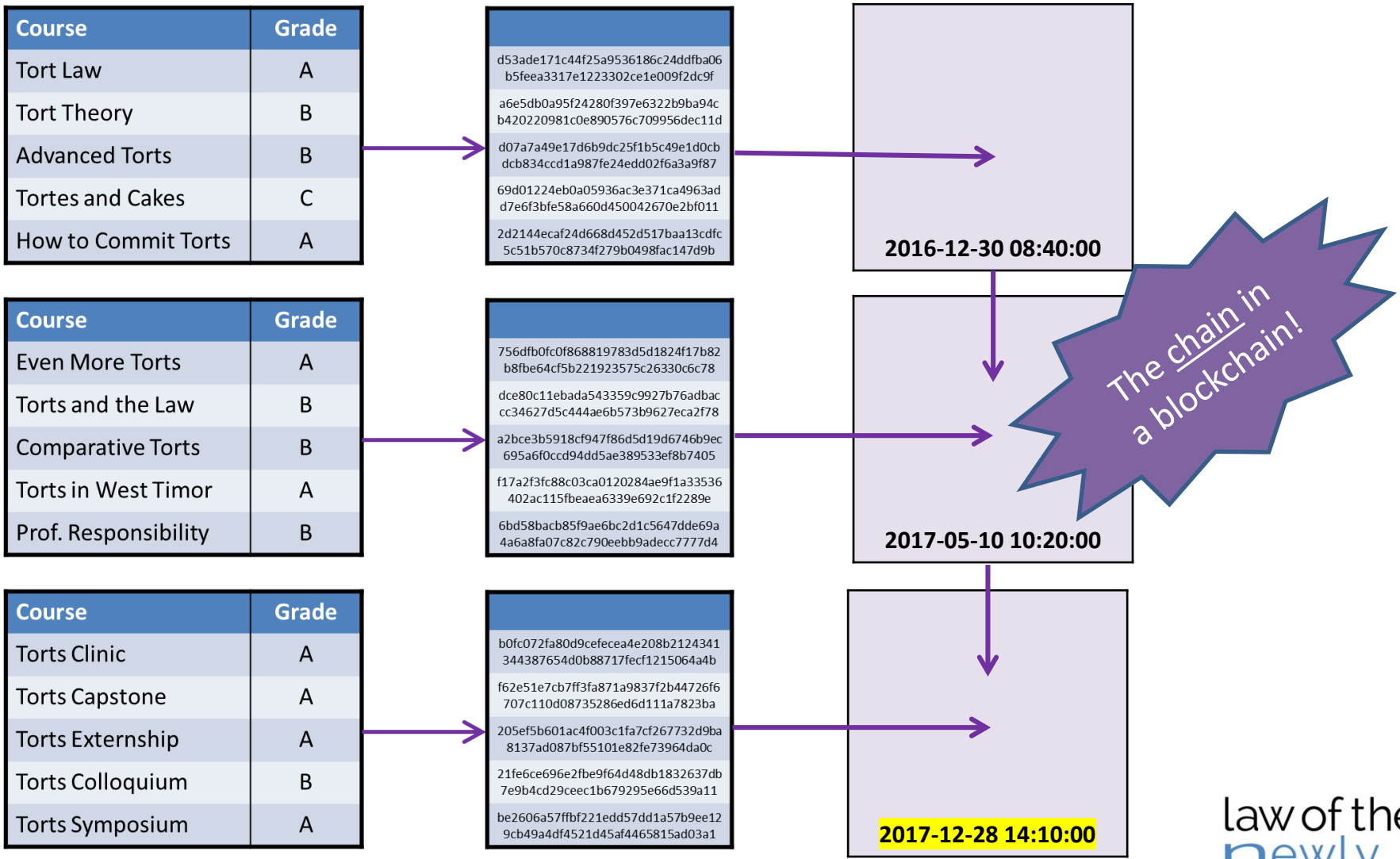
Refining our illustration



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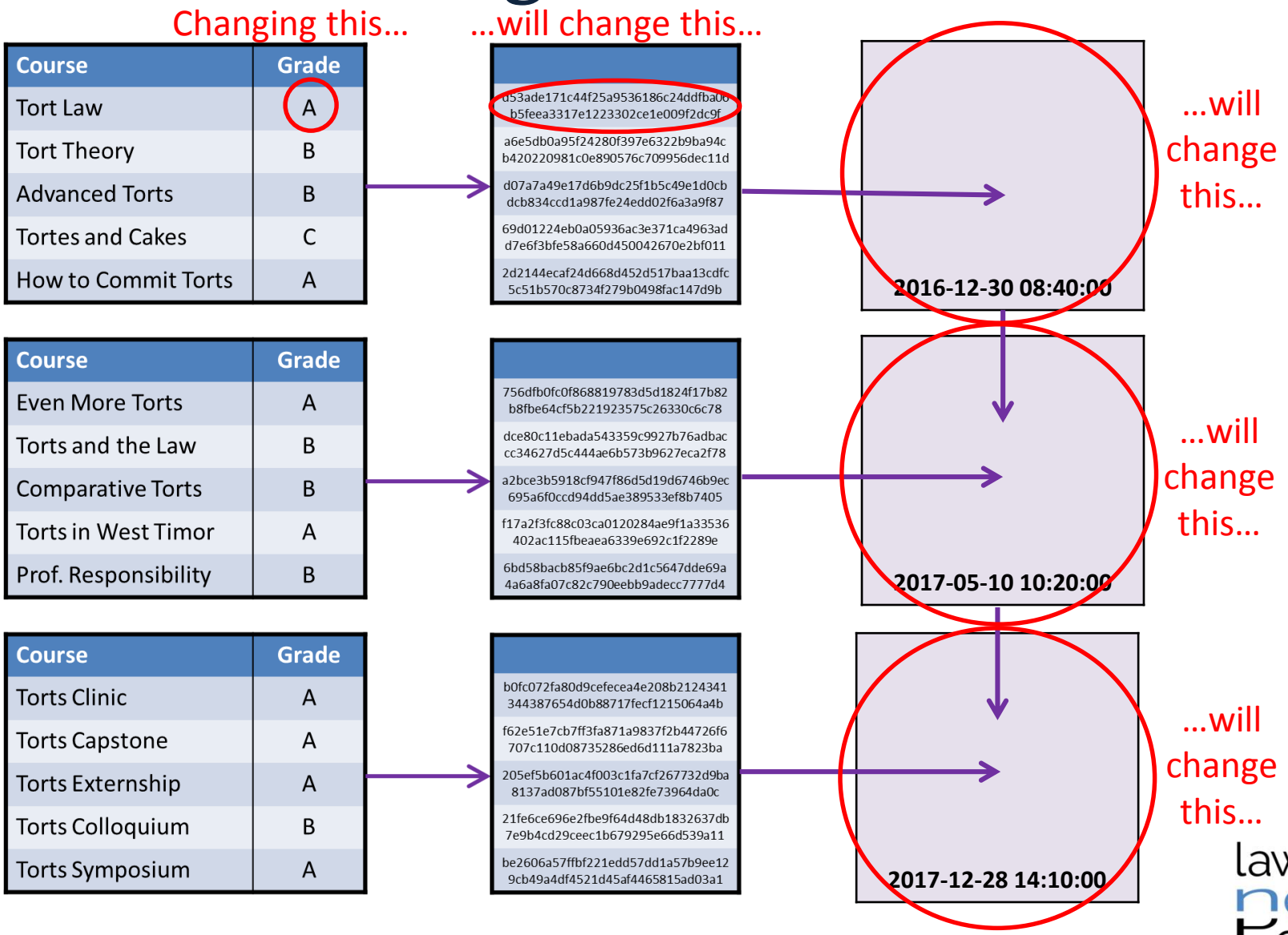
Refining our illustration



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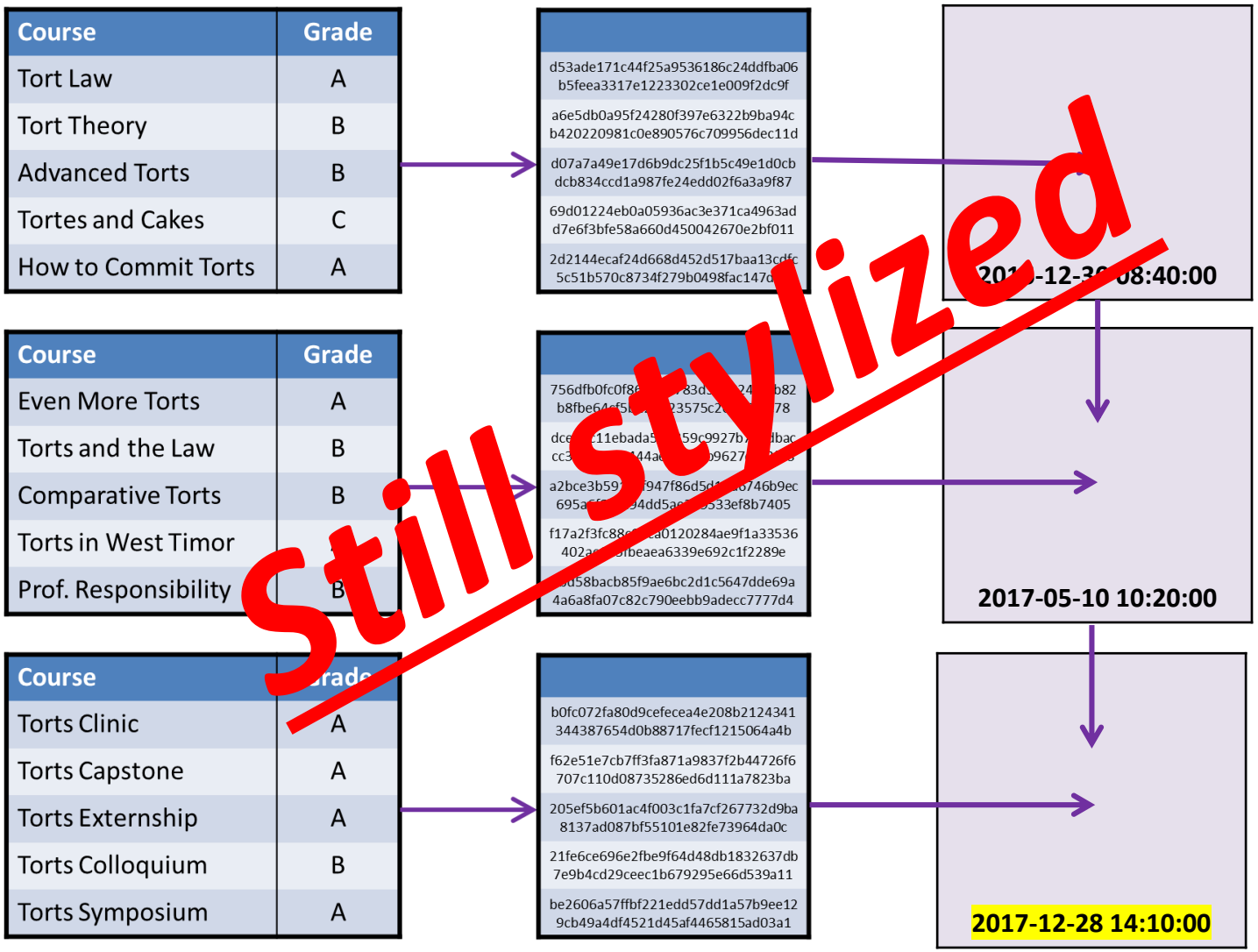
Refining our illustration



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Why?

- Authenticatable: Deviation is identifiable
- Decentralized: Shared among participants rather than controlled by a central authority
- Direct: Intermediaries are unnecessary

But...

- Scalable?
- Speedy?
- Robust?

And for the really crazy….

Blockchain mining!

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Some early and potential uses

- Cryptocurrencies (including the original Bitcoin)
- Personal Identification
- Property registration
- Software verification
- “Smart” contracts
- Medical records
- Voting
- …!