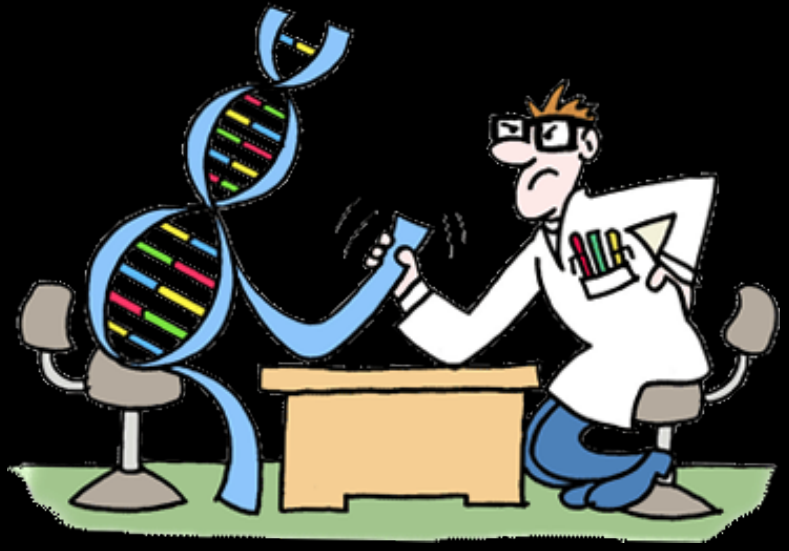
GECCO
Genetic and Evolutionary
Computation Conference
Denver, Colorado, USA
July 20-24, 2016
2016
A recombination of the
25th International Conference on
Genetic Algorithms (ICGA) and the
21st Annual Genetic Programming Conference (GP)
www.sigevo.org/gecco-2016
One Conference – Many Mini-Conferences
GECCO = ACO-SI + AIS-BIO + CO + CS + DETA + ECOM + EML + EMO + GA + GP + IGEC + PES + RWA + SBSE + THEORY

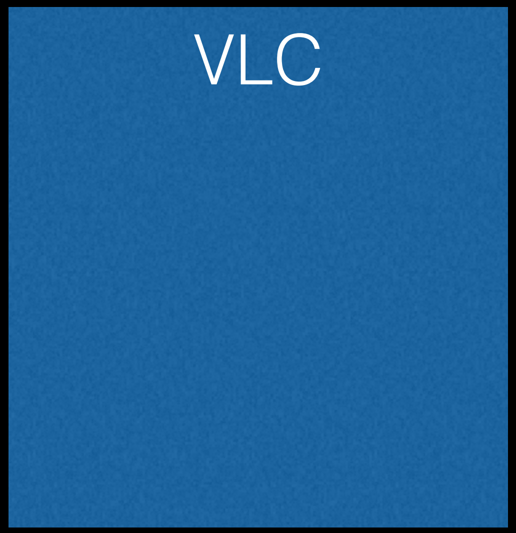


# Automated Software Transplantation

Earl T. Barr    Mark Harman    Yue Jia    **Alexandru Marginean**    Justyna Petke

CREST, University College London

# Why Autotransplantation?



# Why Autotransplantation?

VLC

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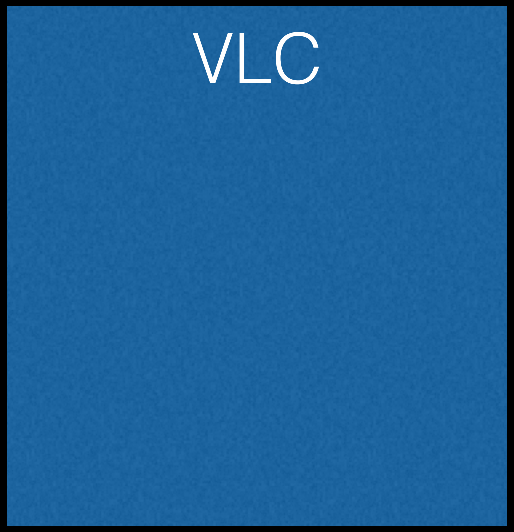

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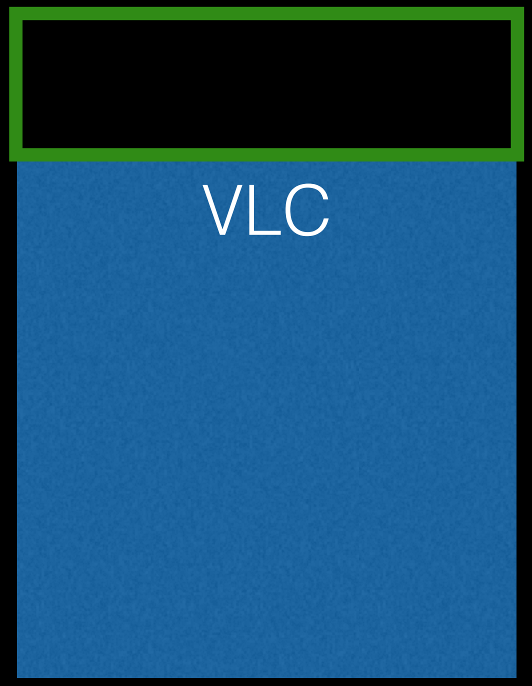

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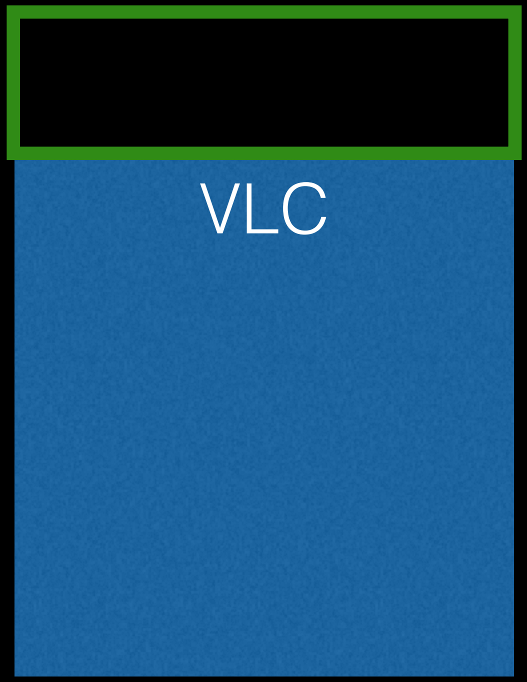
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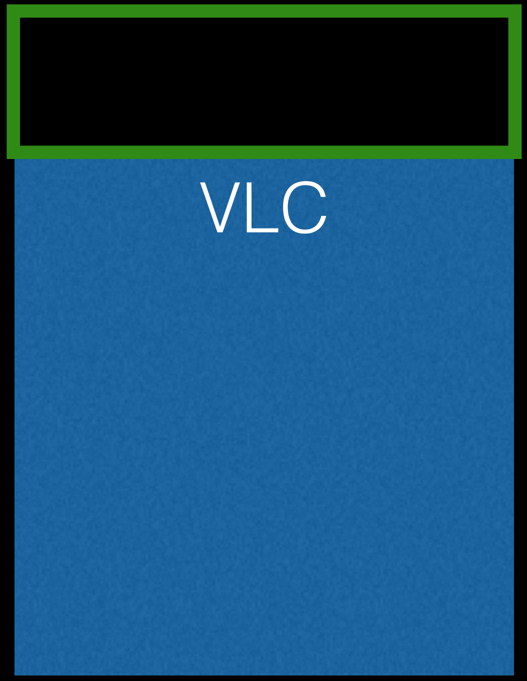

Start from scratch

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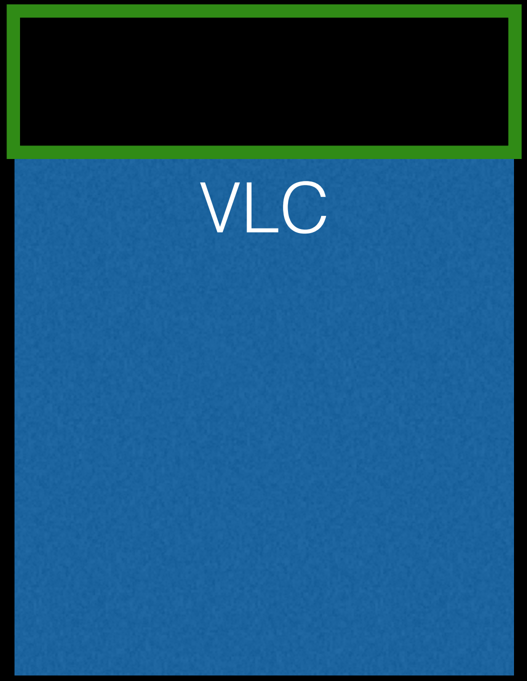

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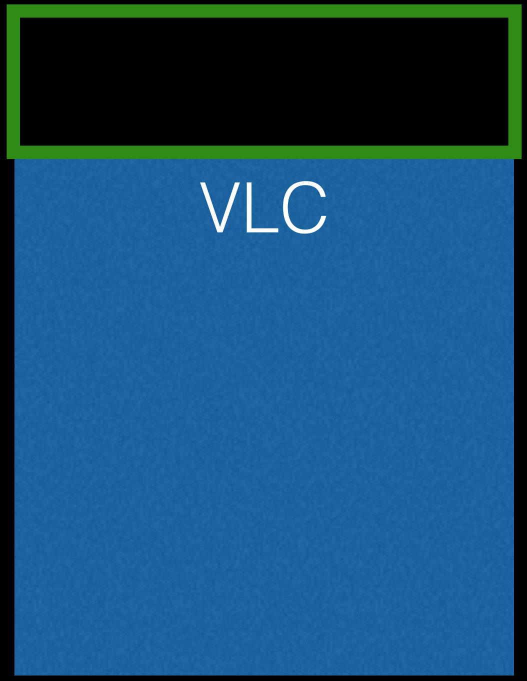

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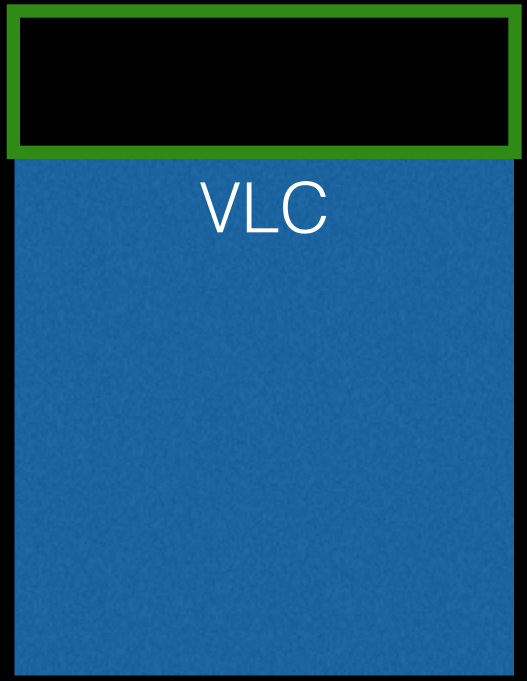

VLC

Check open source repositories

~~Start from scratch~~

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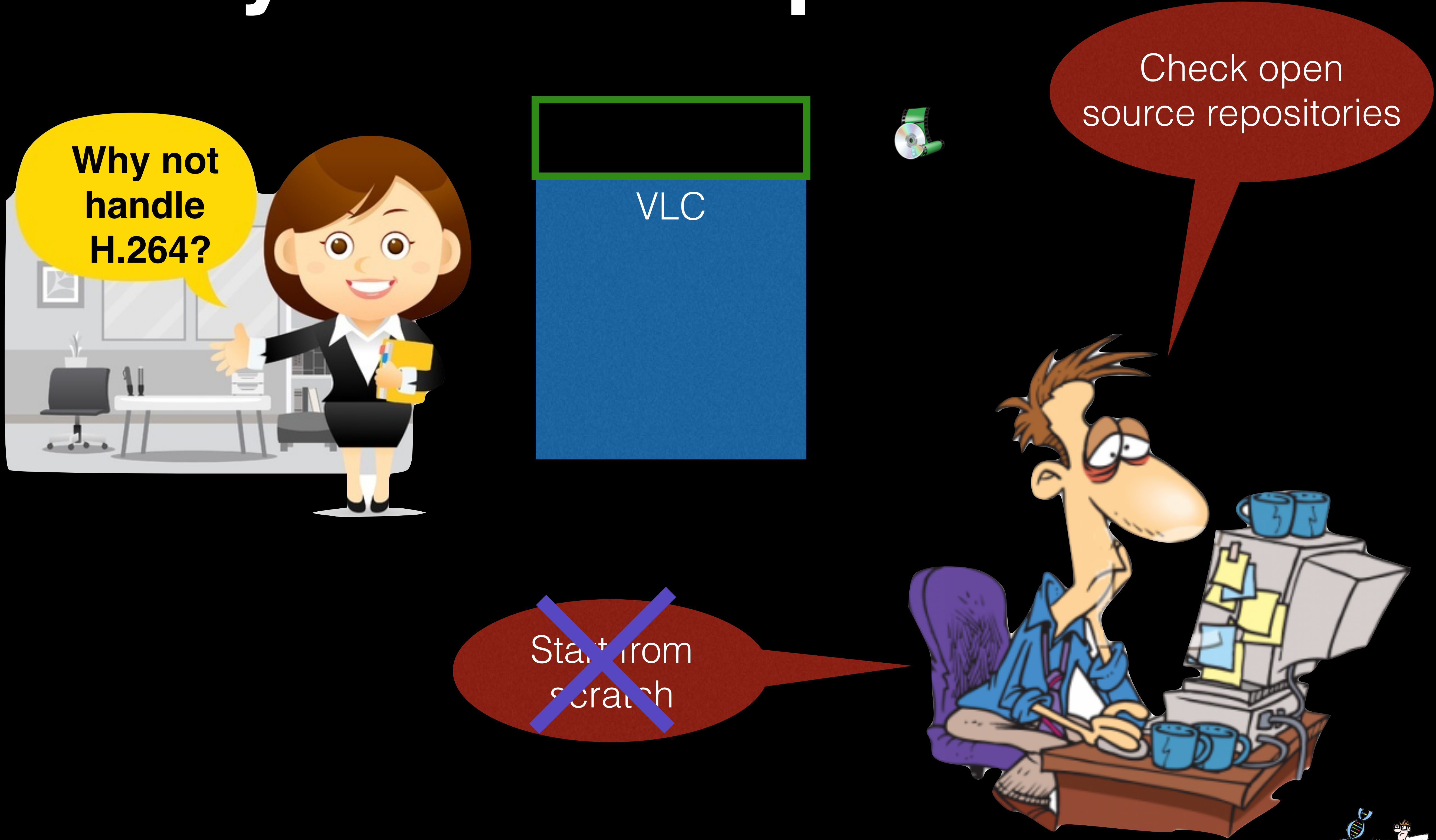

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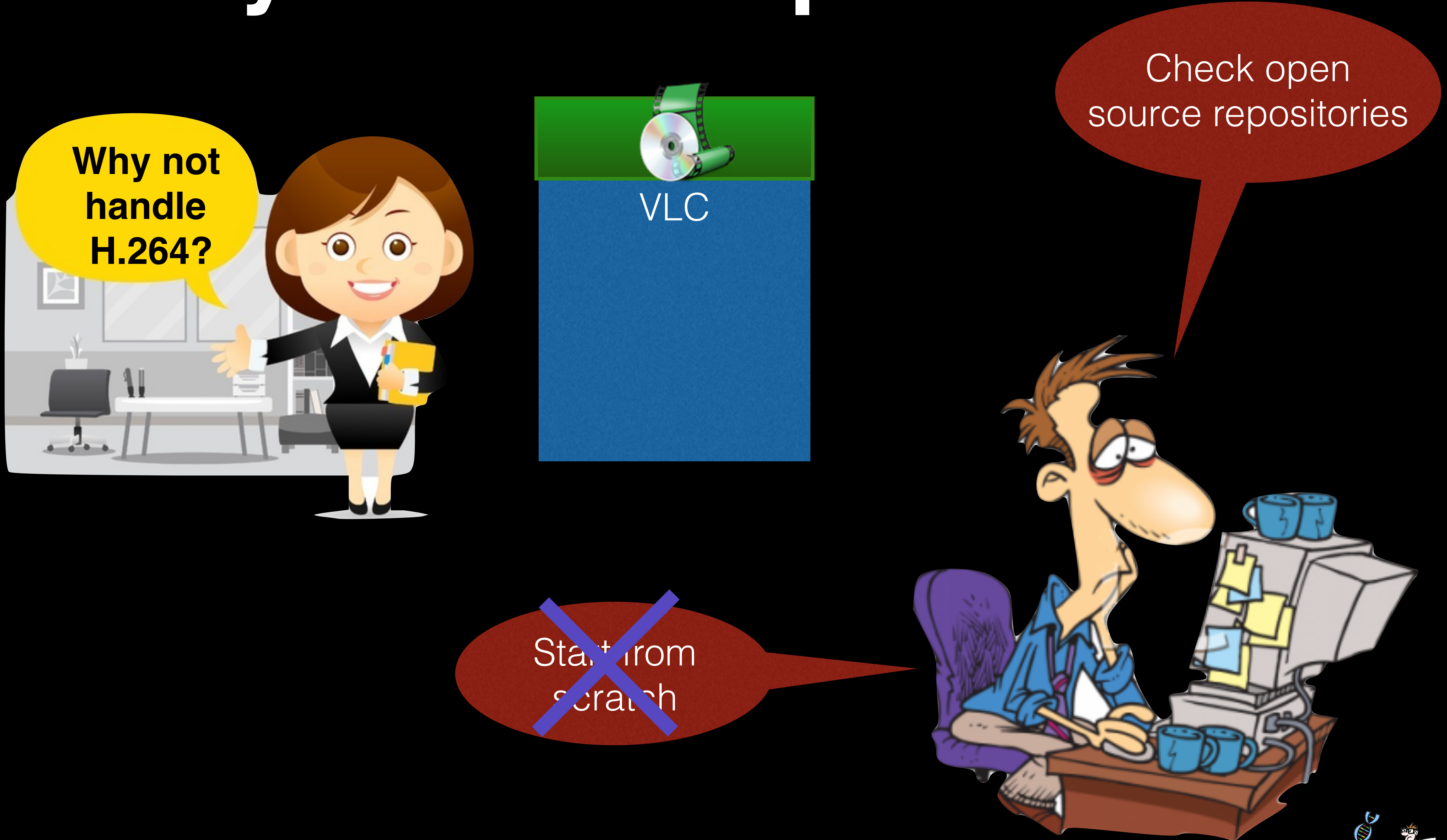

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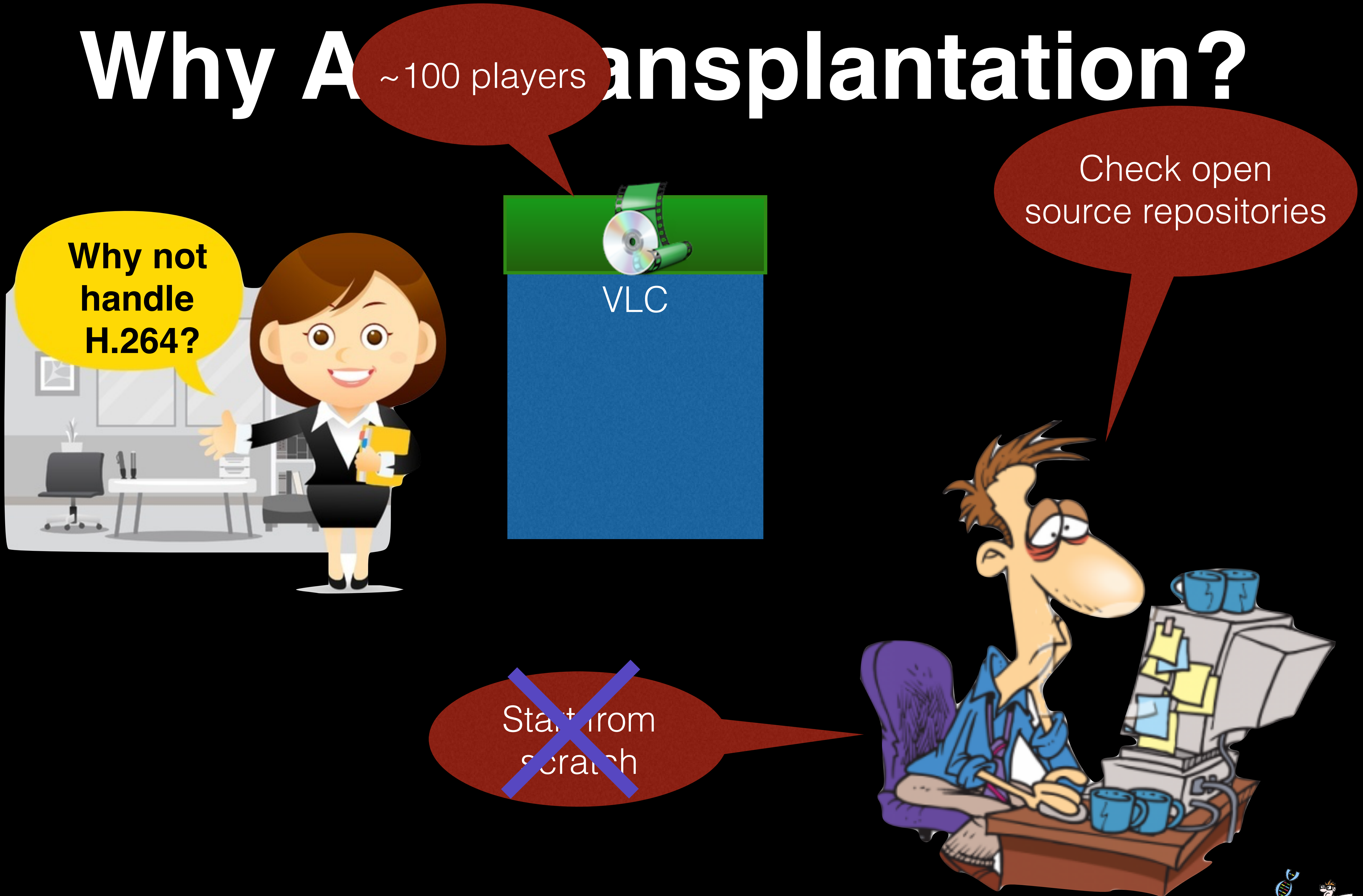

(G) The result solves a problem of indisputable difficulty in its field.

# Human Competition

## x264

```
char *vF;
vF = getFile();
initCodec(vF);
```

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Stream *ds = decodeFile(vF);
encodeStream(ds, out);
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## VLC

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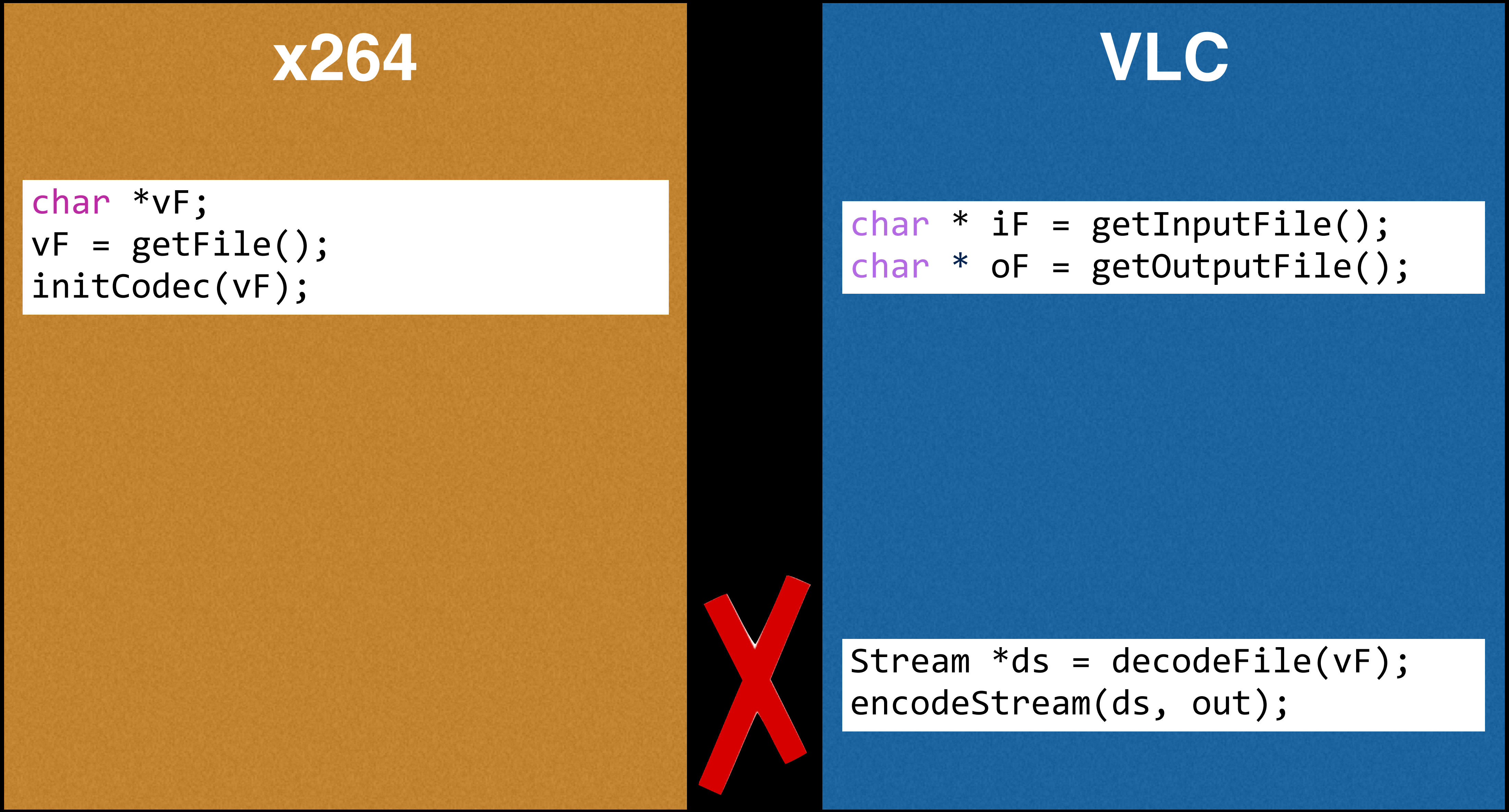

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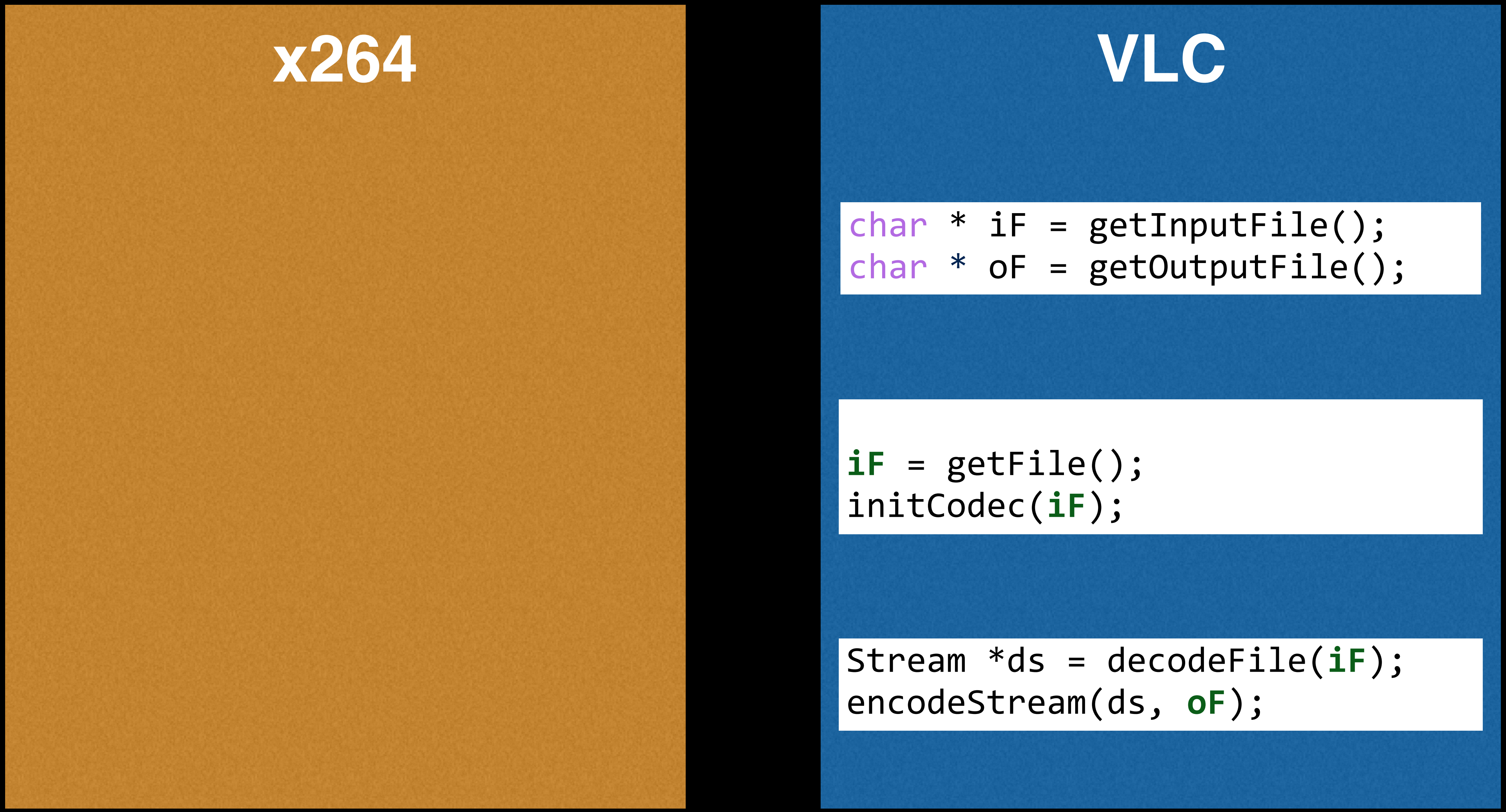

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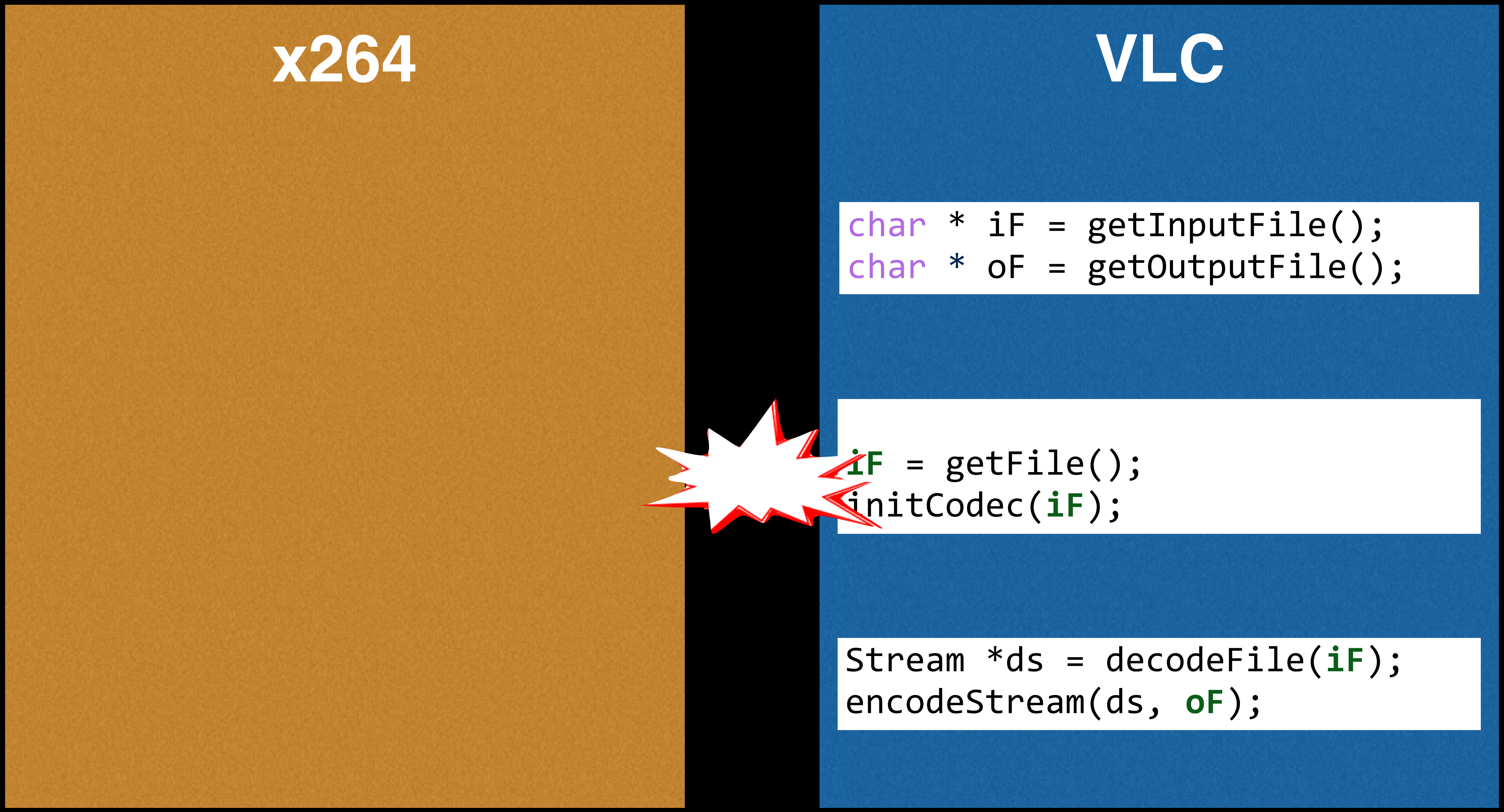

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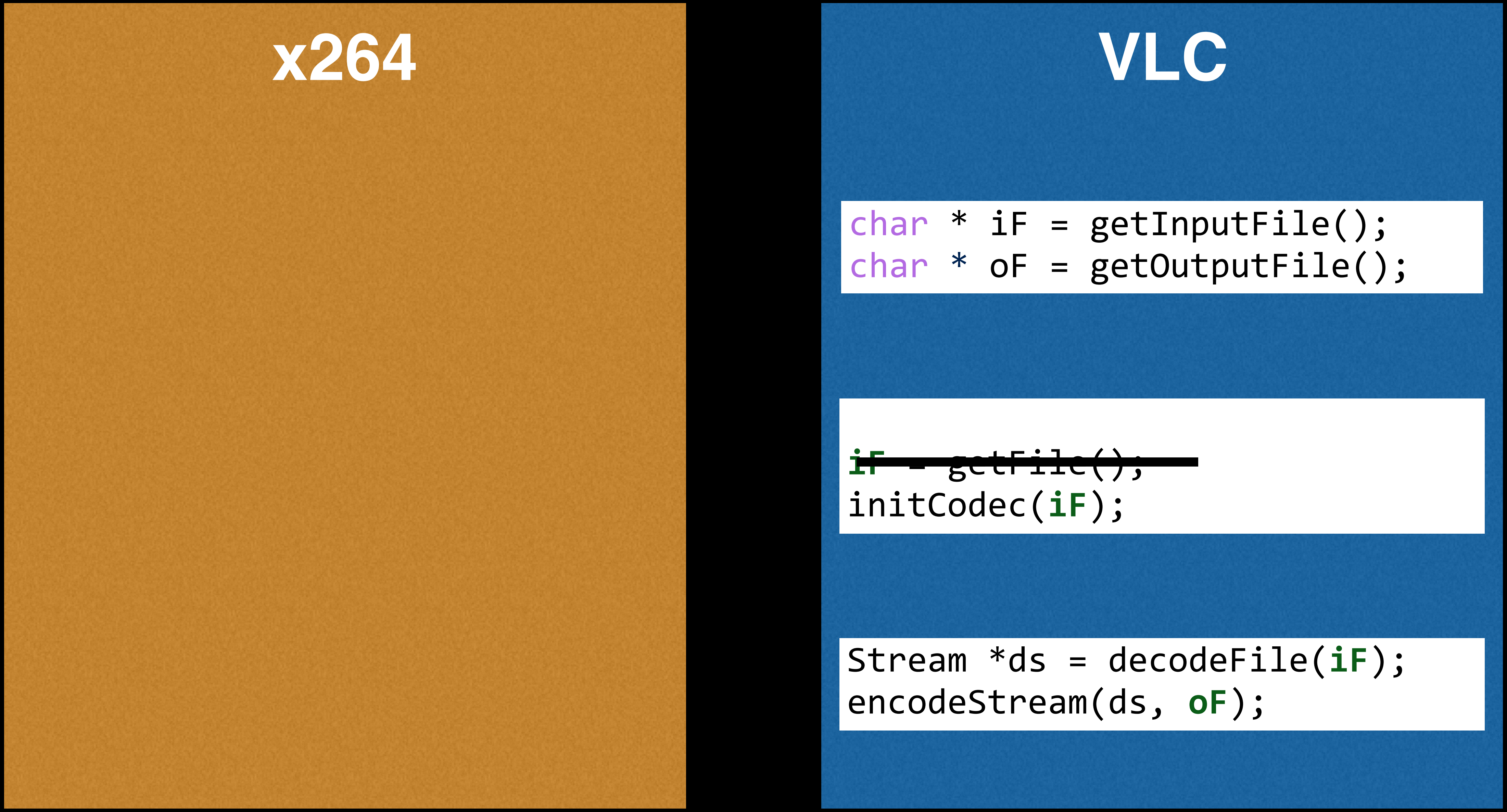

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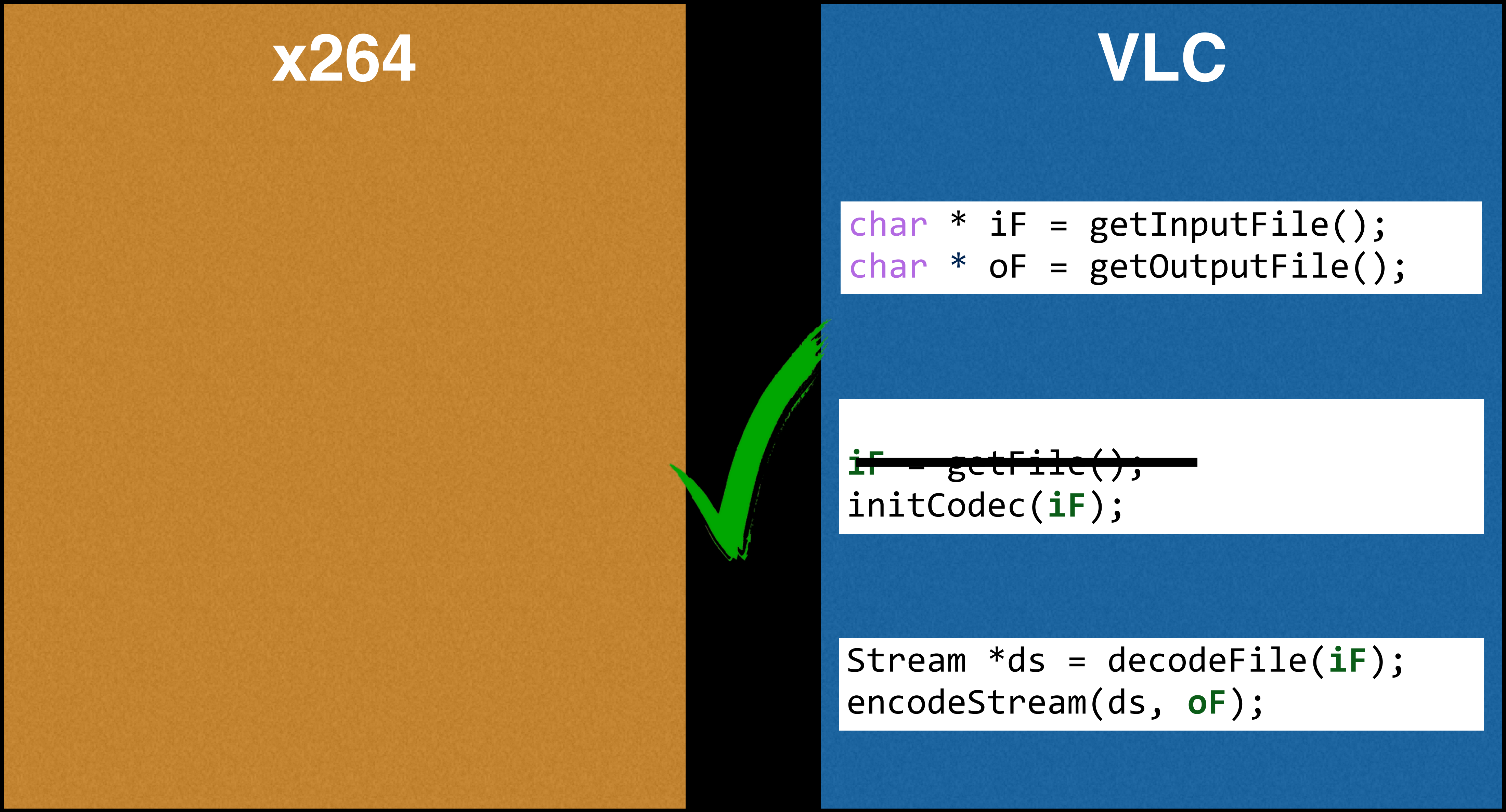

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# Our Approach

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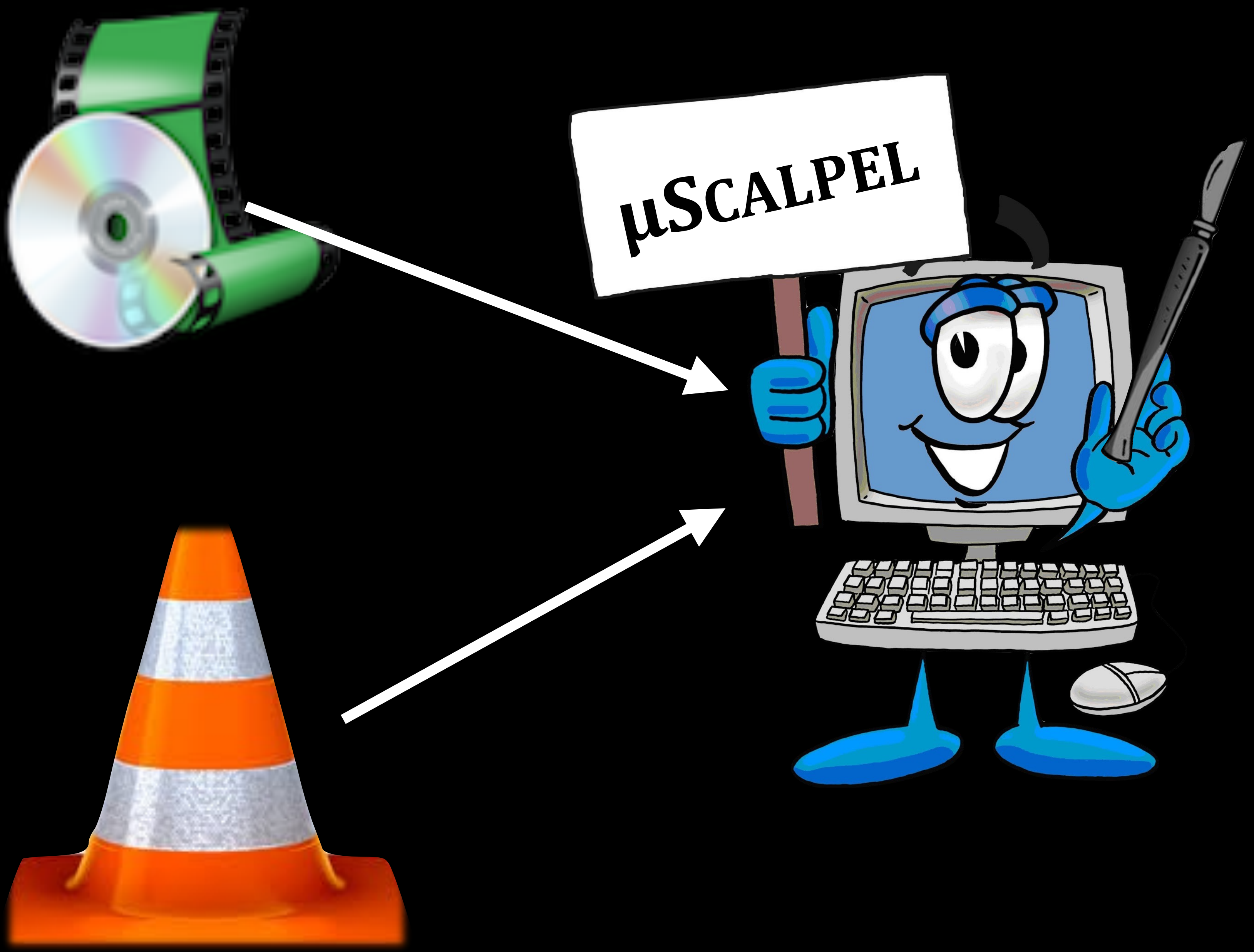

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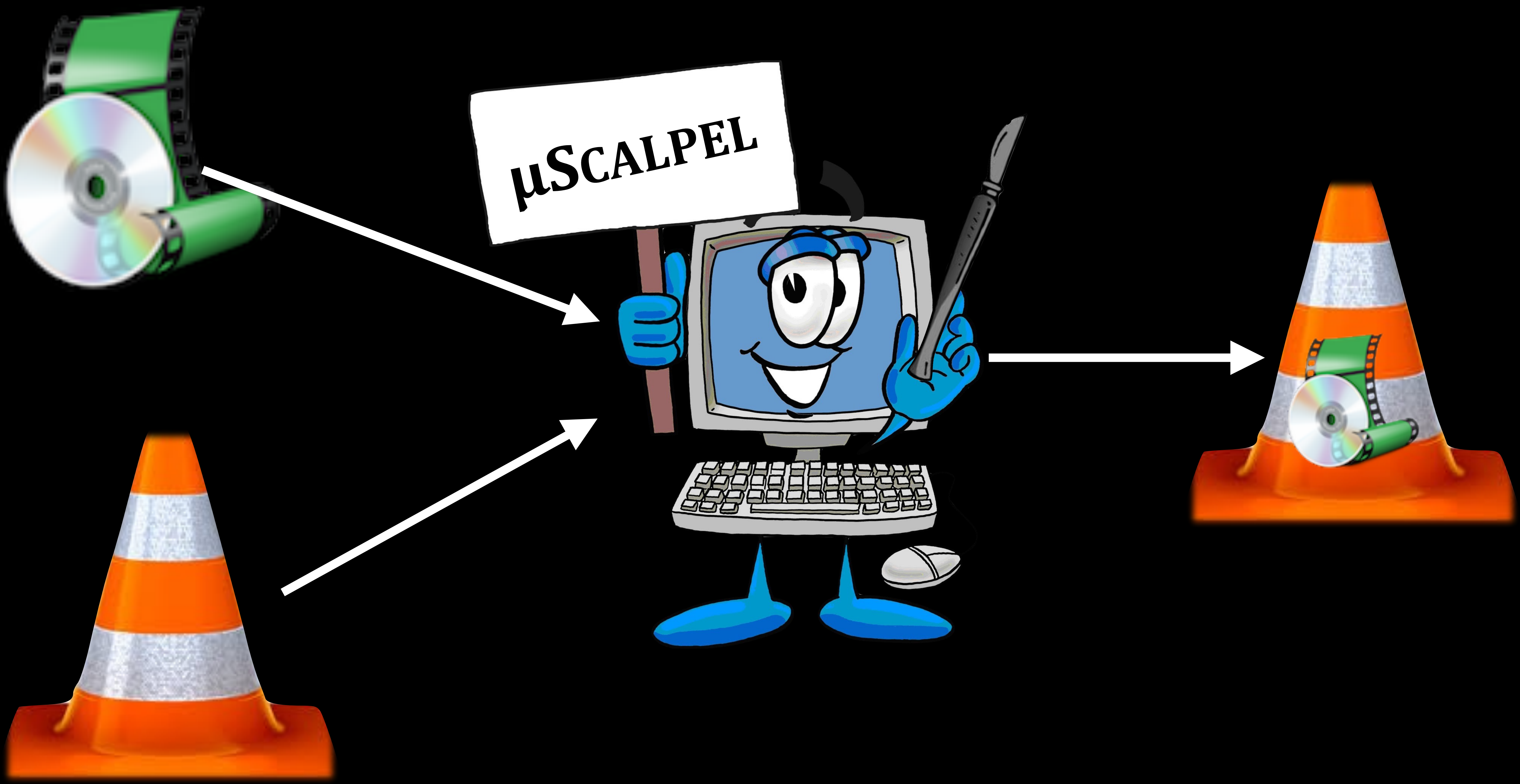

ISSTA * Artifact * AEC * Consistent * Complete * Well Documented * Easy to Reuse * Evaluated

# Result: x264 & VLC

Donor

Host

ISSTA * Artifact * AEC * Consistent * Complete * Well Documented * Easy to Reuse * Evaluated

# Result: x264 & VLC

Award winning tool for H.264 encoding [2,3,4]

Donor

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“Most popular desktop video player” [1]

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Organ: H264

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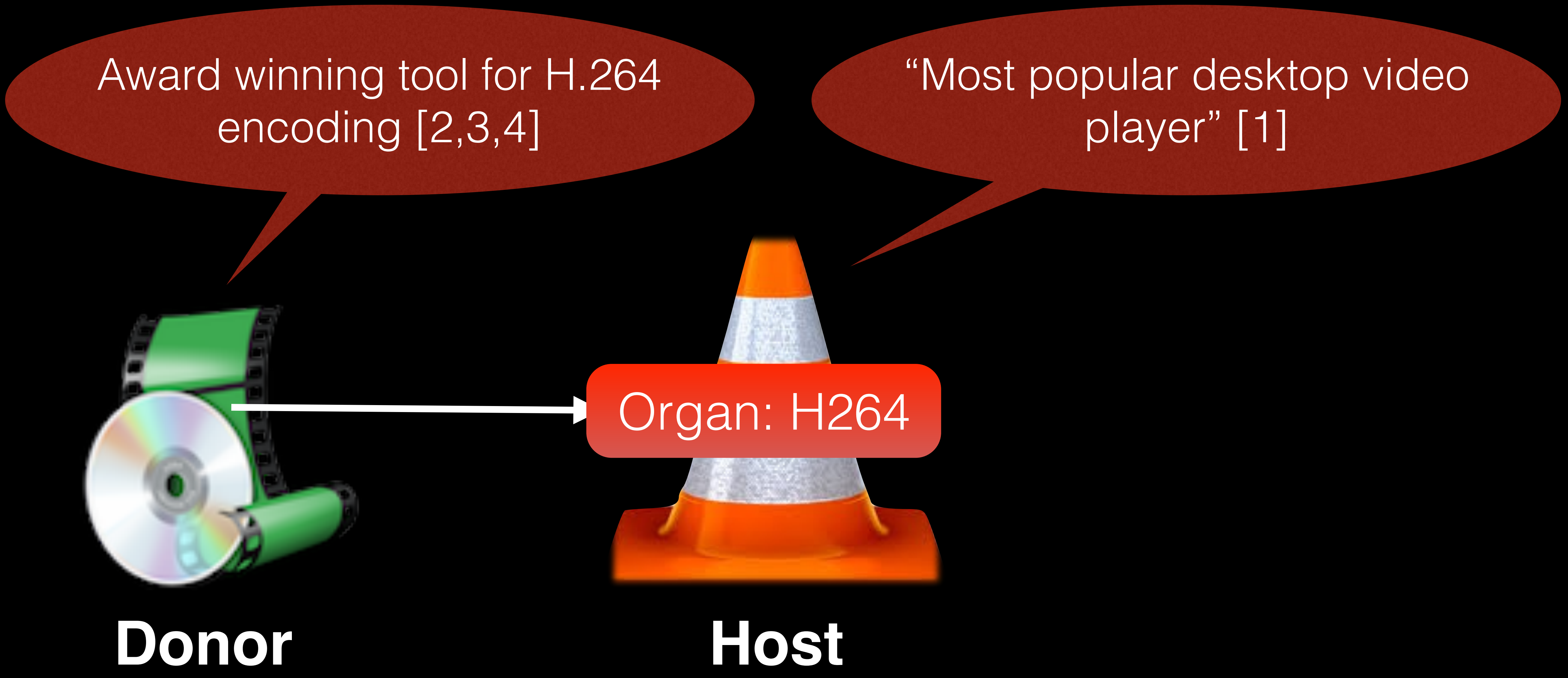

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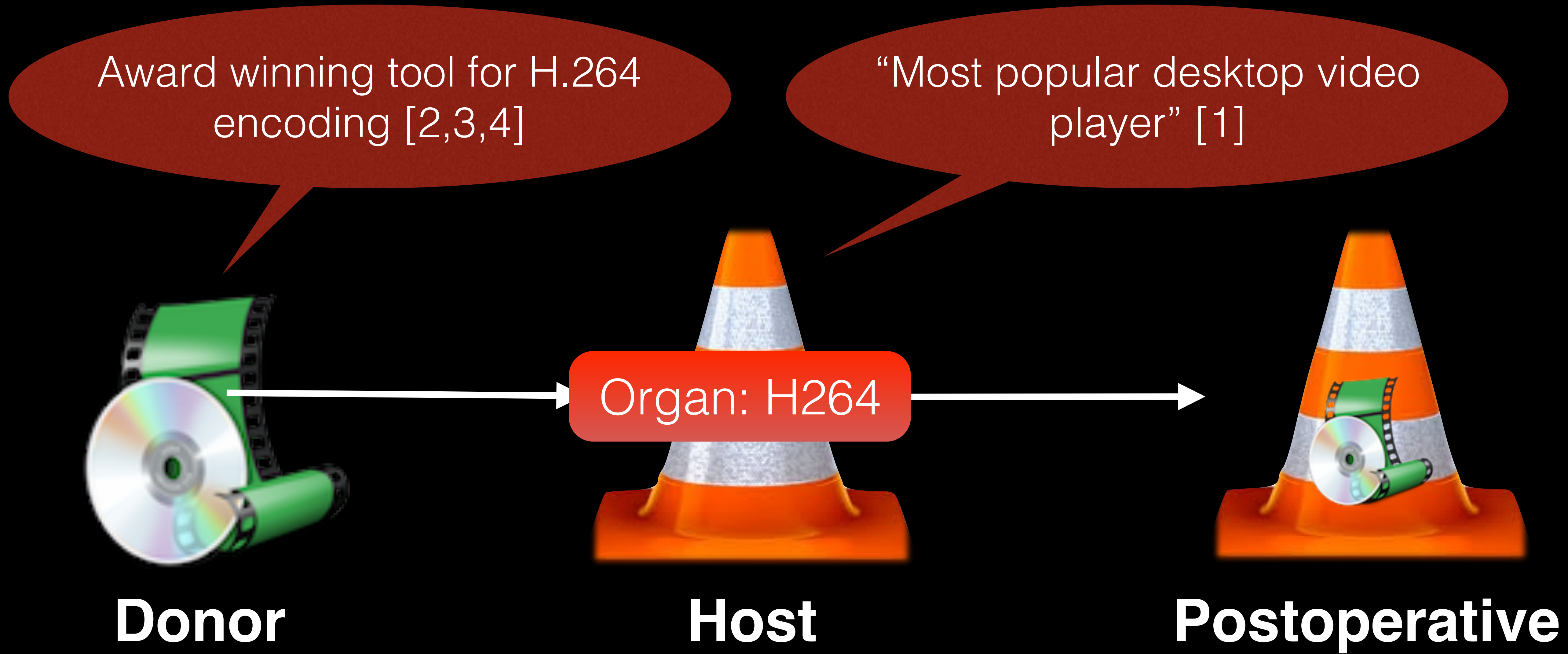


Award winning tool for H.264 encoding [2,3,4]

“Most popular desktop video player” [1]

Organ: H264

**Donor**

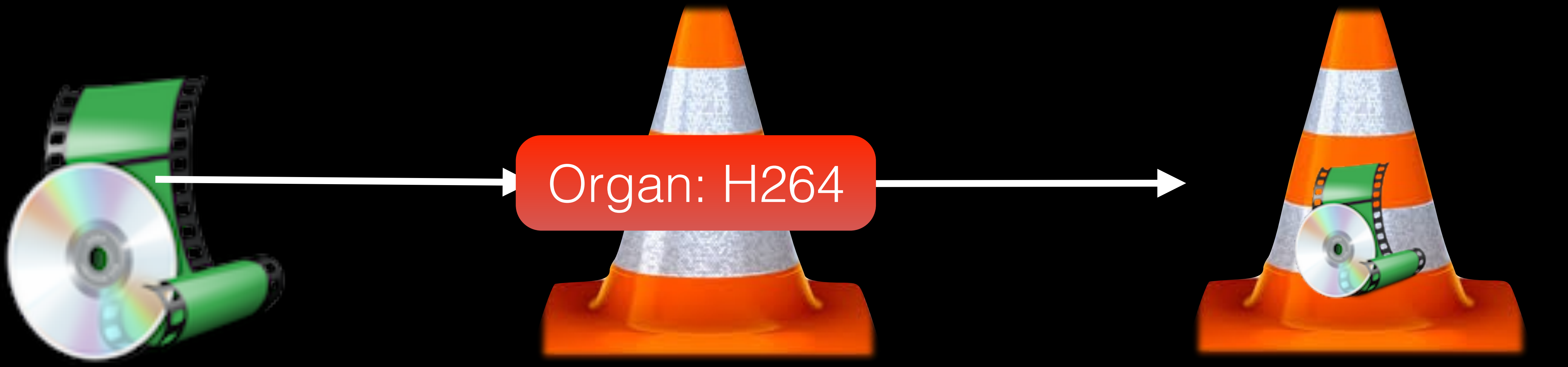
**Host**

**Postoperative**

# Result: x264 & VLC

**Automatic Transplantation of H264 Encoder**

| | Time (hours) | Regression Tests | Manual Tests | Acceptance Tests |
|---|---|---|---|---|
| µSCALPEL | 26 | 100% | 100% | 100% |



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# Autotransplantation vs Human Transplantation

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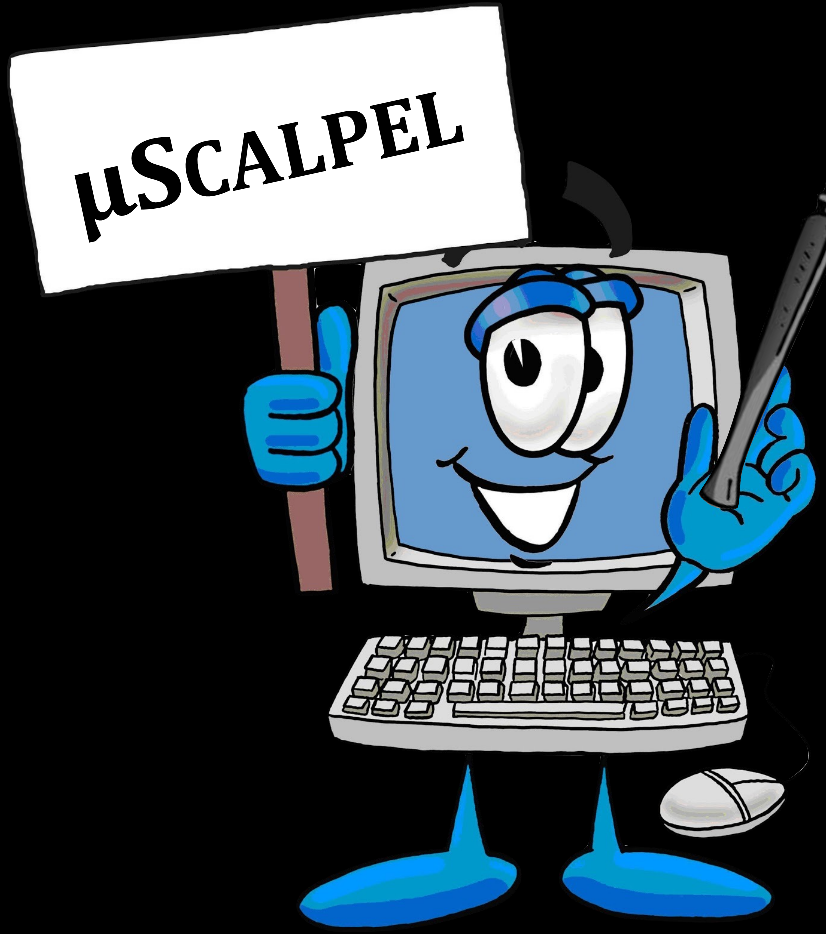
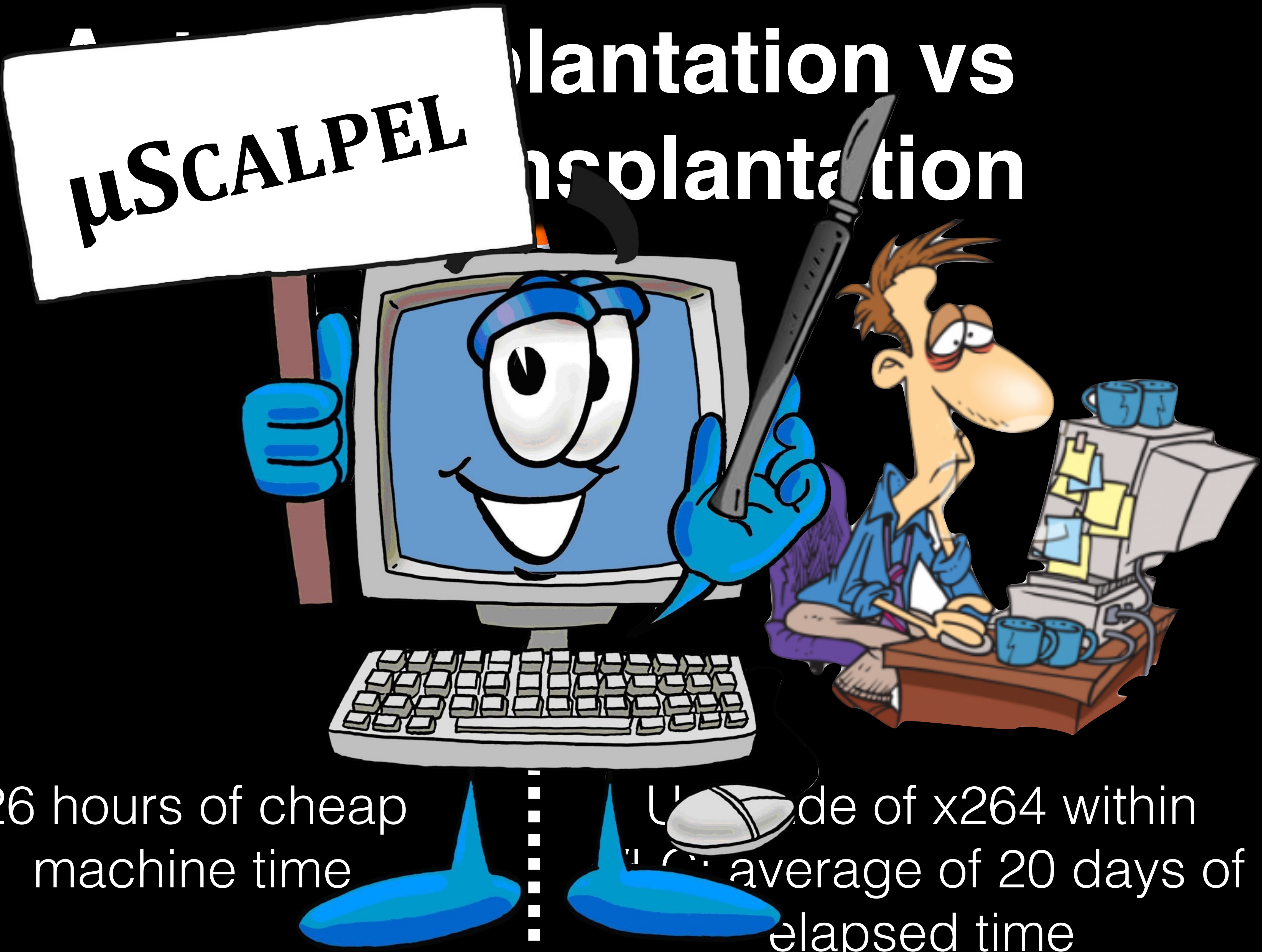


26 hours of cheap machine time

Upgrade of x264 within VLC: average of 20 days of elapsed time

# A… plantation vs … nsplanta tion



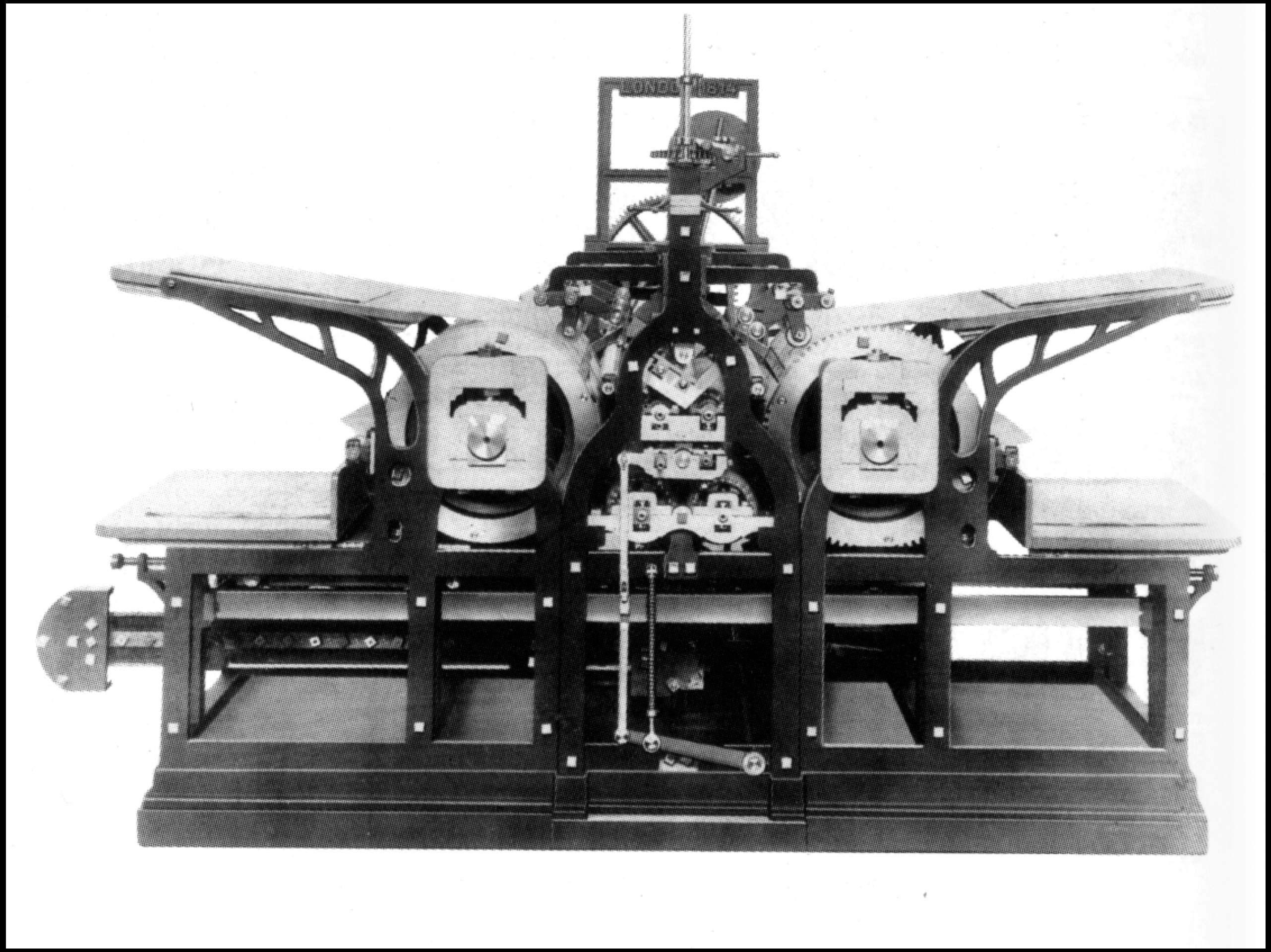
26 hours of cheap machine time

U… de of x264 within … average of 20 days of elapsed time

(H) The result holds its own or wins a regulated competition involving human contestants (in the form of either live human players or human-written computer programs).

(C) The result is equal to or better than a result that was placed into a database or archive of results maintained by an internationally recognised panel of scientific experts

# Regulated Competition



**The printing press predated font design competitions.**

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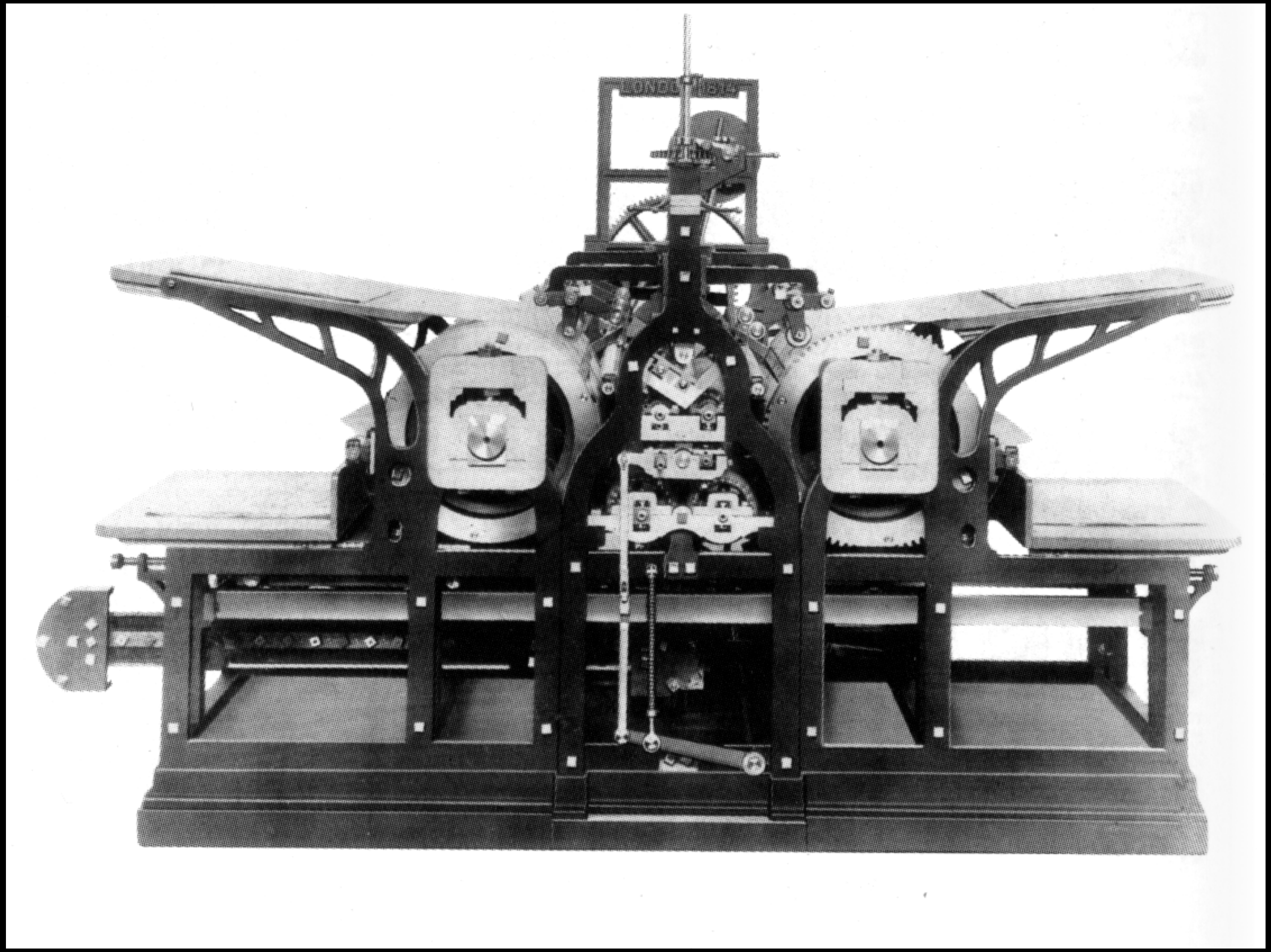

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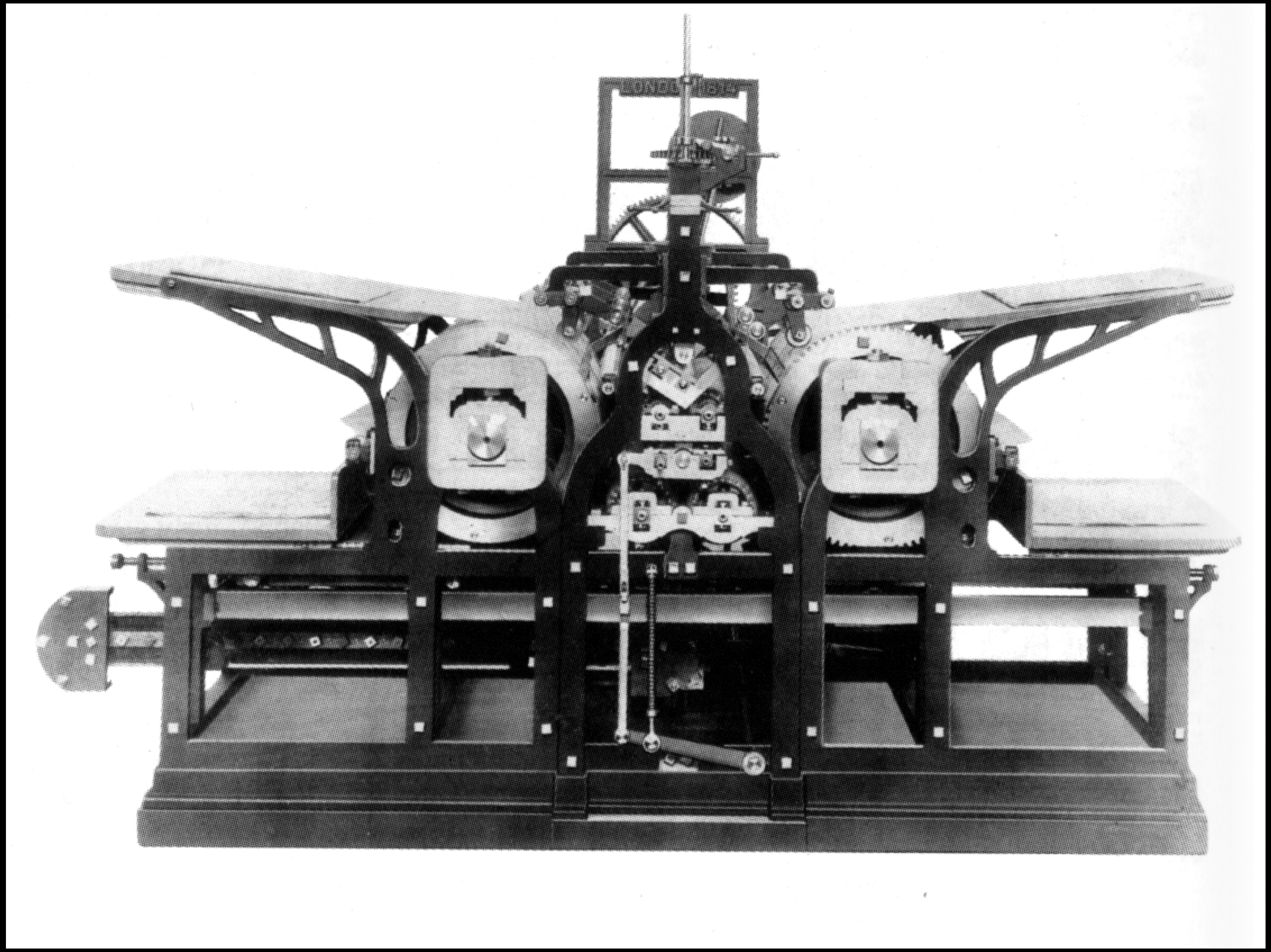

**The printing press predated font design competitions.**

**μSCALPEL predates transplantation competitions.**

We hope so 🙂

# Regulated Competition

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GRAPHICS & MEDIA LAB
VIDEO GROUP

MSU Sixth MPEG-4 AVC/H.264 Video Codecs Comparison [4]

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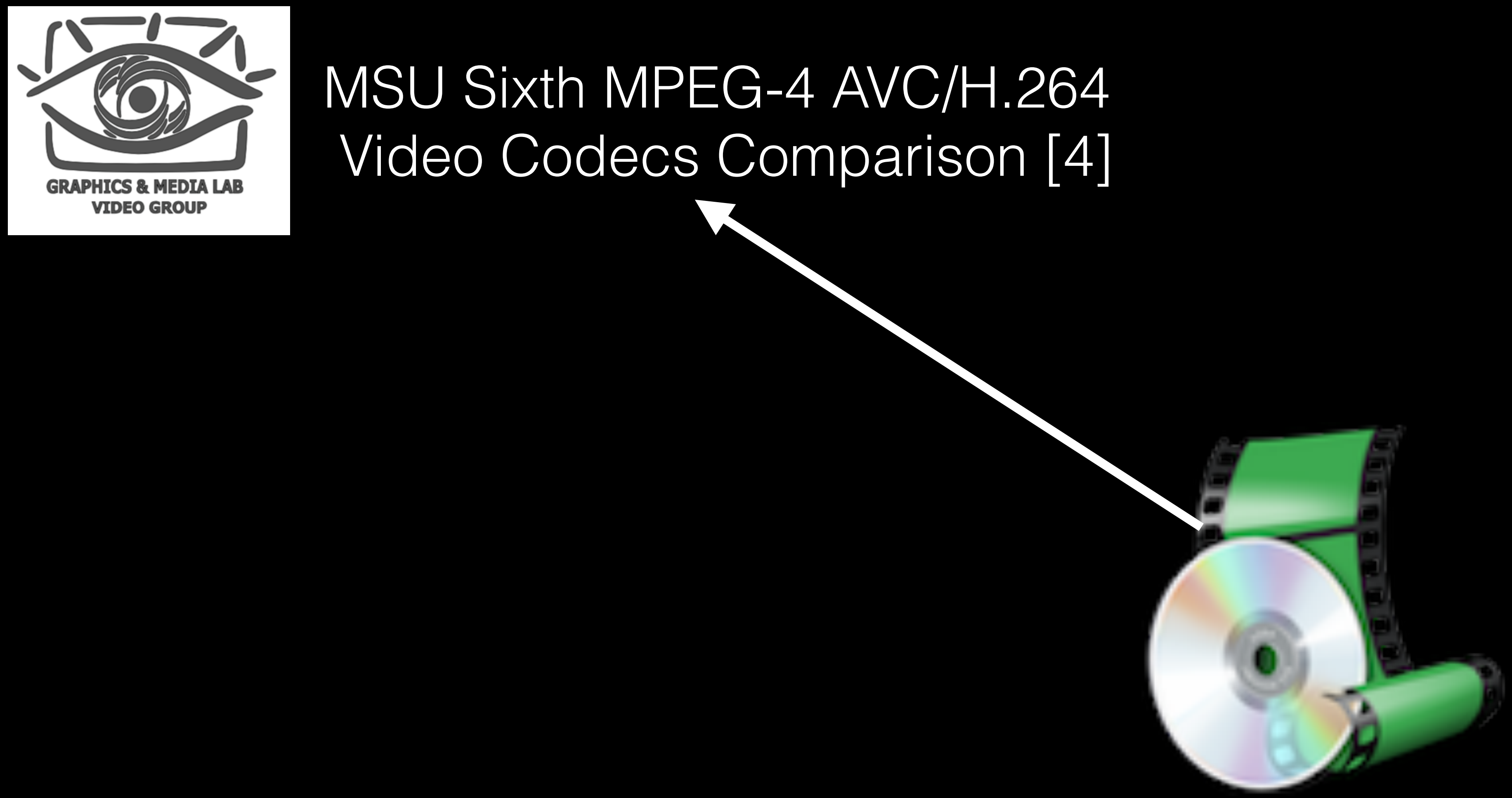

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x264 won with ~24% better encoding than second place

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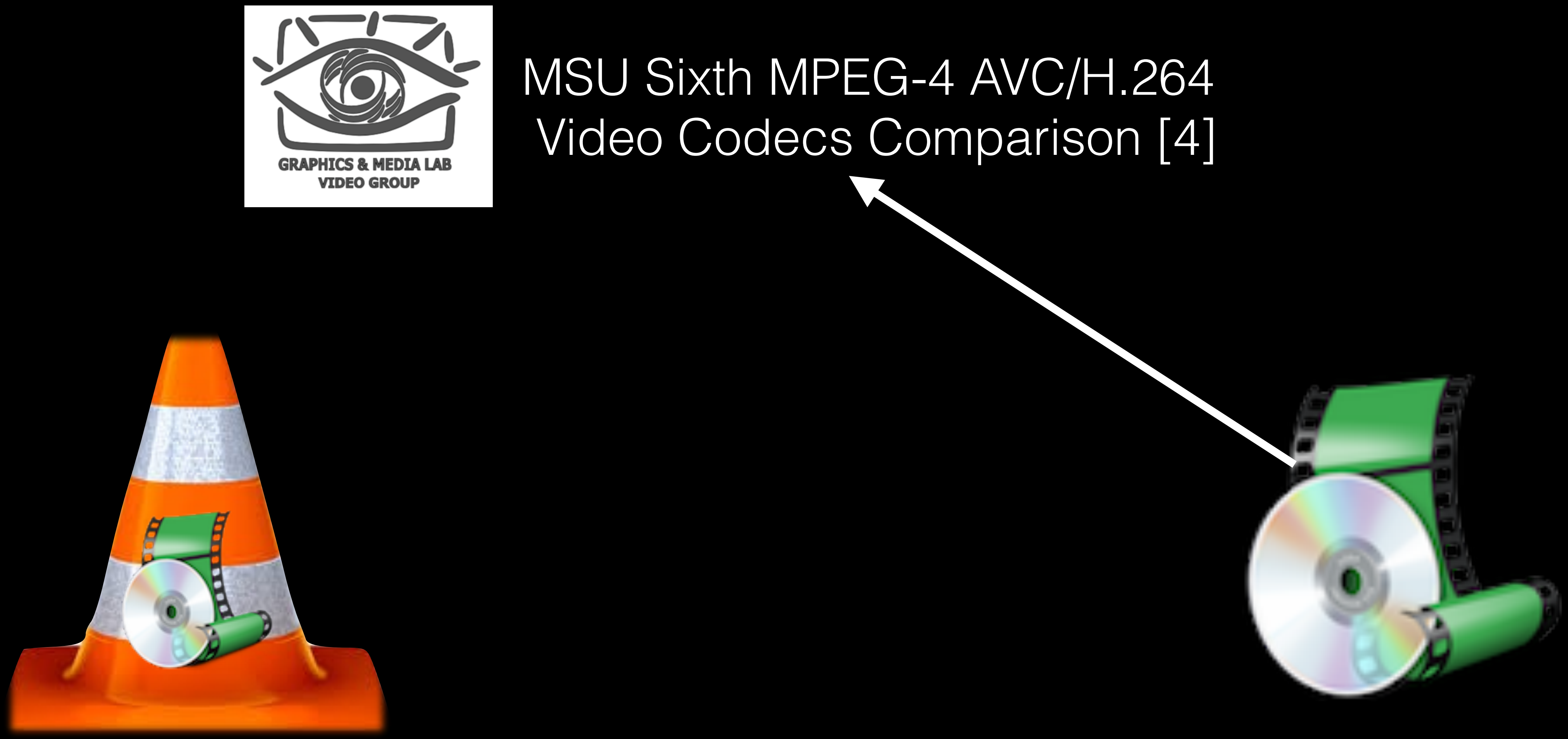

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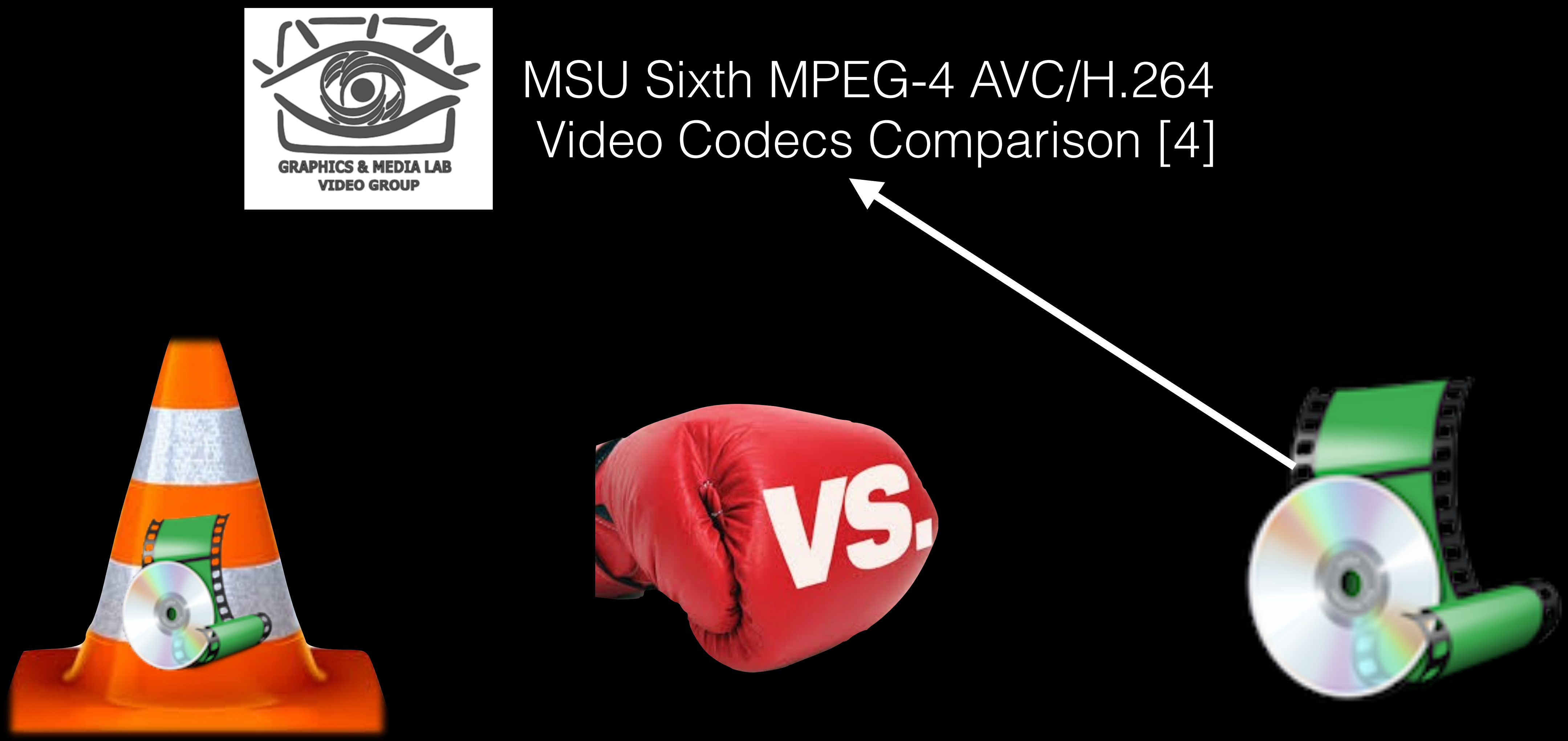

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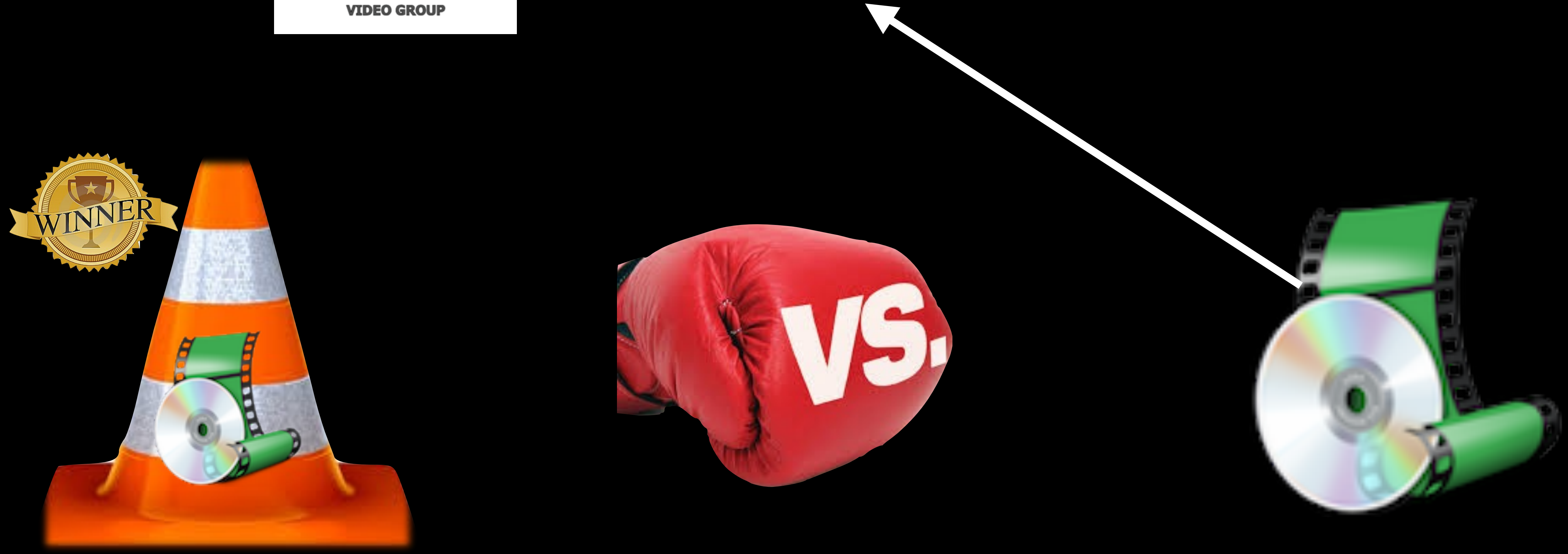

2.4% faster

# Regulated Competition

GRAPHICS & MEDIA LAB
VIDEO GROUP

MSU Sixth MPEG-4 AVC/H.264
Video Codecs Comparison [4]

2.4% faster

We automatically transplanted new functionality!

# Regulated Competition

MSU Sixth MPEG-4 AVC/H.264
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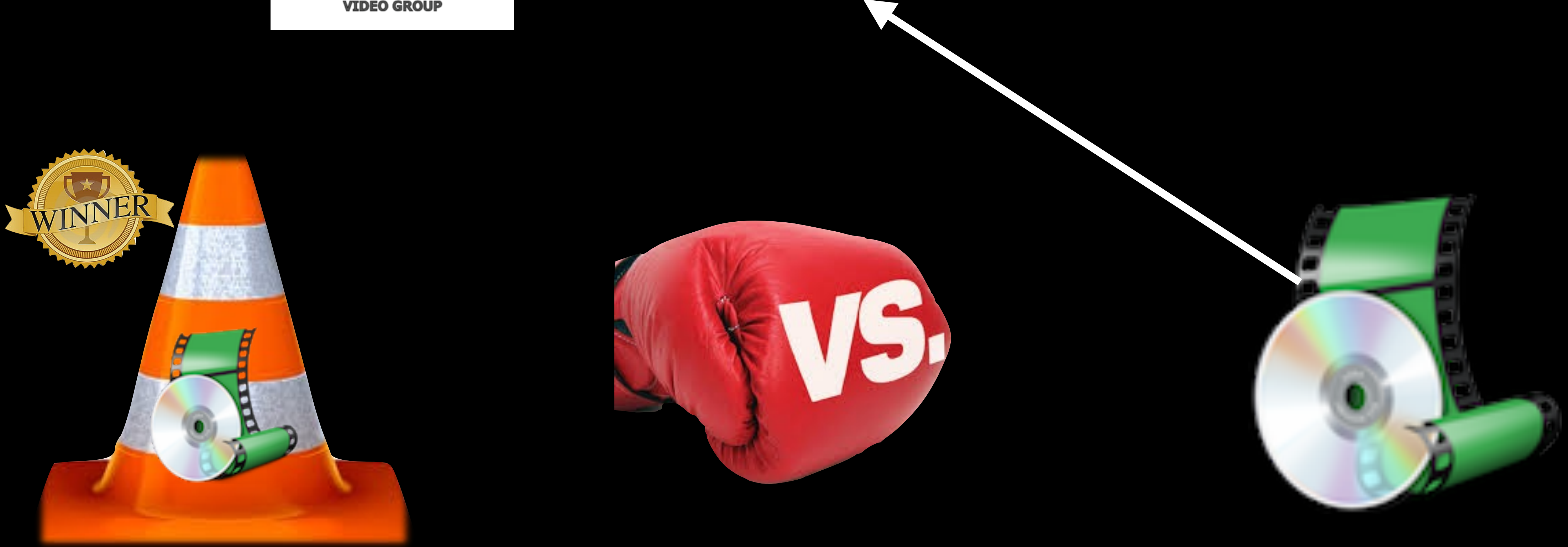

2.4% faster

(E) The result is equal to or better than the most recent human-created solution to a long-standing problem for which there has been a succession of increasingly better human-created solutions.

(F) The result is equal to or better than a result that was considered an achievement in its field at the time it was first discovered.

# Long Standing Problem

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1990 1993 1996 1999 2002 2005 2008 2011 2014

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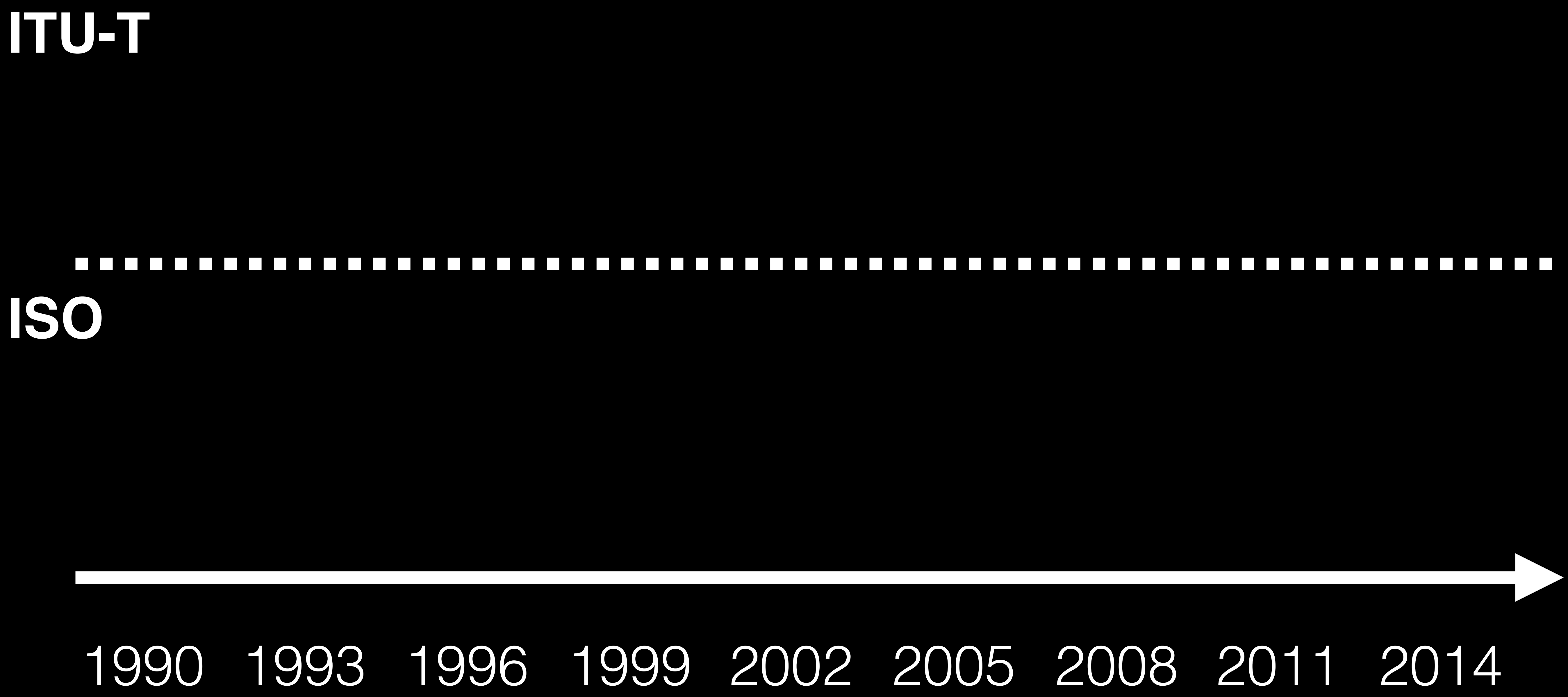

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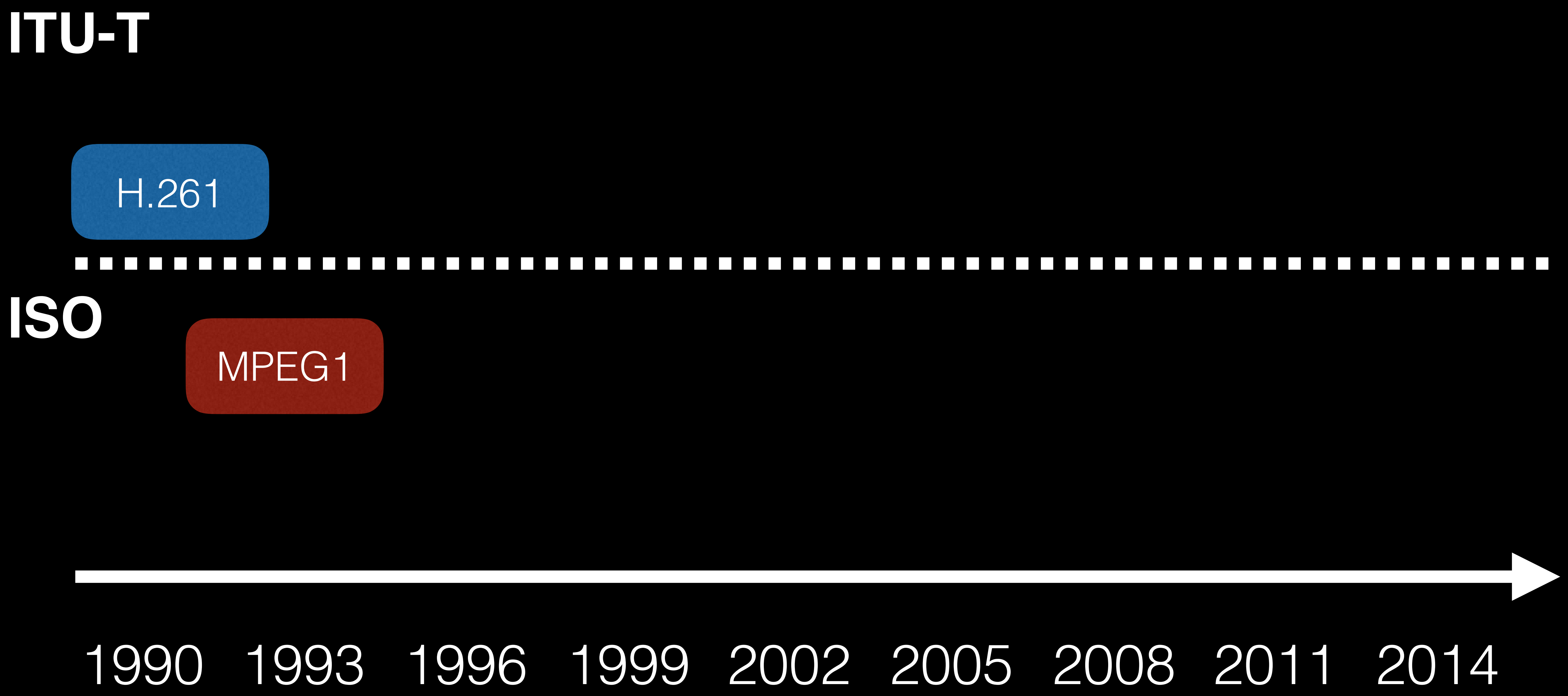

ITU-T

H.261

ISO

MPEG1

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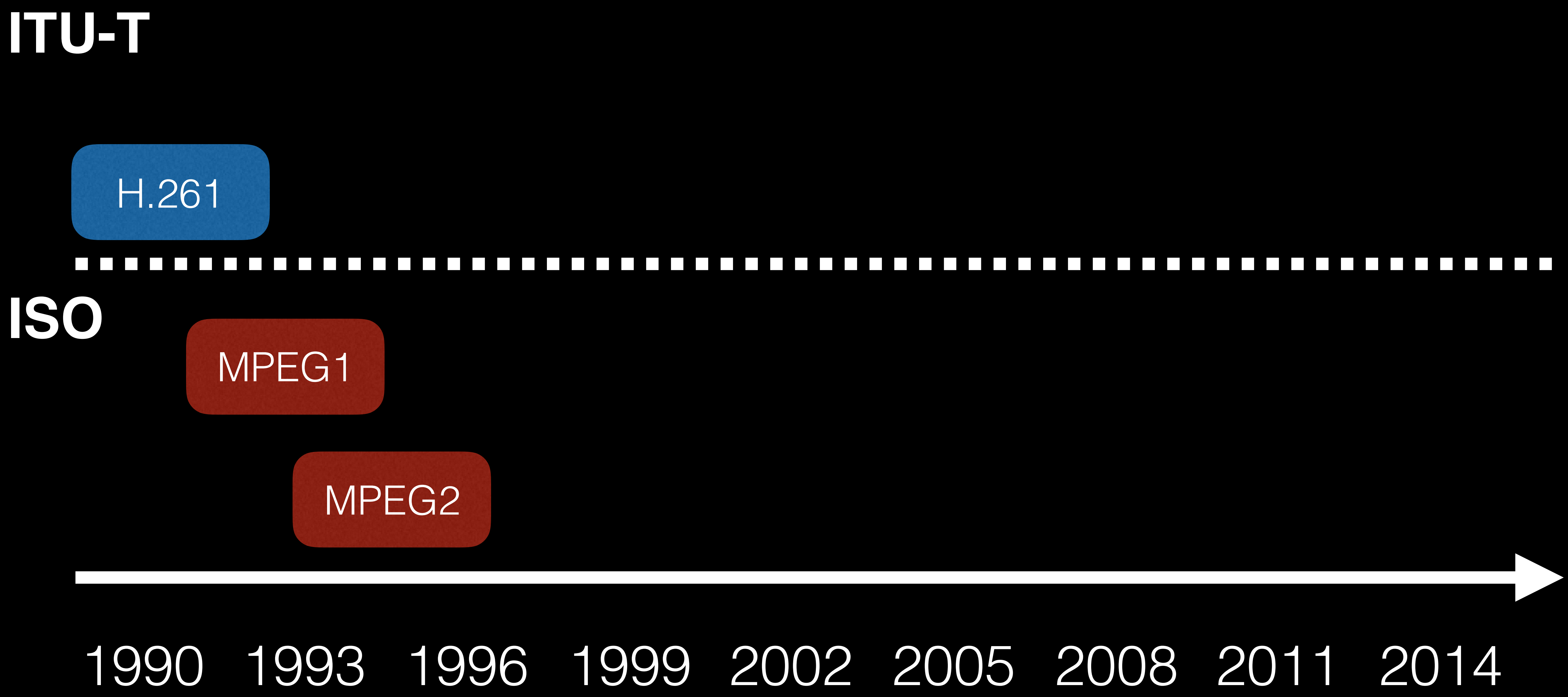

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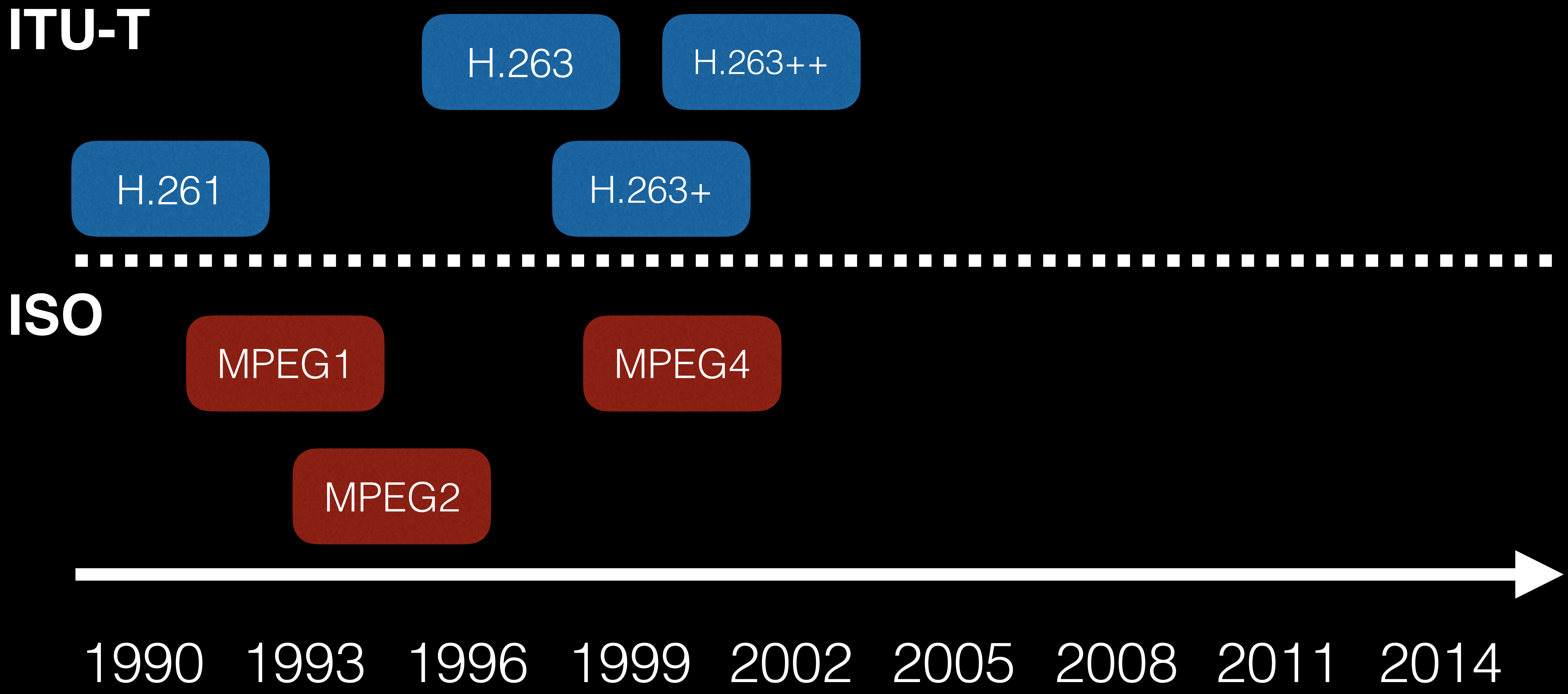

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H.263++

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H.263+

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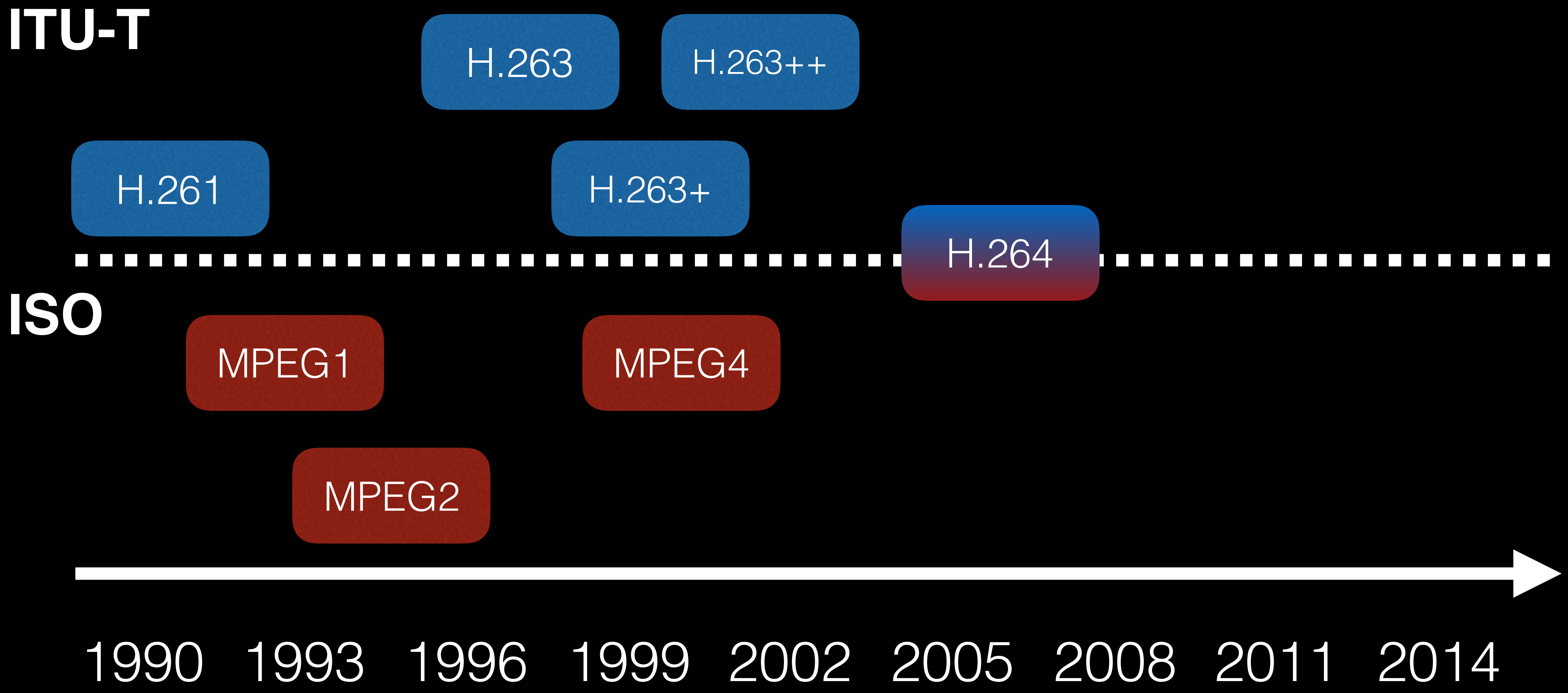

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H.261

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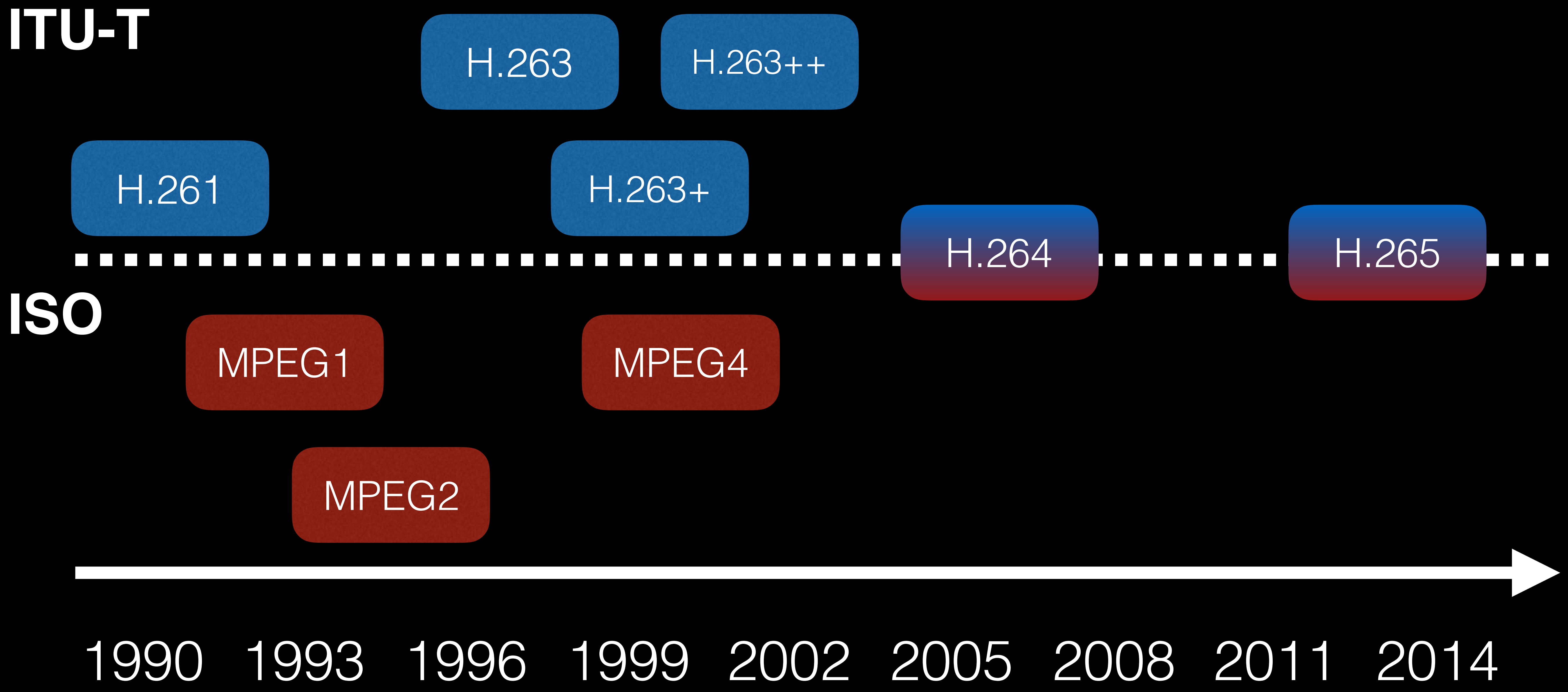

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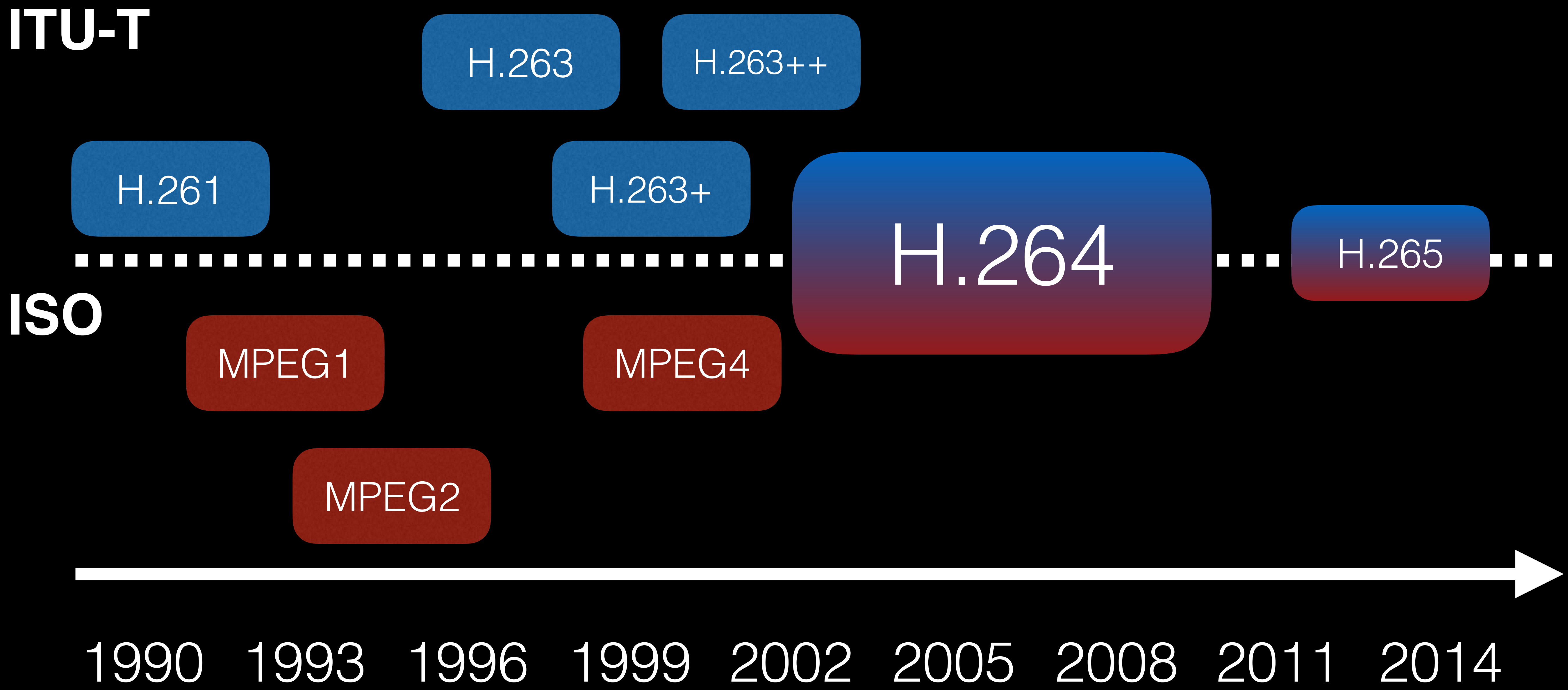

# Are We Really Human-Competitive? “Am I Obsolete?”

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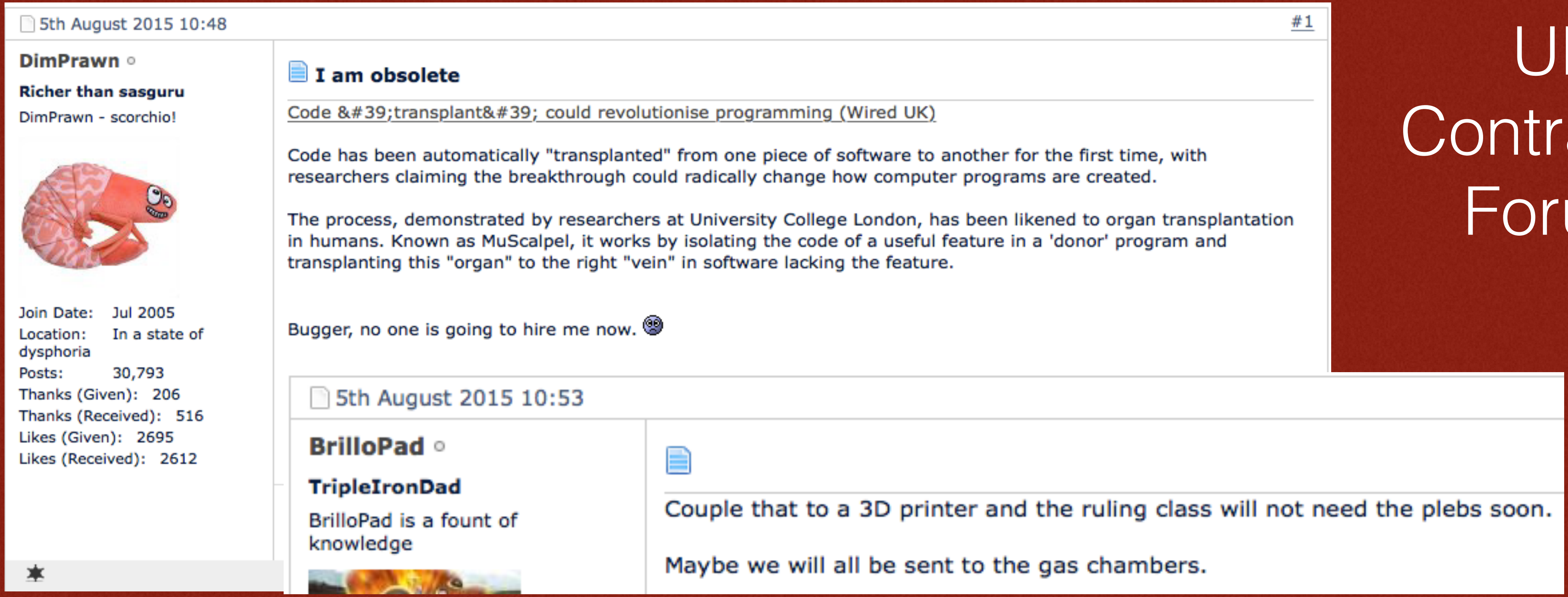

5th August 2015 10:48 #1

**DimPrawn**

**Richer than sasguru**

DimPrawn - scorchio!

Join Date: Jul 2005
Location: In a state of dysphoria
Posts: 30,793
Thanks (Given): 206
Thanks (Received): 516
Likes (Given): 2695
Likes (Received): 2612

**I am obsolete**

Code &#39;transplant&#39; could revolutionise programming (Wired UK)

Code has been automatically "transplanted" from one piece of software to another for the first time, with researchers claiming the breakthrough could radically change how computer programs are created.

The process, demonstrated by researchers at University College London, has been likened to organ transplantation in humans. Known as MuScalpel, it works by isolating the code of a useful feature in a 'donor' program and transplanting this "organ" to the right "vein" in software lacking the feature.

Bugger, no one is going to hire me now.

5th August 2015 10:53

**BrilloPad**

**TripleIronDad**

BrilloPad is a fount of knowledge

Couple that to a 3D printer and the ruling class will not need the plebs soon.

Maybe we will all be sent to the gas chambers.

UK Contractor Forum

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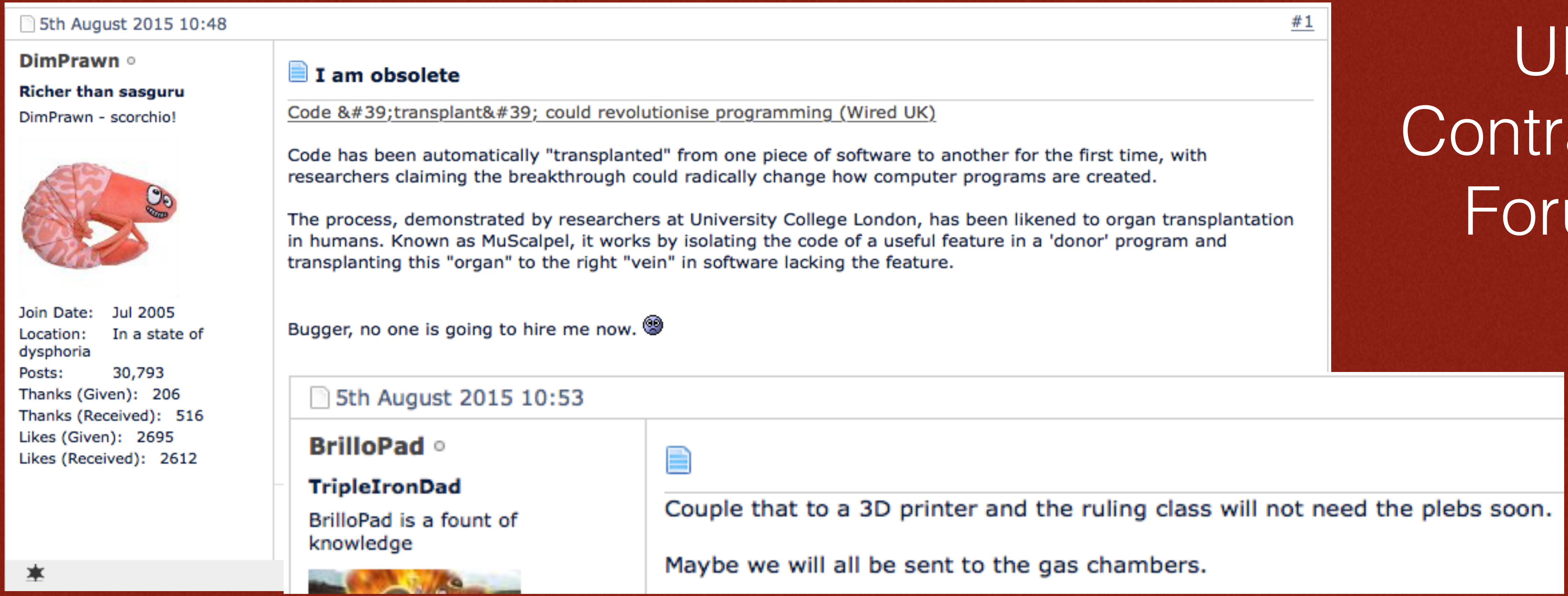

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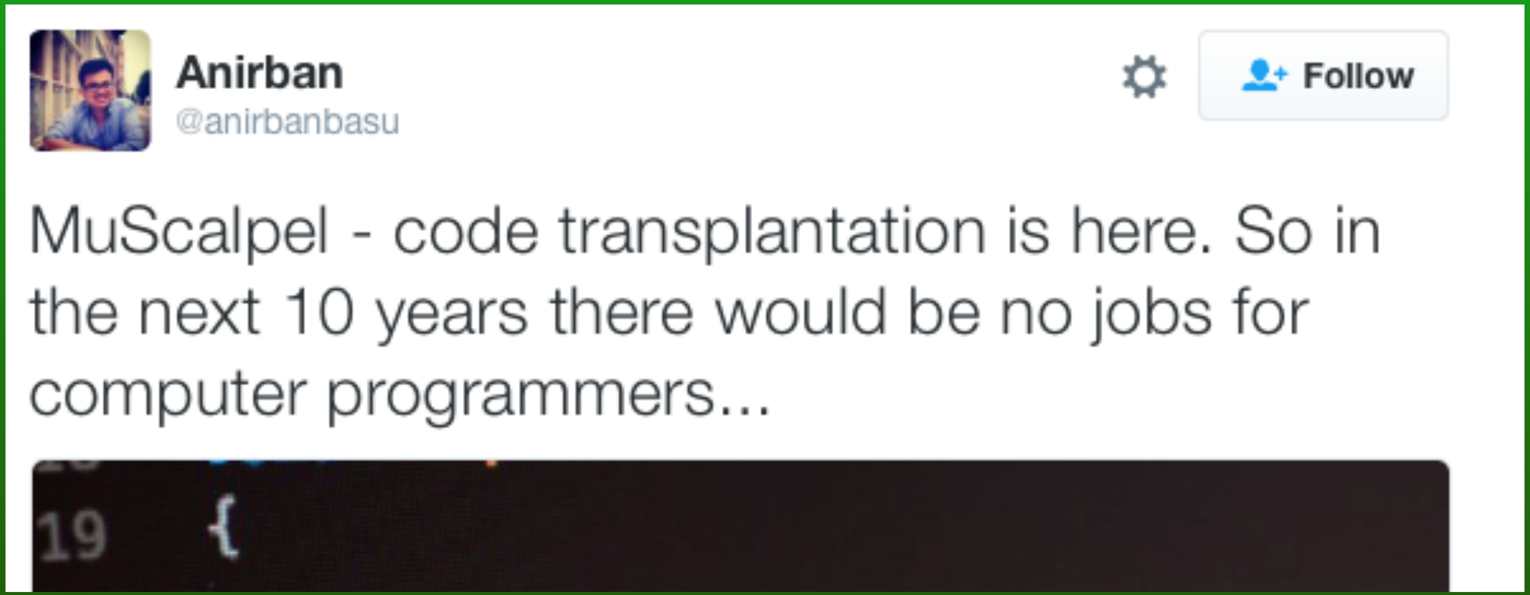
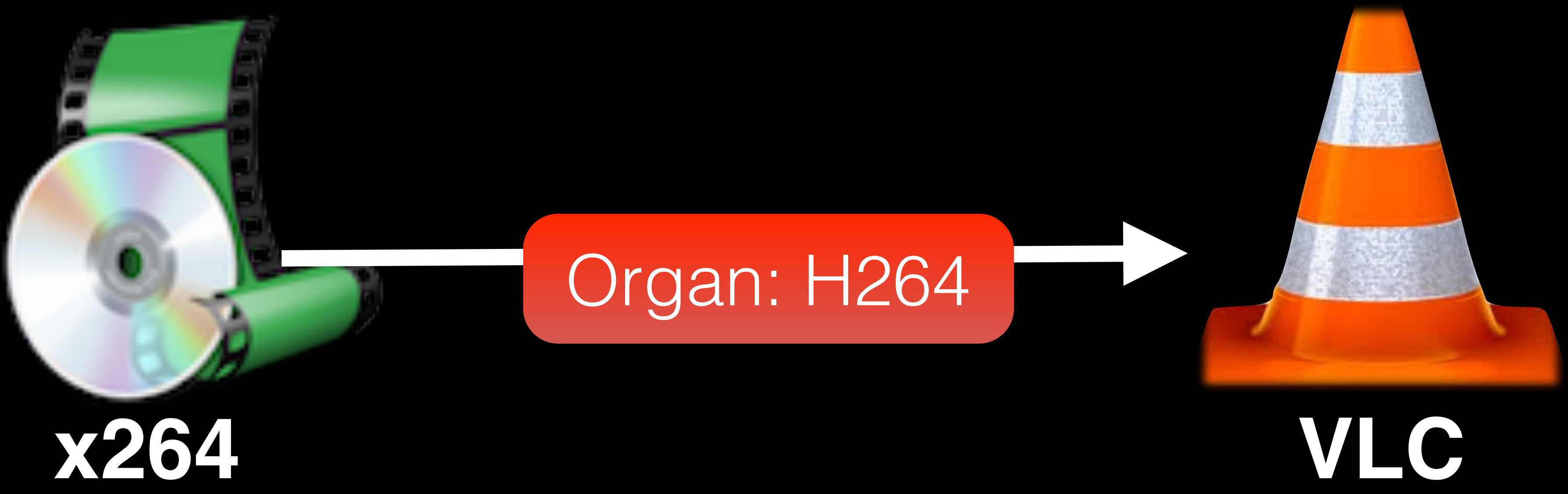


**Anirban**
@anirbanbasu

MuScalpel - code transplantation is here. So in the next 10 years there would be no jobs for computer programmers...

```
    {
```

# Why is Autotransplantation the Best?



x264

Organ: H264

VLC

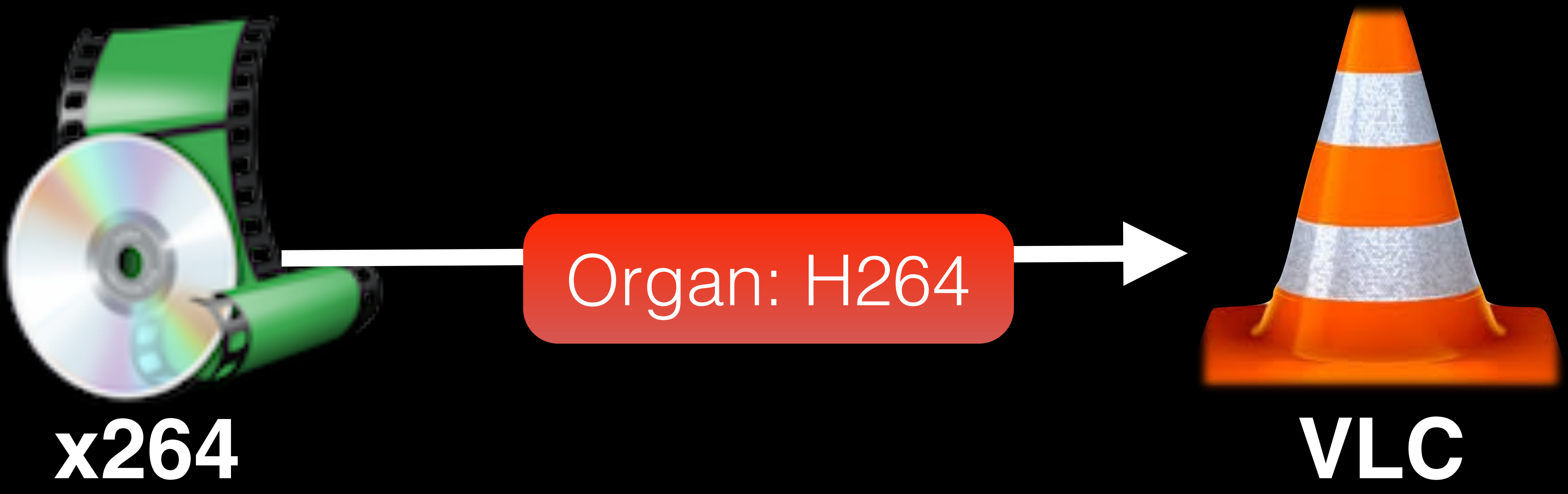
# Why is Autotransplantation the Best?

Code reuse is a seminal problem in computer science.

Automatic moving code is a difficult problem.

First transplant of useful, non-trivial functionality between two unrelated systems.

First application of GP to transplant functionality between two unrelated systems.



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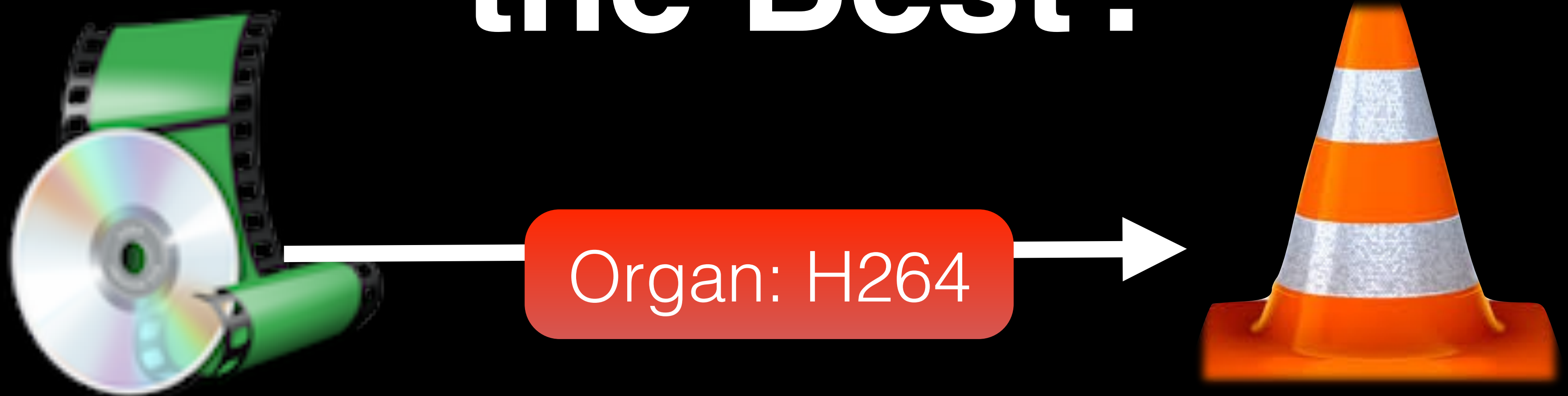


Organ: H264

**x264**

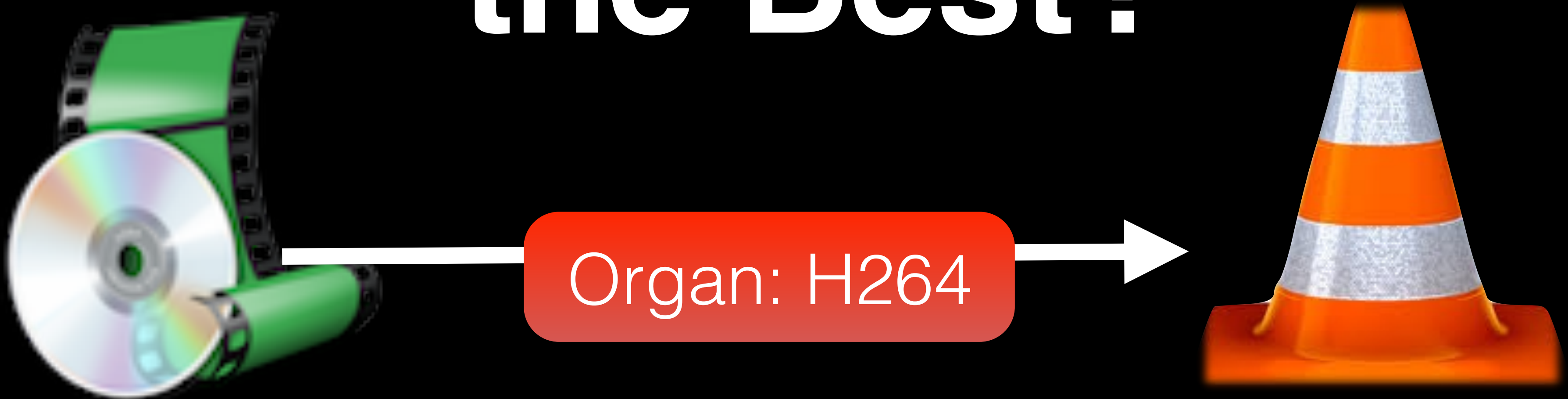
**VLC**

63K LOCs

23k LOCs

422K LOCs

# Why is Autotransplantation the Best?



**x264**

**VLC**

63K LOCs

23k LOCs

422K LOCs

**Popular, substantial, real world systems.**

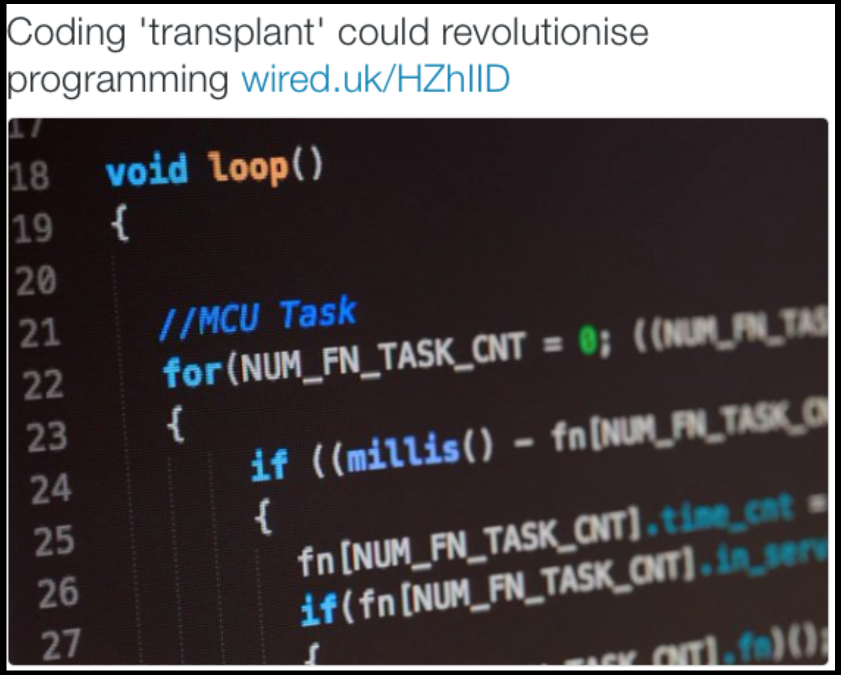
**Media encoding is an increasingly important problem.**

**Media encoders compared in various competitions [2,3,4].**

**As a side effect of GP we are 2.4% faster than the best H.264 encoder.**

# Why is Autotransplantation the Best?

# Why is Autotransplantation the Best?



Coding 'transplant' could revolutionise programming wired.uk/HZhIID

```
void loop()
{

  //MCU Task
  for(NUM_FN_TASK_CNT = 0; ((NUM_FN_TAS
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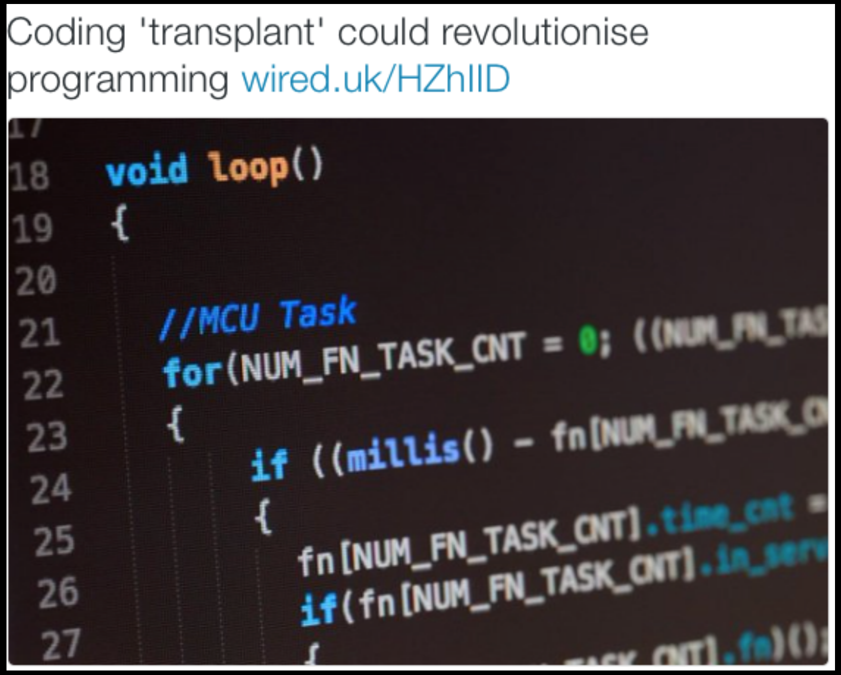
```

WIRED

article, with more than 2000 shares

# Why is Autotransplantation the Best?



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                    TASK_CNT].fn)();
```

WIRED

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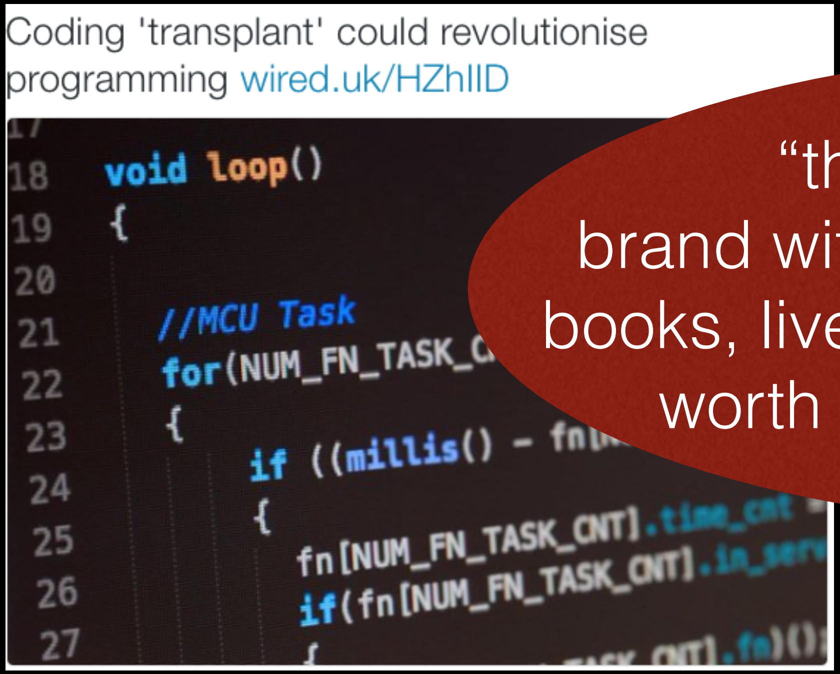

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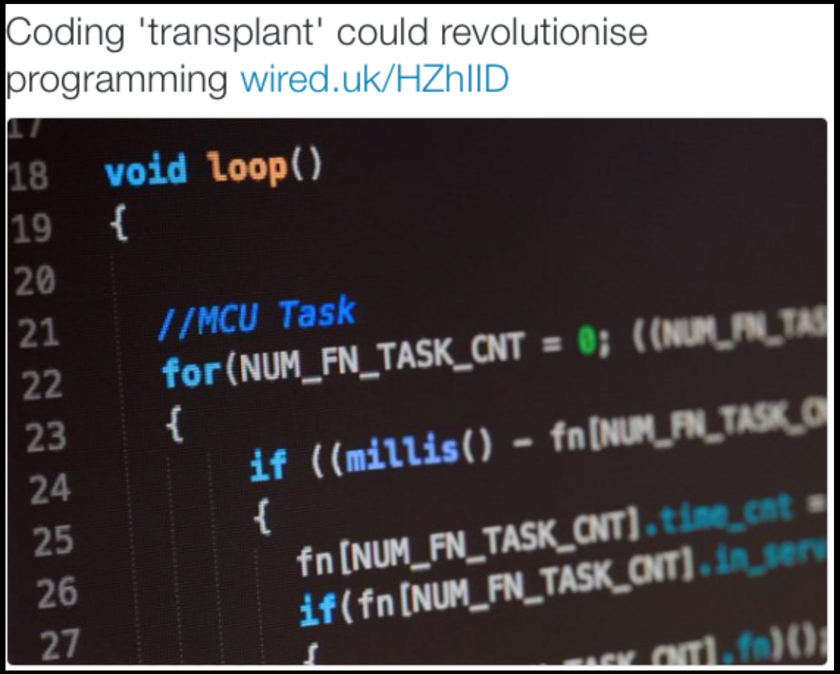
“the BBC’s biggest global brand with sales of the TV show, DVDs, books, live shows and other merchandise worth more than £50m a year” [5]

than 2000 shares

# Why is Autotransplantation the Best?



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WIRED

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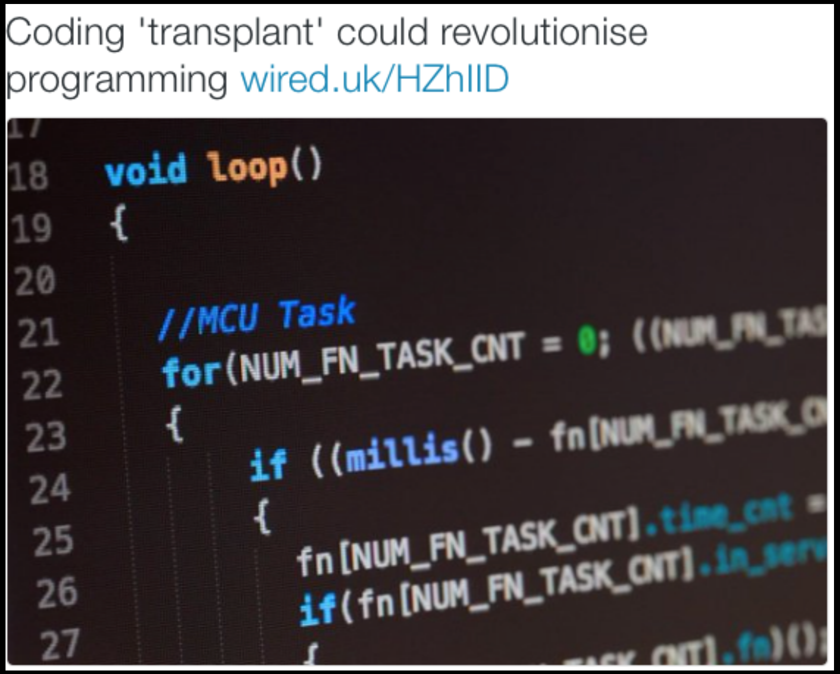

Coding 'transplant' could revolutionise programming wired.uk/HZhIID

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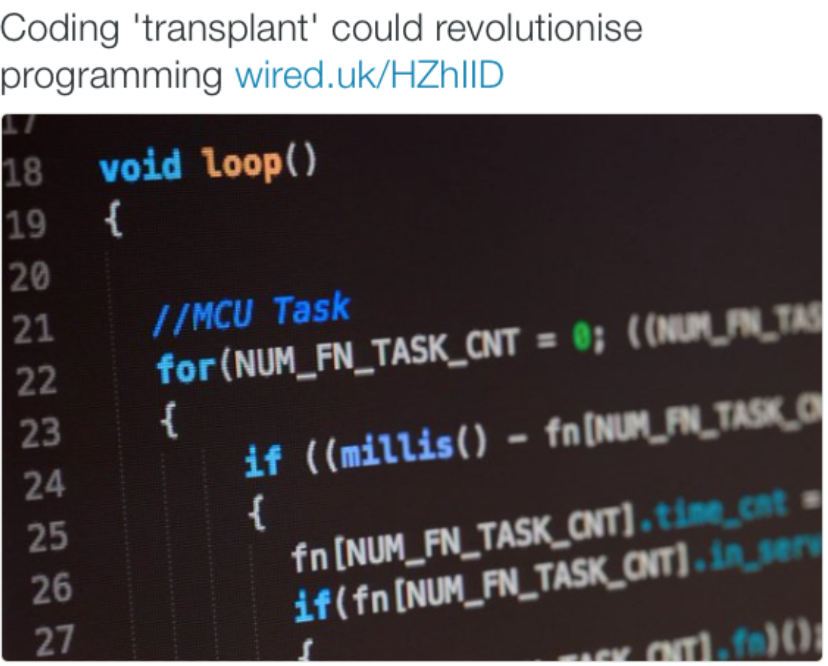

Coding 'transplant' could revolutionise programming wired.uk/HZhlID

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```

WIRED

article, with more than 2000 shares

More shares for Autotransplantation!

# Why is Autotransplantation the Best?

# Why is Autotransplantation the Best?

ACM Distinguished Paper Award at ISSTA ‘15

Distinguished
Paper
Award

# Why is Autotransplantation the Best?

## ACM Distinguished Paper Award at ISSTA ‘15

Distinguished Paper Award

## Featured on:

BBC WORLD SERVICE Click

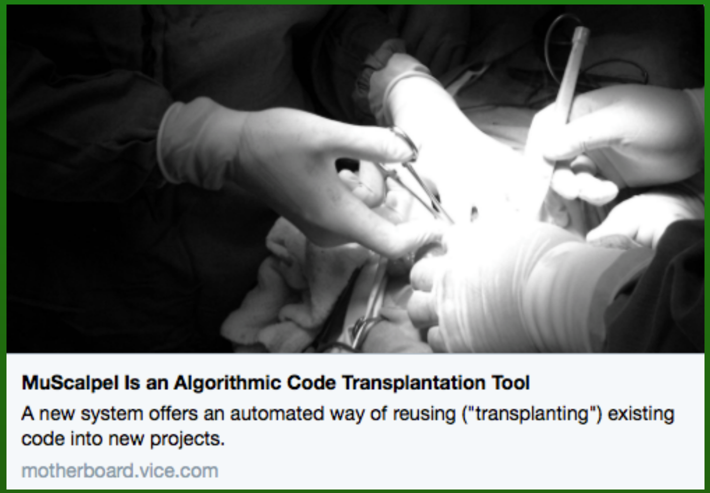
MOTHERBOARD

Wi-Fi Aware Connects Smartphones

Click talks to Kelly Davis-Felner of the Wi-Fi Alliance about the latest developments of Wi-Fi Aware which will make smartphones more aware of their surroundings by detecting

Available now

28 minutes



**MuScalpel Is an Algorithmic Code Transplantation Tool**

A new system offers an automated way of reusing ("transplanting") existing code into new projects.

motherboard.vice.com

# Contributions

# Contributions

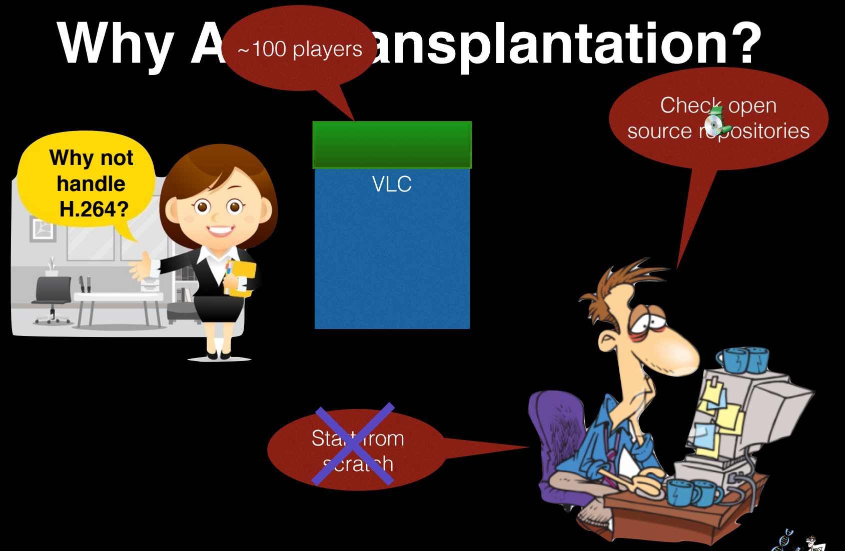
**We automatically transplanted H.264 encoder from x264 into VLC.**

# Contributions

We automatically transplanted H.264 encoder from x264 into VLC.

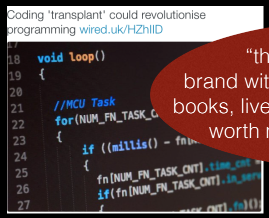
As a side-effect of GP, our transplant is faster than the winner of many encoder competitions.

## Why A ansplantation?



# Autotransplantation

## Why is Autotransplantation the Best?



Coding 'transplant' could revolutionise programming wired.uk/HZhIlD

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```

"the BBC's biggest global brand with sales of the TV show, DVDs, books, live shows and other merchandise worth more than £50m a year" [5]

than 2000 shares

More shares for Autotransplantation!

**We automatically transplanted H.264 encoder from x264 into VLC.**

**As a side-effect of GP, our transplant is faster than the winner of many encoder competitions.**

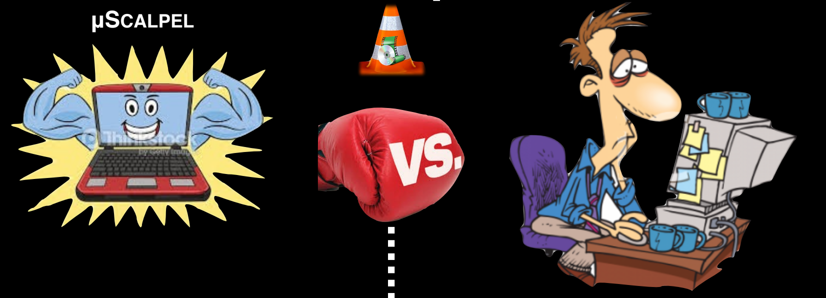
2016

DENVER, COLORADO, USA
JULY 20-24, 2016

GECCO

## Autotransplantation vs Human Transplantation

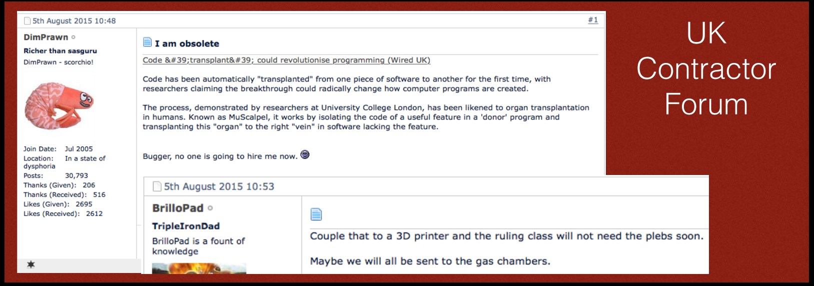
μSCALPEL



26 hours of cheap machine time

Upgrade of x264 within VLC: average of 20 days of elapsed time

## Are We Really Human-Competitive? "Am I Obsolete?"



5th August 2015 10:48 #1

**DimPrawn**
**Richer than sasguru**
DimPrawn - scorchio!

Join Date: Jul 2005
Location: In a state of dysphoria
Posts: 30,793
Thanks (Given): 206
Thanks (Received): 516
Likes (Given): 2695
Likes (Received): 2612

**I am obsolete**

Code &#39;transplant&#39; could revolutionise programming (Wired UK)

Code has been automatically "transplanted" from one piece of software to another for the first time, with researchers claiming the breakthrough could radically change how computer programs are created.

The process, demonstrated by researchers at University College London, has been likened to organ transplantation in humans. Known as MuScalpel, it works by isolating the code of a useful feature in a 'donor' program and transplanting this "organ" to the right "vein" in software lacking the feature.

Bugger, no one is going to hire me now.

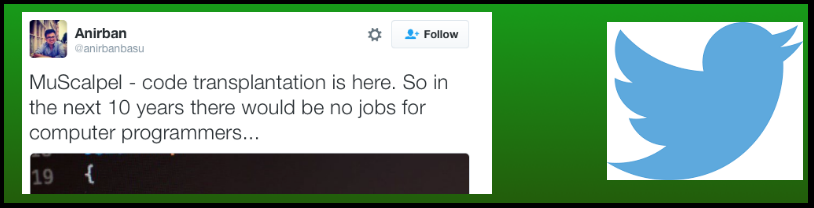
5th August 2015 10:53

**BrilloPad**
**TripleIronDad**
BrilloPad is a fount of knowledge

Couple that to a 3D printer and the ruling class will not need the plebs soon.

Maybe we will all be sent to the gas chambers.

UK Contractor Forum



**Anirban** @anirbanbasu Follow

MuScalpel - code transplantation is here. So in the next 10 years there would be no jobs for computer programmers...

```
19 {
```

# References

- [1] http://lifehacker.com/five-best-desktop-video-players-1503859883/1506086048

- [2] http://www.compression.ru/video/codec_comparison/h264_2012/

- [3] http://www.streamingmedia.com/articles/editorial/featured-articles/first-look-h.264-and-vp8-compared-67266.aspx

- [4] http://www.compression.ru/video/codec_comparison/h264_2010/

- [5] http://www.theguardian.com/media/2015/mar/11/top-gear-bbc-jeremy-clarkson