Computer Vision I

Review & Outlook - 10.07.2013

TECHNISCHE UNIVERSITÄT DARMSTADT

Review & Outlook

- Before the semester ends, I would like to give an overview / review of the things that we have learned this semester.
  - It may have seemed to go by quickly, but we have covered a lot of ground.

>100 Things We've Learned

- Computer vision
- Application examples
- Artistic cues
- Human visual cues
- Pinhole camera
- Perspective projection
- Orthographic projection
- Coordinate transformations
- Spatial sampling
- Vanishing points
- Perspective distortions
- Homogeneous coordinates
- Camera intrinsics
- Extrinsics
- Aperture

Thin lens formula

Depth of field

Camera artifacts

Color cameras

Bayer pattern

Linear filtering

Convolution kernels

Median filter

Morphology

Gaussian pyramid

Aliasing

Template-based recognition

Edge detection

Canny edge detector

Non-maximum suppression

Laplacian pyramid

Template-based matching

SSD

Subspaces

Dimensionality reduction

Correlation

PCA

SVD

Eigenrepresentations

Eigenfaces

Appearance manifolds

View-based recognition

>100 Things We've Learned

- Bag-of-Words model
- Color histograms
- Histogram distances
- Receptive field histograms
- Interest points
- Invariant features
- Structure tensor
- Harris points
- Scale space
- Scale selection
- Harris-Laplace points
- SIFT features
- Shape context
- Performance evaluation
- Vector quantization

Bayesian decision theory

Naive Bayes classifier

Discriminative & generative approaches

SVMs

Kernel trick

Histogram & Pyramid match kernels

Sliding window detector

HOG

Motion field

Optical flow

Image interpolation

Brightness constancy

OFCE

Aperture problem

Lucas-Kanade

Image registration

Image warping

Coarse-to-fine estimation

Linear camera calibration

Homogeneous least squares

Homographies

Coordinate normalization

RANSAC

Panorama stitching

Triangulation

>100 Things We've Learned

- Epipolar geometry
- Epipolar constraint
- Essential matrix
- Fundamental matrix
- Eight-point algorithm
- Estimating projection matrix
- Binocular stereo
- Disparity
- Rectification
- Baseline
- Window-based matching
- Normalized correlation
- Uniqueness constraint
- Ordering constraint

Segmentation

Figure-ground labeling

Superpixels

Gestalt factors

Occlusion

Clustering

K-Means

Mean Shift

Kernel Density Estimate

Graph-based clustering

Graph-cut segmentation

Normalized cuts

So are we done?

[Marr]

Computer Vision Timeline

1975-1985

Vision as AI

Early view (50's-60's): Minsky thought the vision sub-problem of AI could be solved by a single PhD student in a single summer. Done. Move on.

- Lofty goals and early excitement.

[Black]

Computer Vision Timeline

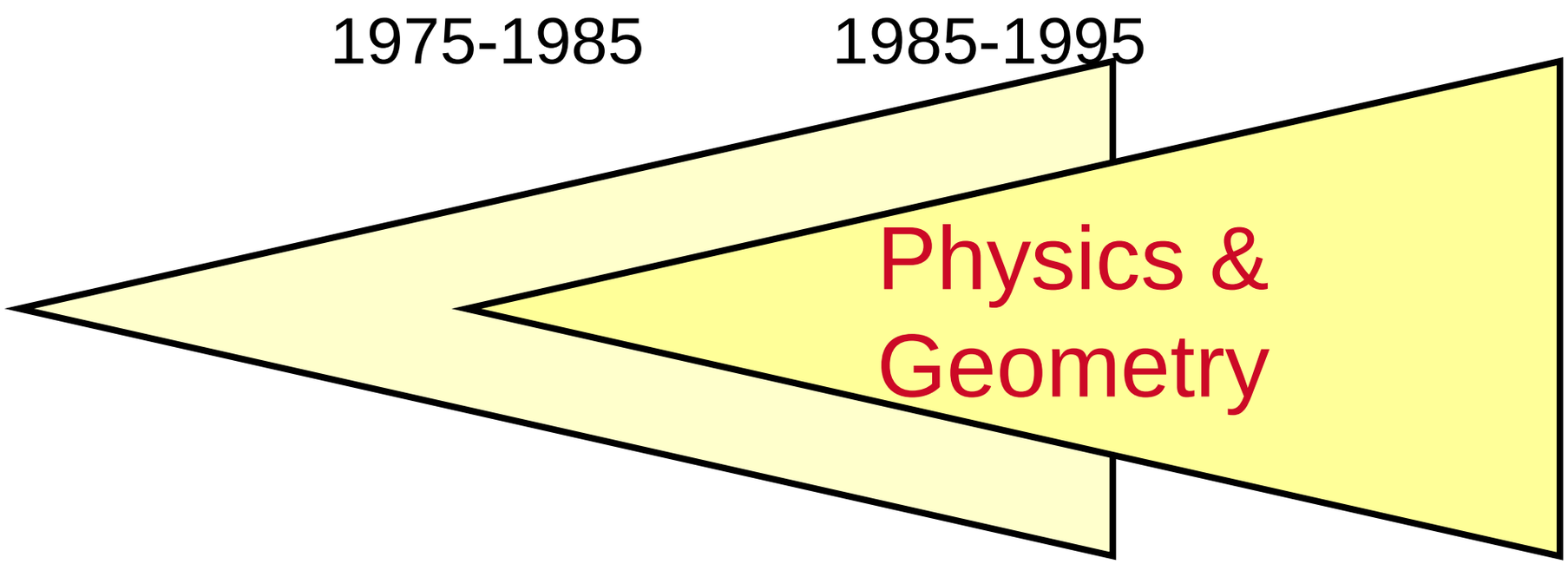
1975-1985

Vision as AI

- Shattered dreams and early disappointment.

[Black]

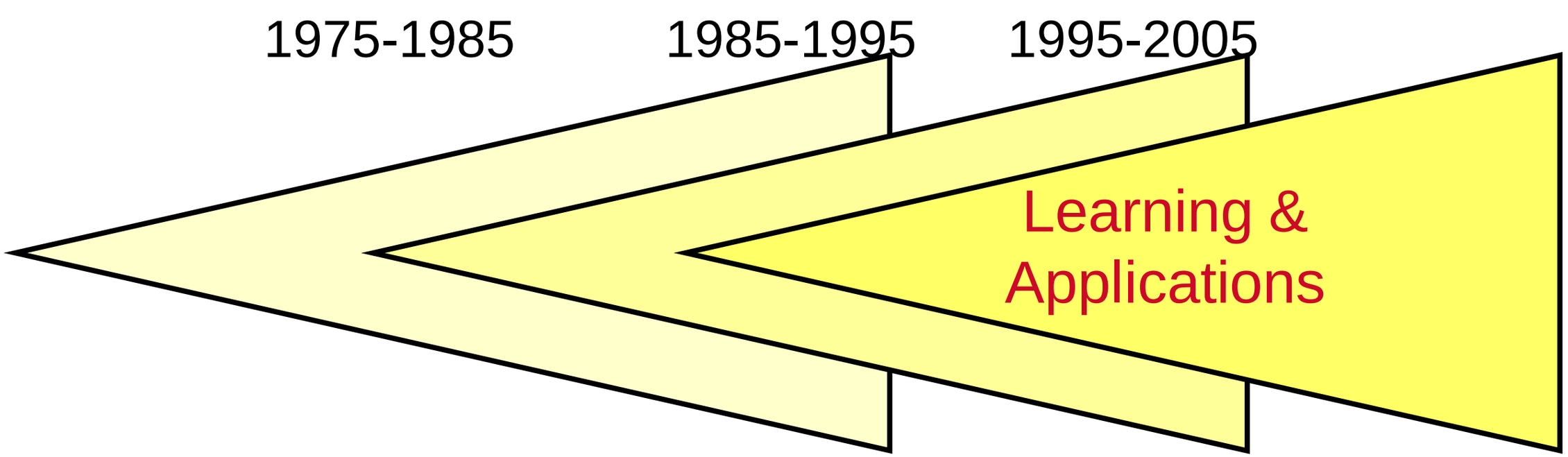
Computer Vision Timeline



- Regroup, focus on the basics:
  - Metric reconstruction, quantitative evaluation
  - Optimization methods

[Black]

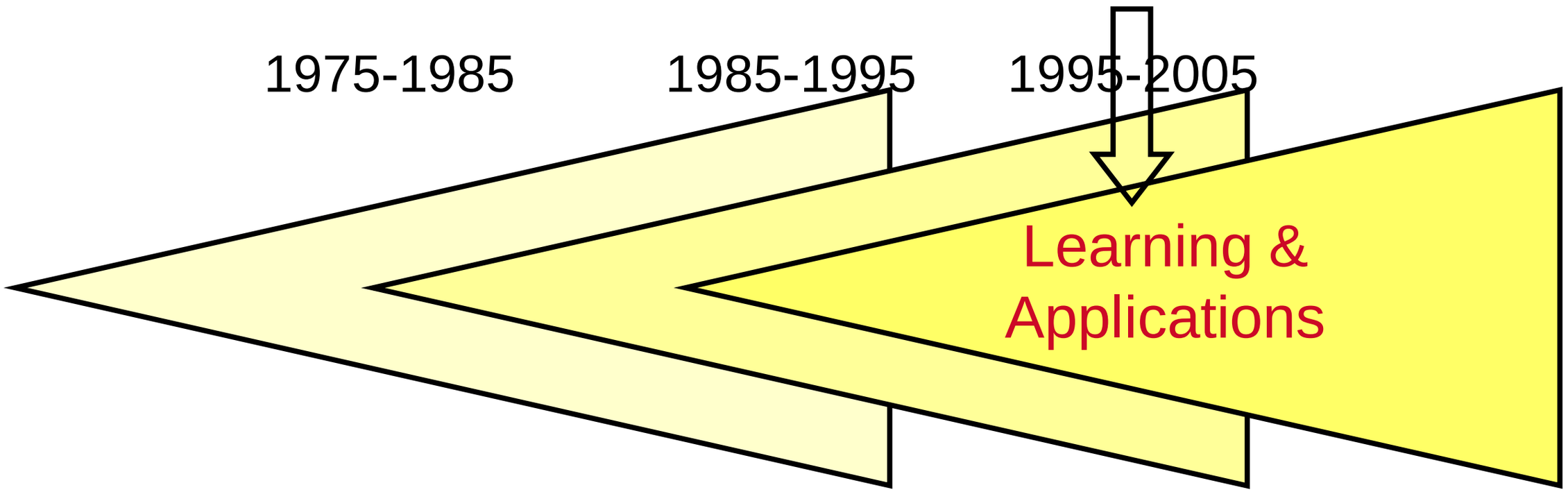
Computer Vision Timeline



- Trends: Big disks, digital cameras, fast processors, desktop video.
  - Machine learning provides a new grounding.

[Black]

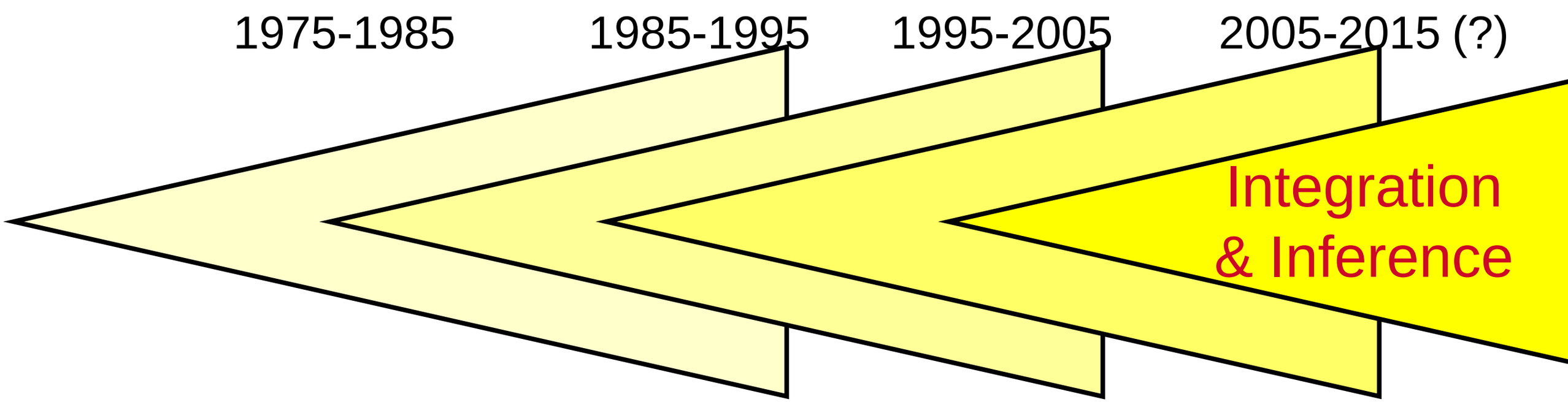
Computer Vision Timeline



- Real applications come around late:
- E.g., optical flow:
  - Horn & Schunk, early 80s
  - Application in movies (e.g. “The Matrix”), late 90s

[Black]

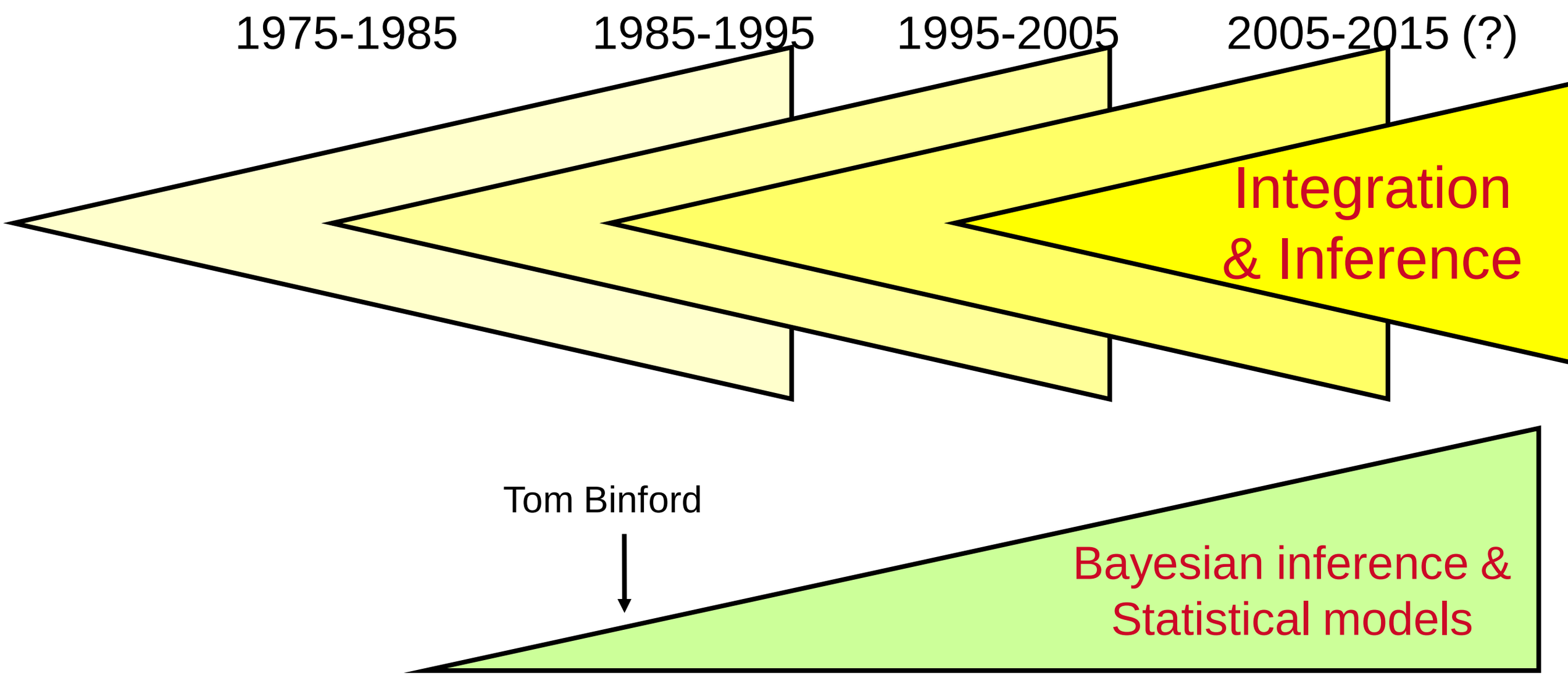
Computer Vision Timeline



Return to some of the early goals with new tools.

[Black]

Computer Vision Timeline



Probabilistic Modeling and Inference

- One trend is quite clear recently:
  - Statistical tools & probabilistic inference are used in more and more areas of computer vision.
  - Machine learning has become an important tool for vision and for many other areas in CS.

What's next

- If you want to learn more about this:
  - Computer Vision II
  - Probabilistic methods in computer vision
  - Winter term, V2 + Ü2

- Also recommended:
  - Machine Learning: Statistical Methods I+II
  - Introductory class on statistical machine learning, V2 + Ü2
  - WS: ML II, SS: ML I

Exam

- Written exam
  - Wednesday 21.08.2012, 10:00 -- 12:00am
  - Place: C205@Piloty & 074@S3|05,
  - Language: English or German, as you prefer
- Exam aids:
  - closed book, i.e. no books, smart phones etc. allowed
  - But: May bring a handwritten A4 help sheet (no typing/printing)
  - use only one side
- Are you registered?

Exam

- Problems aim at checking the understanding of important concepts and methods.
- No extensive computation/derivation
  - but the key formulas are important
  - you should know what they say and which assumptions were made to arrive there
- No Matlab programming
- There will be some open questions
- More details will be announced by email through the mailing list