Breakscience

Technological and Musicological Research in Hardcore, Jungle, and Drum & Bass

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McGill

Overview

1. Hardcore, Jungle, and Drum & Bass
2. Content Delivery and the Internet
3. Breakscience Project
   a. Written History
   b. Interviews
   c. Automated Analysis

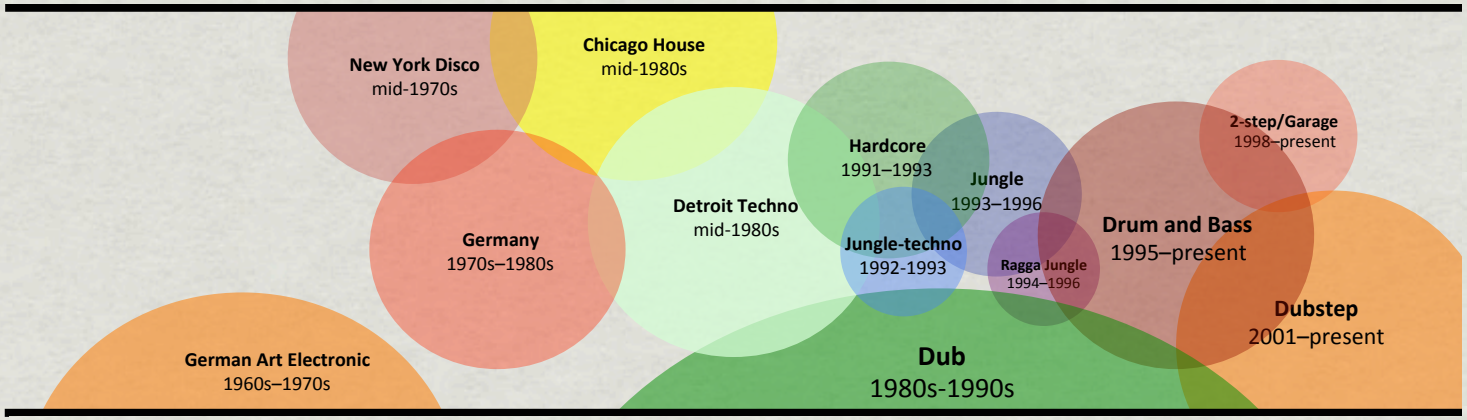
Hardcore, Jungle, and Drum & Bass

- Electronic Dance Music from **1990s**
- Origin: **London, UK**
- **Fast-tempo**
- Dub, bass, and **dread culture**
- **Lack of vocals**
- Individuality expressed through **track economy**

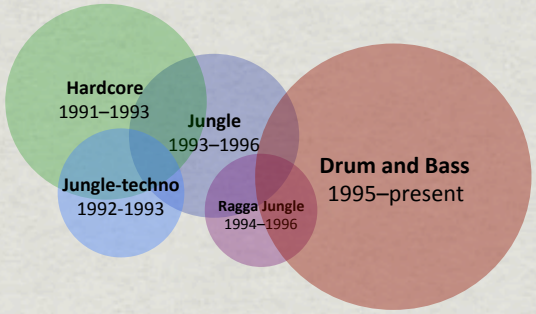
Hardcore, Jungle, and Drum & Bass

- Role of **drums**: intensity, structure
- **Sample-based** (predominantly breakbeat-based)
- **Breakbeats**: samples of percussion solos from Funk or Jazz recordings, typically from 1960s–1980s

Timeline


New York Disco
mid-1970s
Chicago House
mid-1980s
Germany
1970s–1980s
Detroit Techno
mid-1980s
Hardcore
1991–1993
Jungle
1993–1996
Jungle-techno
1992-1993
Ragga Jungle
1994–1996
Drum and Bass
1995–present
2-step/Garage
1998–present
Dubstep
2001–present
German Art Electronic
1960s–1970s
Dub
1980s-1990s

Timeline


Hardcore
1991–1993
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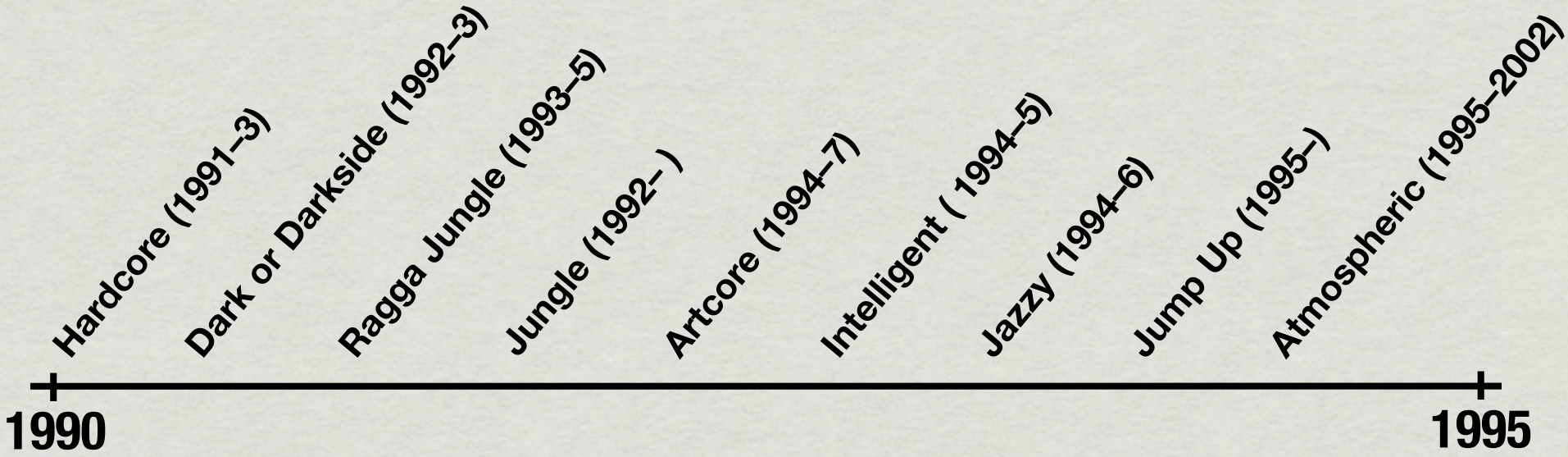
Timeline


Hardcore (1991–3)
Dark or Darkside (1992–3)
Ragga Jungle (1993–5)
Jungle (1992–)
Artcore (1994–7)
Intelligent (1994–5)
Jazzy (1994–6)
Jump Up (1995–)
Atmospheric (1995–2002)
1990
1995

Timeline


95–)
Atmospheric (1995–2002)
2-step (1995–)
Liquid (1995–)
Darkstep (1995–7)
Techstep (1995–9)
Neurofunk (1998–2000)
Drumfunk (1998–)
Clownstep (2007–)
Autonomic (2009–12)
1995
2012

Hardcore

- Aka *'ardcore*, *ardcore*
- Specifically the **Breakbeat Hardcore** variety
- Many Hardcore tracks have **kick drums on beats** under breakbeats
- **~140–160 BPM**
- Precursor to Jungle
- Breakbeats tend to be in **similar order to original samples**
- Synthesizers **more akin to techno** (lead sounds, e.g., TB-303)
- Often feature **pitched-up vocals**

Jungle

- **~150–170 BPM**
- Kick drum not backing up beat points as in hardcore
- Synthesizers used more for **pads and bass**
- Enter the **MC**
- Tempo-shift also allows for **R&B vocals** and **slower Dub bass**
- **Breakbeats are rearranged** a great deal more
- Possibly **longer phrase length** and **varied composition**

Drum & Bass

- Aka *Drum'n'Bass*, *Drum&Bass*, *D&B*, *DNB*
- **~160–175 BPM**
- Shift towards improved **production techniques**
- popularity of **2-step**: absence of additional drums, with more emphasis on **main kick and snare pattern**
- Mood influenced by **science fiction** and **technology's dark side**
- Breakbeats are often **layered** and **switched**
- **Rhythmically more simple**

Content Delivery and the Internet

- **1995:**

  Vinyl tested/bought at a **physical store/mail order**

  Mixtapes!!

  DJs known through **store affiliation**: Blackmarket, Dara, DB, etc.

  Speed of **business much slower** (track creation to release)

  Physical magazines

  Physical demos used to be sent to a label address

  Party information via flyers, magazines, and **text/pager**

Content Delivery and the Internet

- **1995:**

  Vinyl teste

  Mixtapes

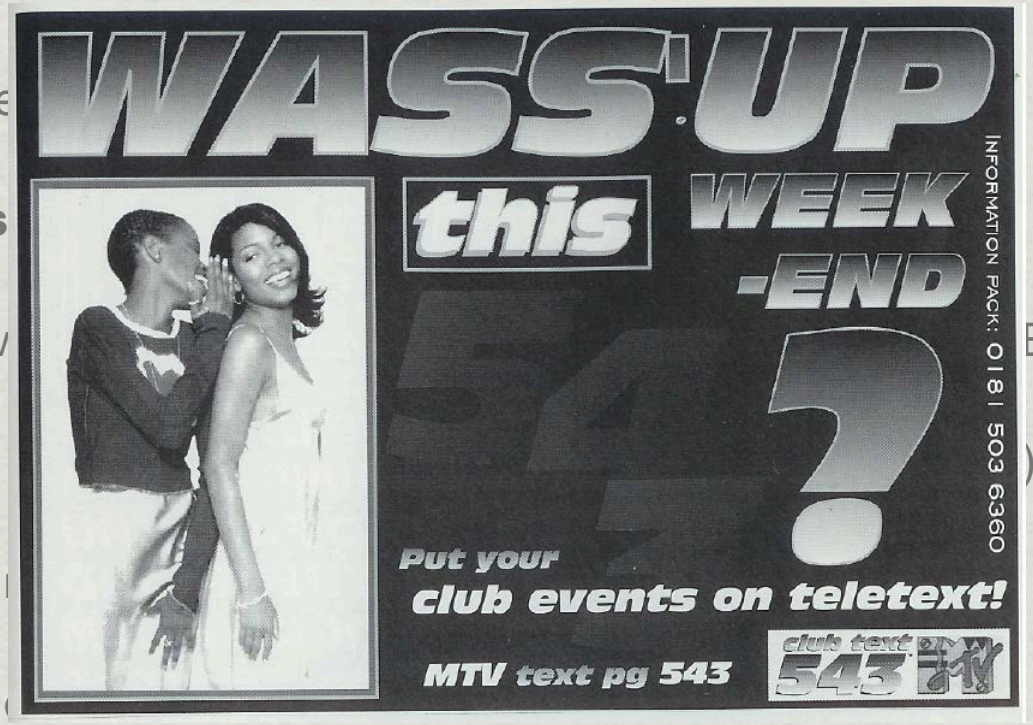
  DJs know B, etc.

  Speed of)

  Physical

  Physical

  Party information via flyers, magazines, and **text/pager**



Content Delivery and the Internet

- **2012:**

  MP3s previewed/bought at an online store

  Mixes online and **live broadcasts**

  DJs known through **production or label ownership**

  Speed of **business much faster** (track creation to release)

  Blogs

  Party information via **Facebook** and other social media sites, flyers

  Demos sent via AIM/Soundcloud

Content Delivery and the Internet

- **Vinyl, CDs, MP3s:**

  Vinyl cherished: tactile adjustability, and “superior” sound quality

  Legacy of privately-owned record labels; **dubplate culture**

  CD turntables became widely used in early 2000s

  Over last 5 years, MP3s provided **ease of transportation** and **transmission**

  Transition from vinyl **required internet** as medium and DJ system (e.g., Serato)

- Most of the HJDB genre's music is not digitized
- Vinyl records are not suitable format for for a wide audience
- **Breakscience** project offers:
  1. **Written history** from technological perspective with discussion of major movements within the genres
  2. **Interviews** with HJDB artists
  3. Tools for **automated analysis**

- **Written History**
  - **Musical and Cultural Movements:**
    - from Balearic to Bass Music
  - **Creation of HJDB:**
    - technological development
      - synthesizers
      - samplers and trackers
      - techniques

Interviews

- 0=0
- Justice
- Dave Trax
- Bay B Kane
- Alpha Omega
- Fracture
- Gappa G
- Macc
- Nookie
- Carl Collins
- Deep Blue
- PFM
- Antidote
- Clever
- Code
- + more to come...

Automated Analysis

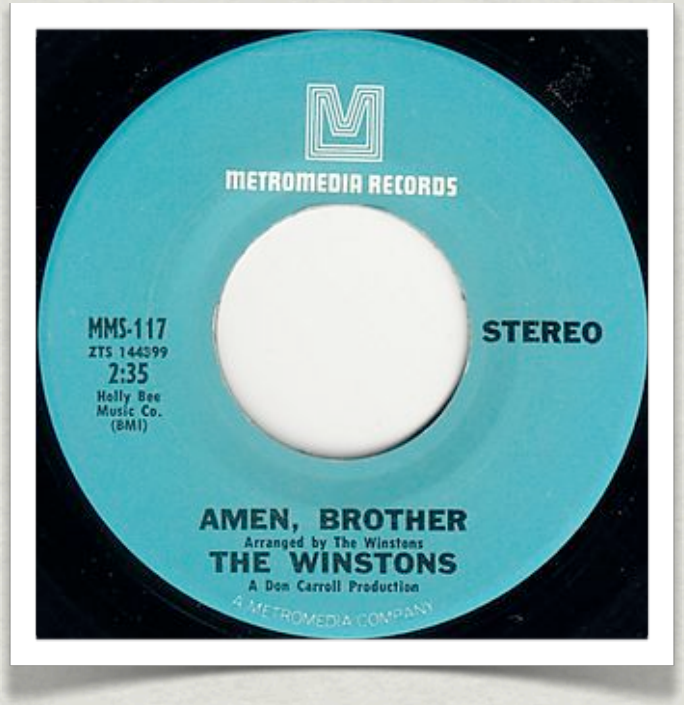
1. Beat and Downbeat Annotation
2. Breaks classification
3. Drum Patterns

Downbeat Detection

Downbeat Detection

- A few methods have been proposed (e.g., **Goto** 2001, **Davies & Plumbley** 2006, **Klapuri et al.** 2006, **Papadopoulos & Peeters** 2010, **Peeters & Papadopoulos** 2011)
- Downbeat detection is **difficult in niche genres** (**Jehan** 2005)
- Suggests the need for **style-specific models**

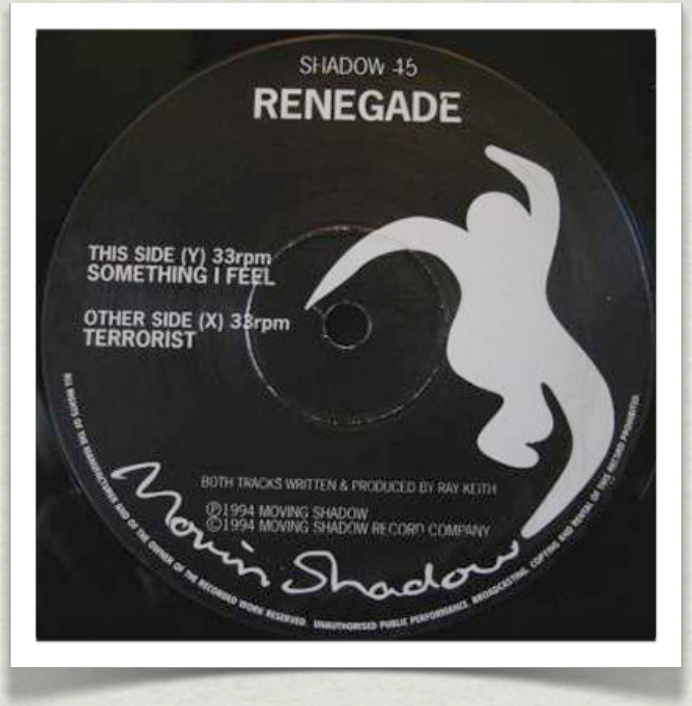
Breakbeats and Tracks



Original Breakbeat

Artist: The Winstons
Track: Amen, Brother
Label: Metromedia Records (MMS-117)
Year: 1969

Breakbeats and Tracks



Jungle Track

Artist: Renegade
Track: Terrorist (PA Mix)
Label: Moving Shadow (SHADOW45)
Year: 1994

Breakbeats and Tracks

Original Breakbeat

Artist: The Jungle Band
Track: Marvellous
Label: Charly Records
Year: 1988

Breakbeats and Tracks

Jungle Track

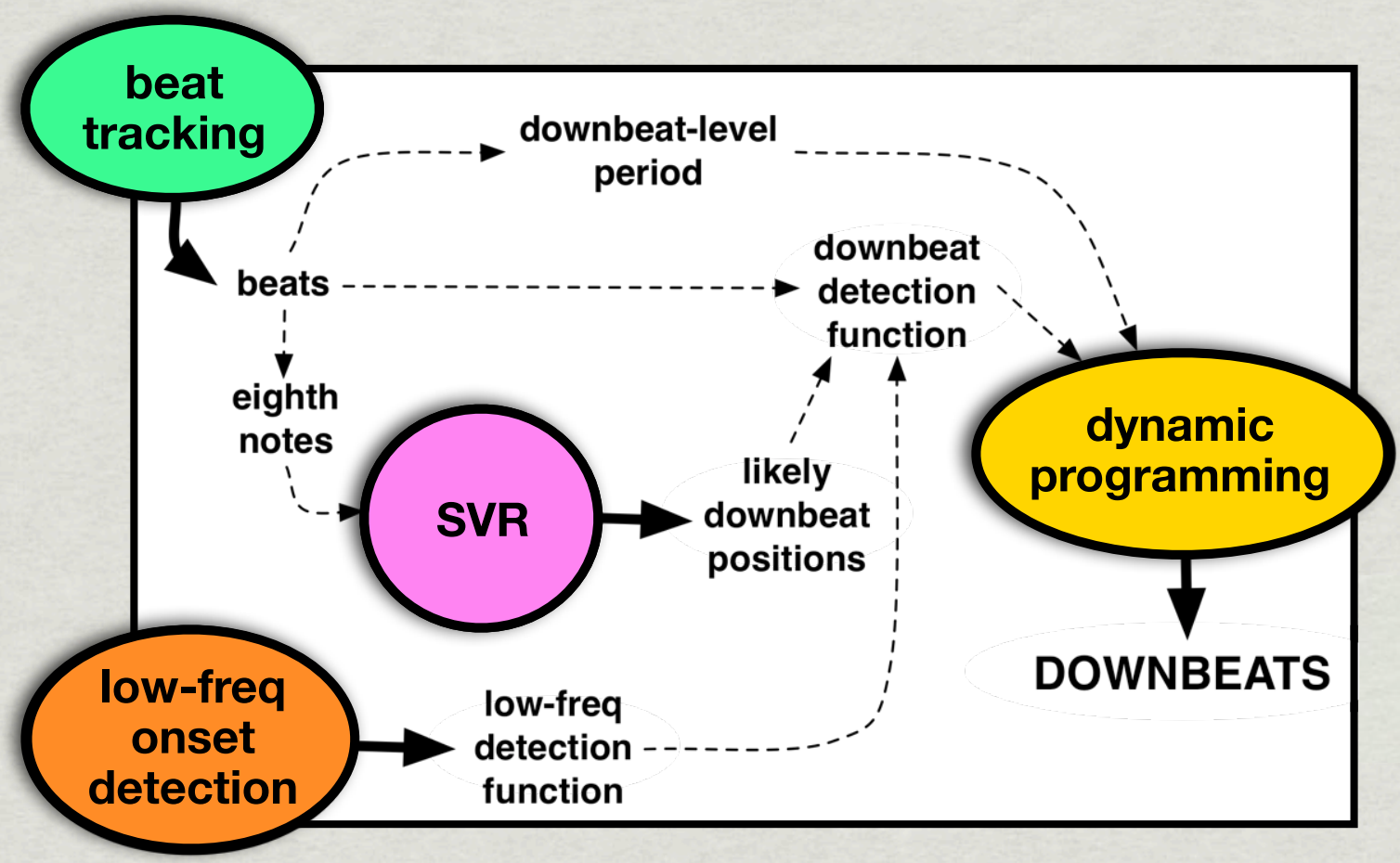
Artist: Icons (Blame and Justice)
Track: Third Eye Visions
Label: Modern Urban Jazz (MJAZZLP1)
Year: 1996

Downbeat Detection Method Overview

Motivation: explore relationship between breakbeats and HJDB tracks

Approach: train a model with extensively used breakbeats

Downbeat Detection Method Overview

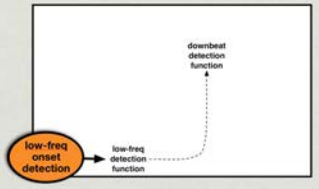


Low-frequency Onset Detection

Motivation: Emphasis on kick drum onsets, as drum type most likely at downbeats is kick drum

Approach (modified Davies et al. 2009)**:**

1. Divide audio into 40 sub-bands
2. Complex-spectral difference in lowest 5 bands
3. Sum 5 bands

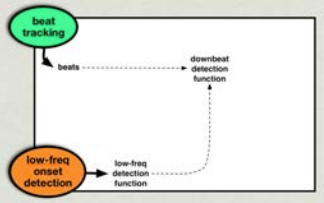


Beat Tracking

Motivation: Provides segmentation grid for regression model and beat-time weighting

Approach:

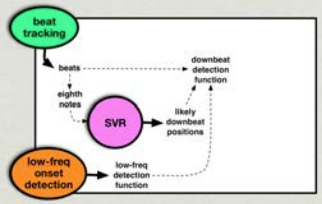
1. Beats found via **Beatroot** (Dixon 2007)
2. Grid generated from 8th note time locations



Support Vector Regression

Motivation: Find likely downbeat positions based on rhythmic and timbral similarity to breakbeats

Approach: Began with Jehan (2005)



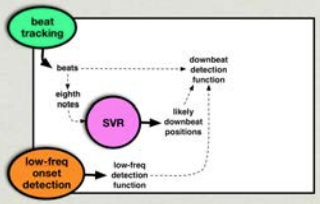
Support Vector Regression

Training: Breakbeats (29 in total)

For each breakbeat:

1. Isolate breakbeat from original song
2. Segment quantized breakbeat into **eighth-note segments,** store their positions within a measure
3. Extract mean segment features (MFCCs, chroma, loudness features) from each eight-note audio segment

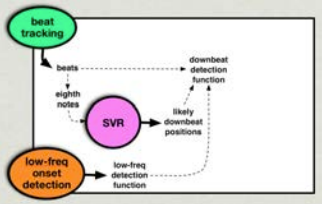
Aggregate breakbeat feature matrices, perform PCA, and train the model



Support Vector Regression

Testing: Hardcore, Jungle, and Drum & Bass

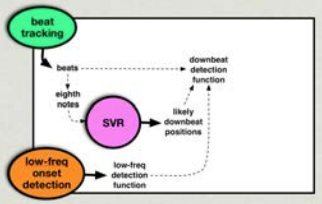
1. segment test audio using 8th-note beat-tracking grid
2. extract features from each segment
3. perform training set PCA transformation
4. perform regression creating output vector that associates each segment with a position in a measure



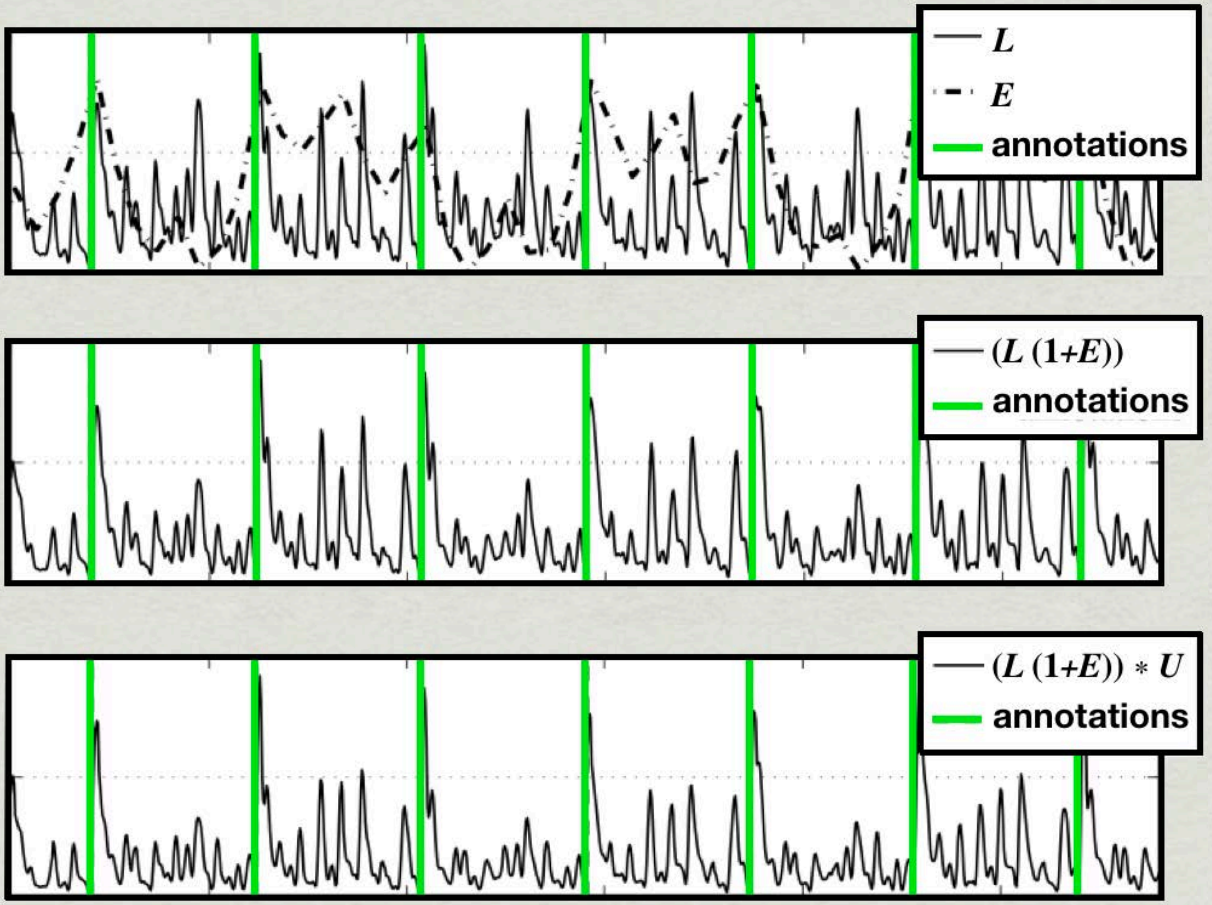
Support Vector Regression

Testing: Hardcore, Jungle, and Drum & Bass

1. segment test audio using 8th-note beat-tracking grid
2. extract features from each segment
3. perform training set PCA transformation
4. perform regression creating output vector that associates each segment with a position in a measure
5. sharpen output by applying linear regression



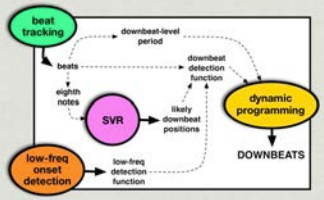
Information Fusion for Downbeat Detection Function



L: low-freq detection function **E: likely downbeat position function** **U: beat-time weighting**

Selection of Downbeats from Detection Function

- **Motivation:** find downbeats in our final detection function
- **Approach: Dynamic Programming** (Ellis 2007)
  - measure-length period estimated as **4x median of all inter-beat intervals** from beat times



Evaluation

Evaluation: HJDB Dataset

- **Dataset size:** 236 excerpts (0:30—2:00 min)
- **Origin:** full-length HJDB vinyl singles featuring variety of artists, styles, and breakbeats
- **Selection:** 3 HJDB DJs/Artists
- **Annotations:** made by professional Drum & Bass musician using Sonic Visualizer
- **Training/Testing:** 30 excerpts for parameter tuning, 206 for testing

Evaluation: Algorithms

- **Four General Models:**

  CS1: Anonymized commercial software #1

  CS2: Anonymized commercial software #2

  KL: Klapuri et al. (2006)

  DP: Davies & Plumbley (2006)

- **Style-specific Model:**

  HJDB: Our algorithm

Evaluation: Method

Methodology: Continuity-based beat tracking metrics used in MIREX (Davies et al. 2009)

Measurement: for a downbeat to be correct

1. Candidate must be within a tolerance window (16^{th} note on either side of annotation)
2. Last candidate must be within its tolerance window
3. Difference between Inter-downbeat-interval (**IDI**) and inter-annotation interval (**IAI**) must be < 6.25% of **IAI**

Evaluation: Method

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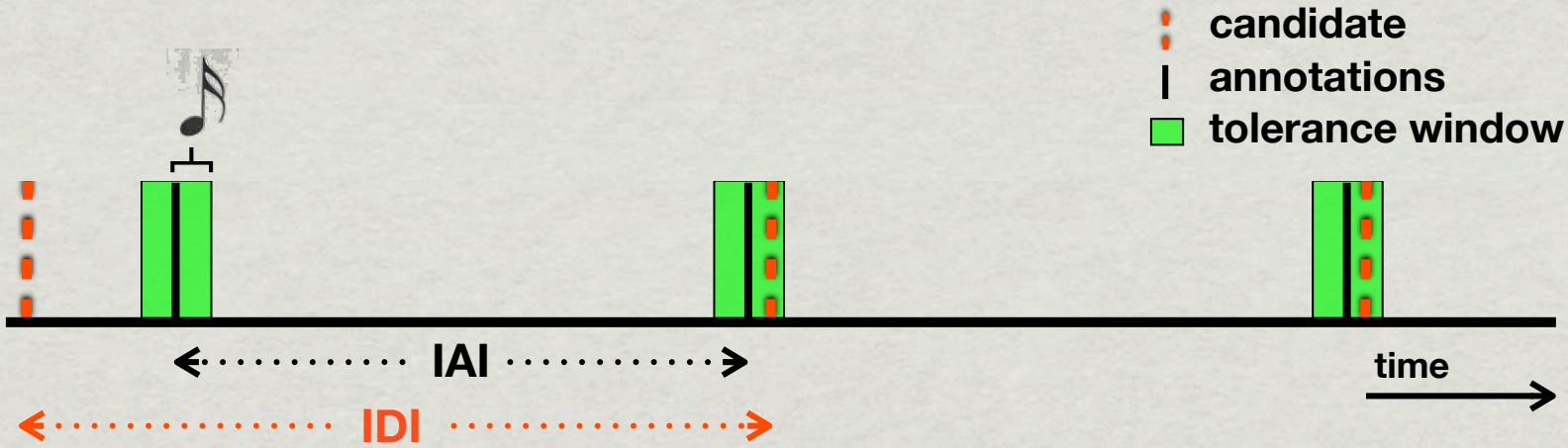


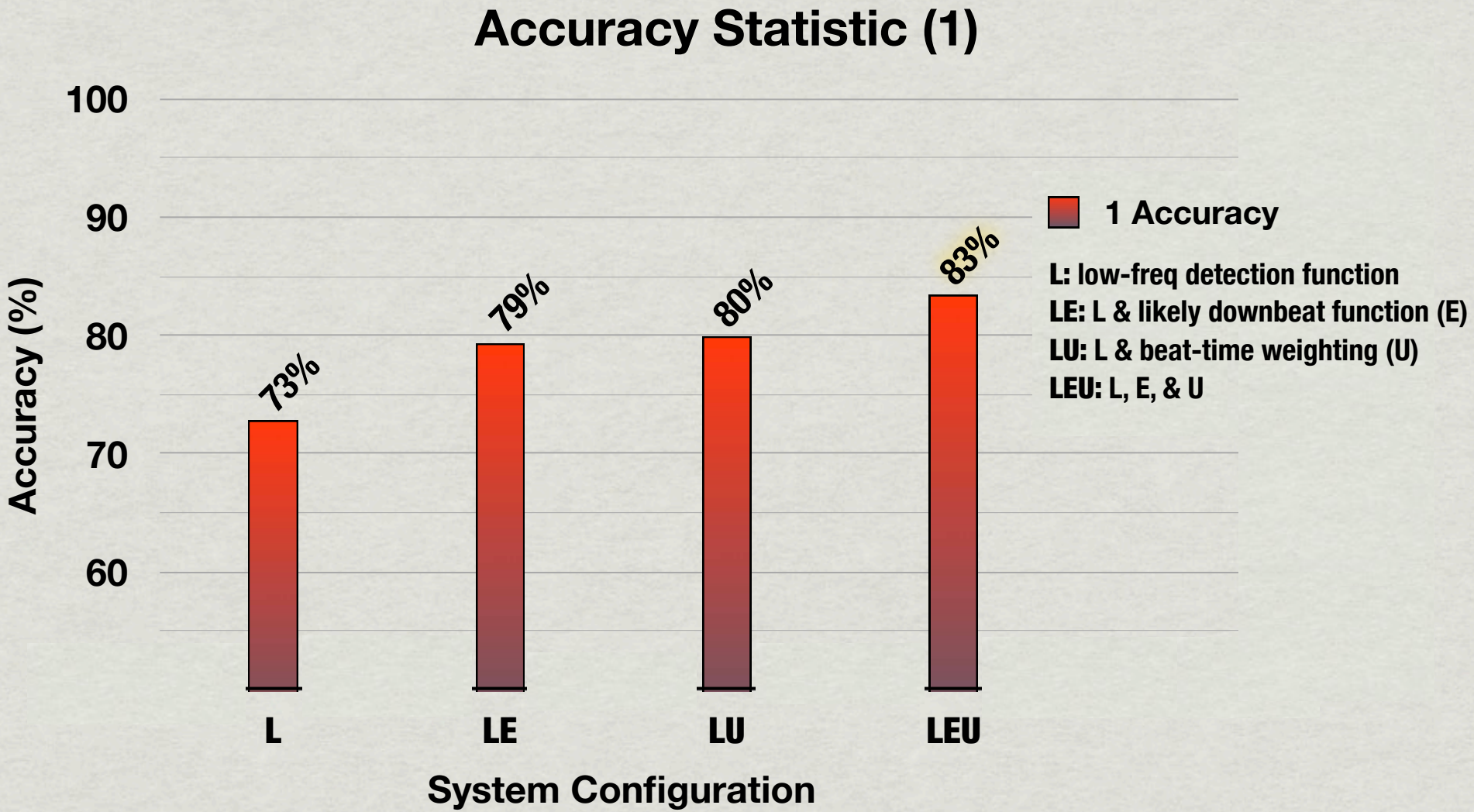
Evaluation: Method

Accuracy: *1* metric provides a mean accuracy across all excerpts

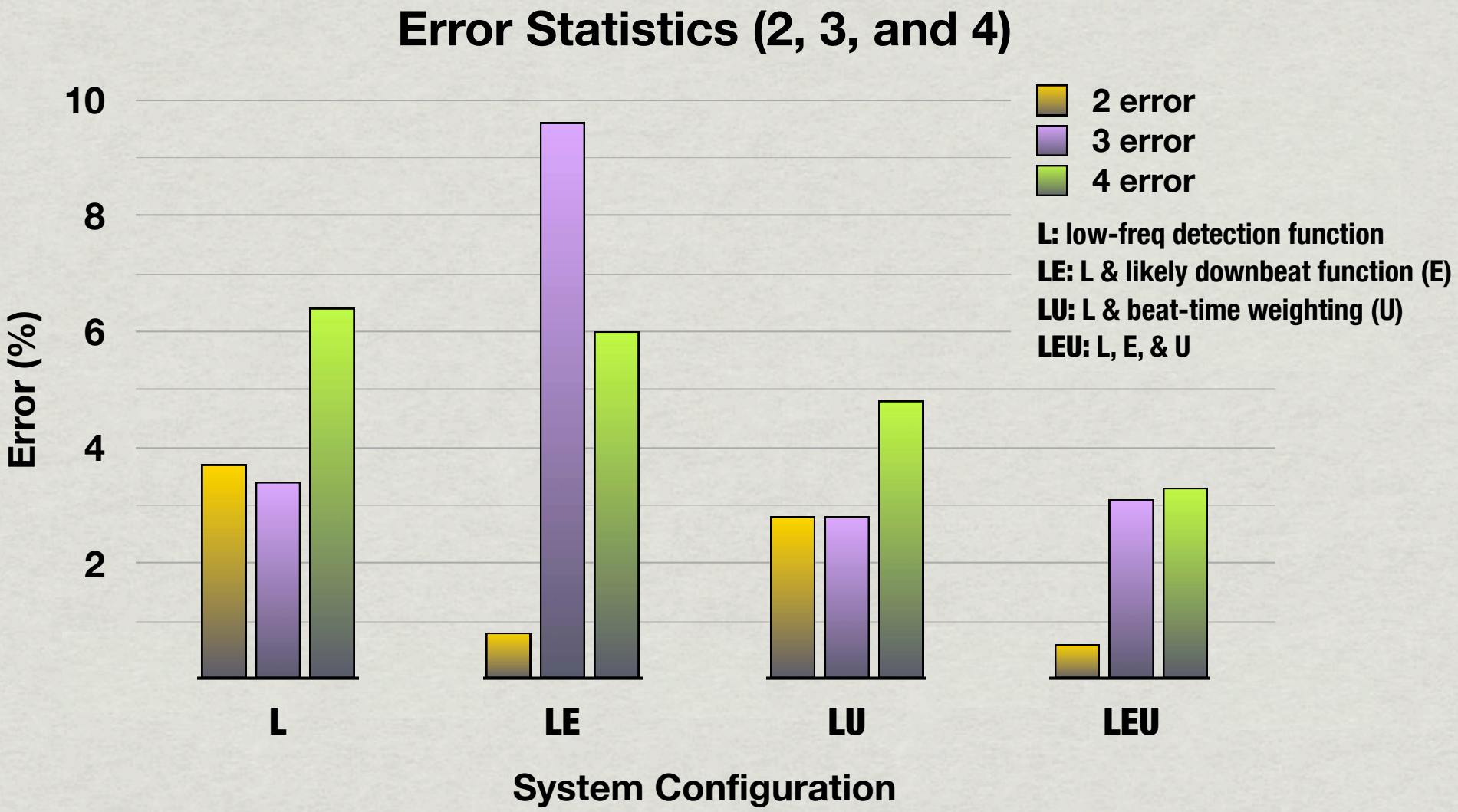
Error:

1. ***2***, ***3***, and ***4* metric** provide mean error across all excerpts at the different beat points
2. ***1/2* metric** provides mean error at the half note rate

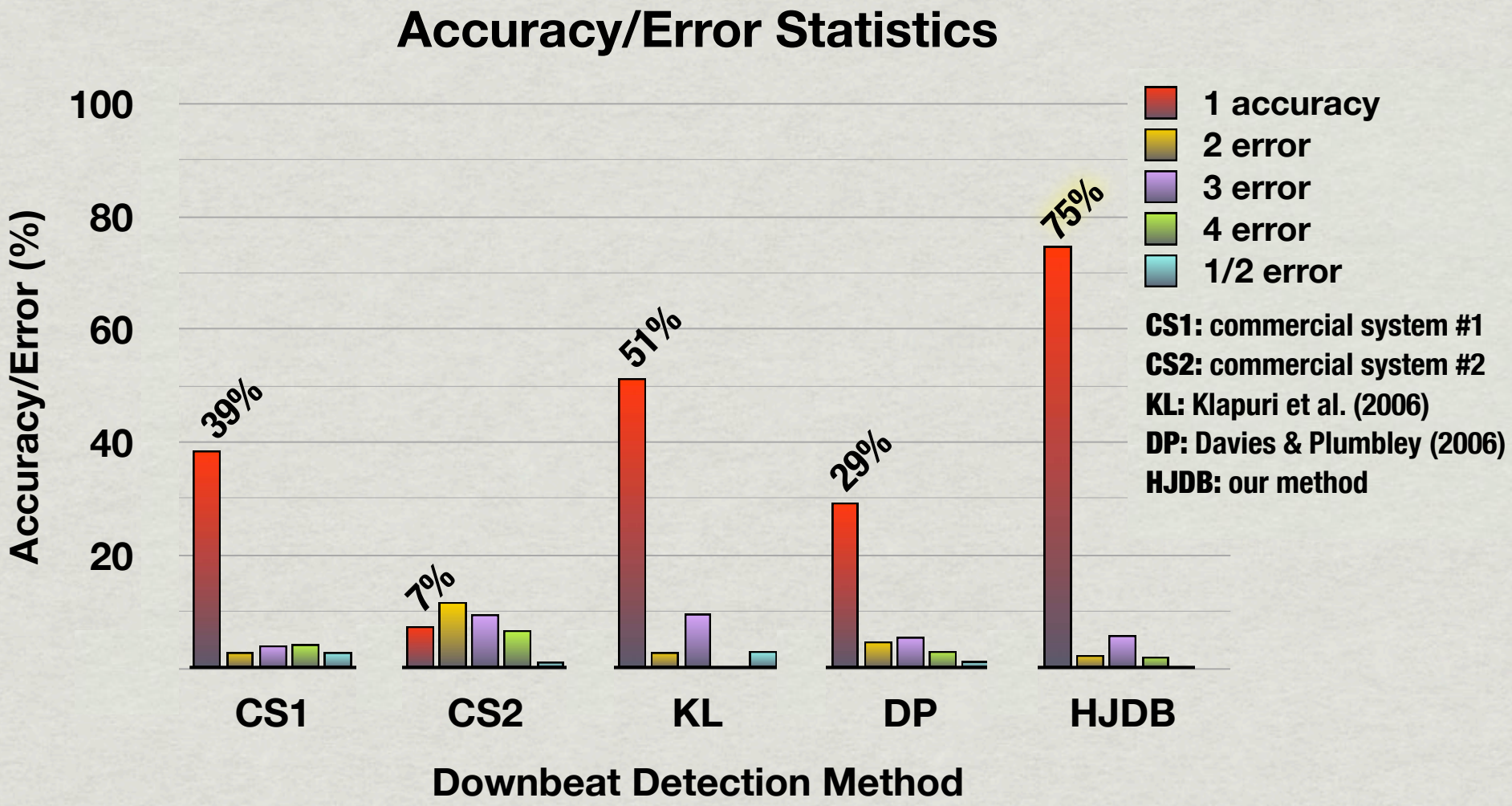
Results: Parameter Tuning



Results: Parameter Tuning



Results: HJDB Evaluation



Discussion

- Style-specific model are beneficial in niche cases
- Parameter tuning results show the robustness of low-frequency onset detection function and dynamic programming for this type of music
- Access to parameter tuning dataset perhaps causes an imbalanced comparison, however ours is only algorithm tested necessitating such tuning

Discussion

- **Future work:** multi-genre or another niche genre *excluding* breakbeats
- Attempted to keep model as general as possible; tuning of the SVR is the only part style adapted
- With knowledge of downbeats, we are exploring the relationship between the Hardcore, Jungle, and Drum & Bass corpus and specific breakbeats

Thank You!

http://ddmal.music.mcgill.ca/breakscience

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