

Artificial creative intelligence time series, orchestration

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Maître de conférences

IRCAM (Repmus) – UPMC (UFR919)



Orchids – Released and debugged

Release of Orchids in late 2014, sold on Forumnet

Already very used and proficient in musical productions (Matlab proto)

Currently GdR/GdT Orchestration every month at IRCAM



Latest version delivered on Forumnet march 2016

Improved accuracy and search heuristics

Fully multi-threaded version

Extended database

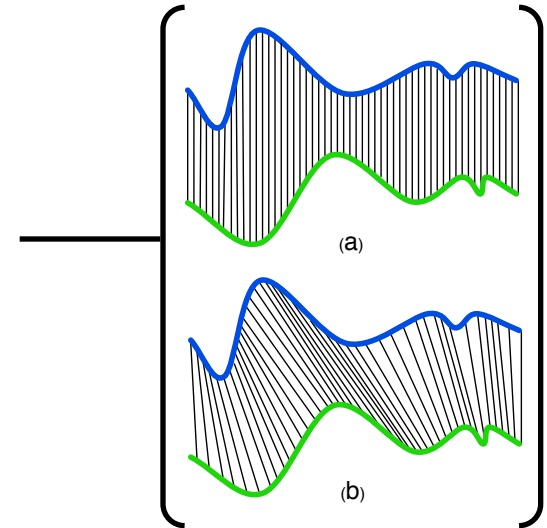
Multiple bug corrections

Participants : P. Esling,, D. Ghisi (residency), Y. Maresz, M. Vitorio Garcia, E. Daubresse

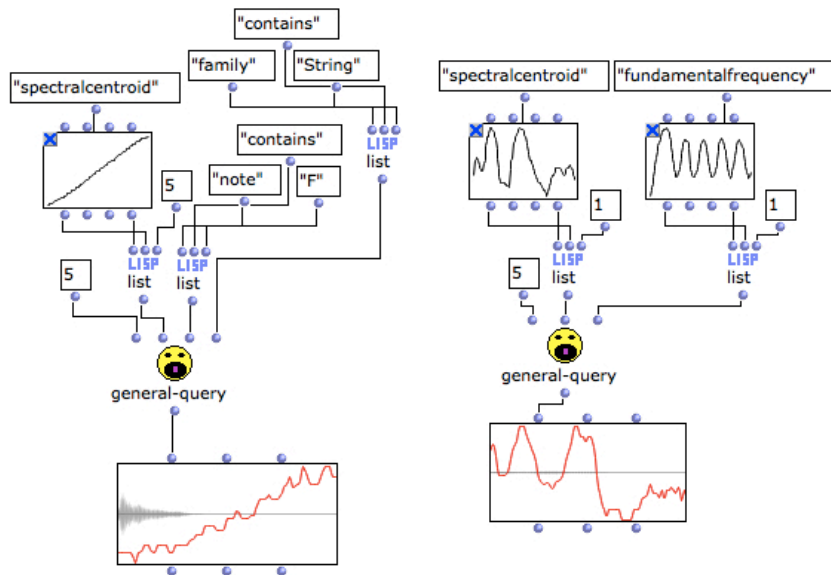
External collaborations : McGill, Montreal (S. McAdams, CIRMMT) – Plymouth University, Uk (E. Miranda) – NorthEastern University, Shenyang, China (Z. Liang) – University of Geneva, Switzerland

Time series mining

- Reaching the modelization gap towards **times series**
- Querying and **non-linear musical similarity**
- **Data mining** over databases of **millions sequences**
- **Efficient audio sample querying** ($\sim 10^7$)
- Introduction of **two search algorithms**
- Research based on **time series**



[Esling Philippe, Agon Carlos "Time series data mining", *ACM Computing Surveys*, vol.46, no.1, 2012]



First **time-series based search** for audio samples

Finding **any kind** of sounds
(objective temporal evolution, no metadata)

... By simply drawing their shapes

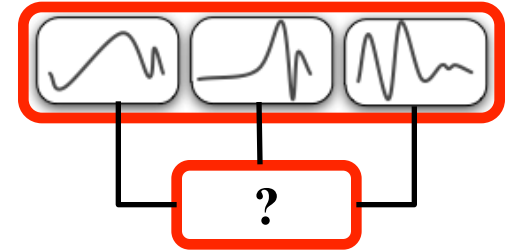
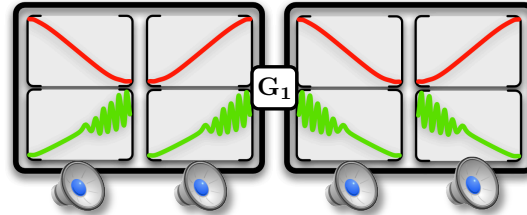
First step towards the **signal-symbolic links**

[AFIM Prize of the young researcher 2010]

Multiobjective time series matching

Sound is not a **uni-dimensional object**

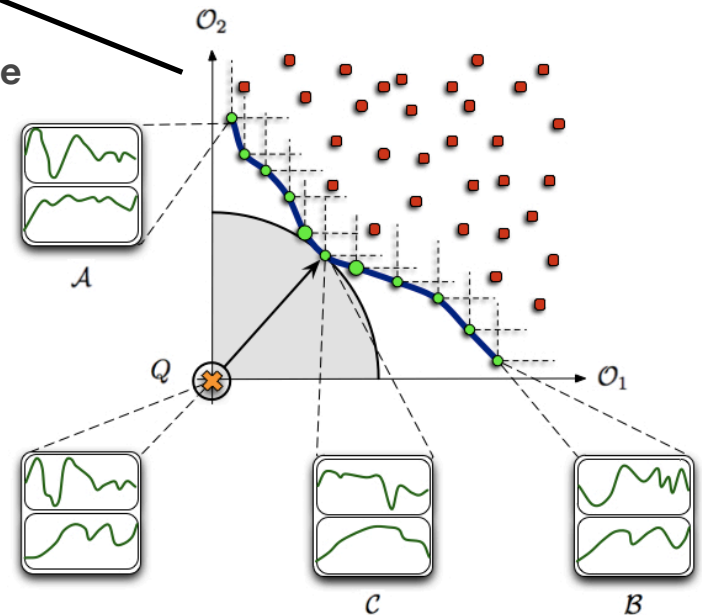
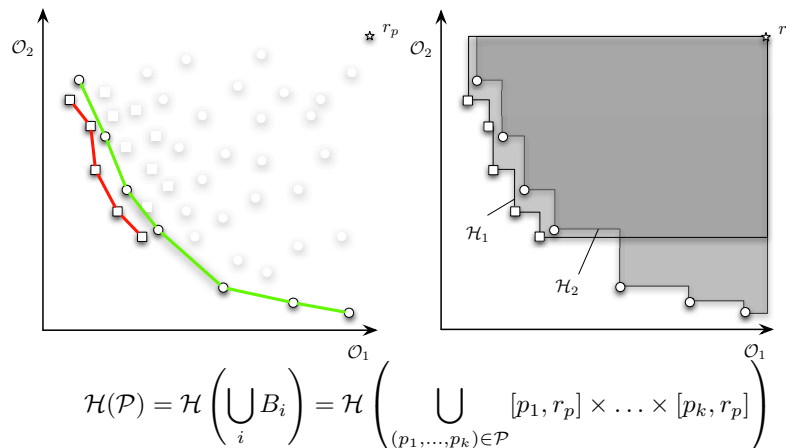
Multiple descriptors (pitch, loudness, ...)
Temporal perception issues



- How to allow a **flexible similarity** over multiple series
- Introduction of **innovative search paradigms** on “conflictive dimensions”
- **Multiobjective** time series matching (MOTS) = **never merge similarities**

$$\mathcal{S}^* = \underset{\mathcal{S}}{\operatorname{argmin}} \left\{ \left(D_Q^k(\mathcal{S}) \right), k = 1, \dots, K \right\}$$

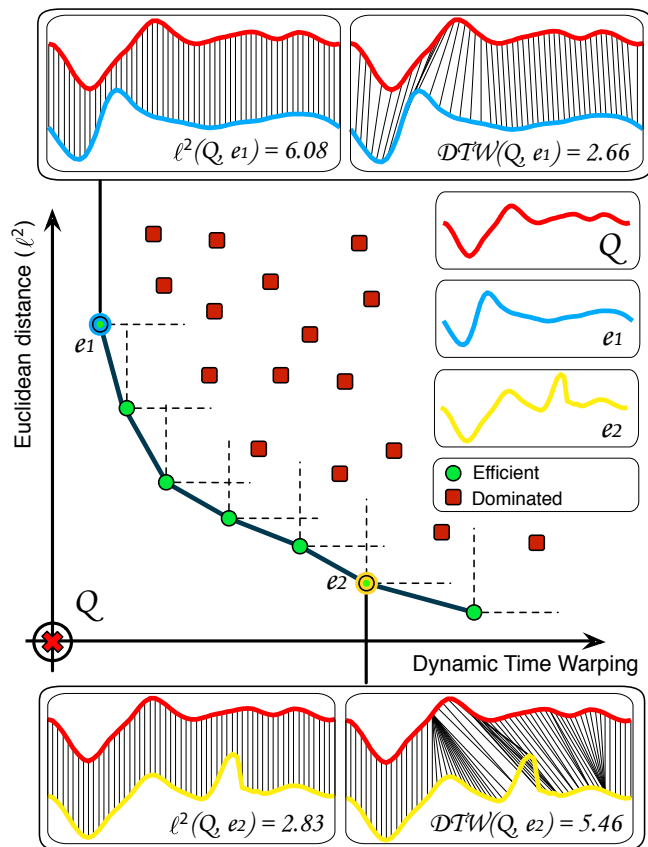
Extension to **classification** by using the **hypervolume dominated** by classes



Deux **algorithmes de recherche efficaces** déjà implémentés

Research extension

New generalization to univariate series, excellent results

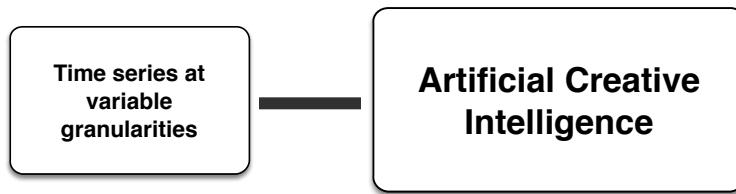


	ℓ^2	DTW_b	DTW_f	ML	$Mult$	HV_s	HV_b
50Words	36.9	24.2	31	33.6	27.9	25.9	25.9
Adiac	38.9	39.1	39.6	25.1	36.1	29.7	27.9
ARSim	48.6	44.3	44.3	36.1	0	0	0
Beef	46.7	46.7	50	20	31.0	34.5	24.1
CBF	14.8	0.4	0.3	10.3	1.1	0.56	0
Chlorine	35	35	35.2	-	33.6	33.6	32.9
Cinc_ECG	10.3	7	34.9	-	6.1	2.9	1.08
Coffee	25	17.9	17.9	0	3.7	3.7	0
CricketX	42.6	23.6	22.3	-	21.3	23.1	20.8
CricketY	35.6	19.7	20.8	-	22.1	19.2	19.2
CricketZ	38	18	20.8	-	23.9	23.4	21.3
DiatomSize	6.5	6.5	3.3	-	4.6	4.9	1.3
ECG	12	12	23	11	17.2	17.2	6.1
ECGFiveD	20.3	20.3	23.2	-	2.9	5.5	1.5
Face (all)	28.6	19.2	19.2	17.6	20.2	20.8	20.2
Face (four)	21.6	11.4	17	11.4	6.9	4.6	3.4
FacesUCR	23.1	8.8	9.5	-	3.7	4.3	3.7
Fish	21.7	16	16.7	14.9	8.1	8.1	5.7
GunPoint	8.7	8.7	9.3	6.7	8.7	0.7	0.7
Haptics	63	58.8	62.3	-	57.3	55.1	52.4
InlineSkate	65.8	61.3	61.6	-	55.7	55.5	53.7
ItalyPower	4.5	4.5	5	-	4.2	4.1	3.0
Lightning2	24.6	13.1	13.1	19.7	18.3	11.7	10
Lightning7	42.5	28.8	27.4	28.8	30.5	26.4	16.7
MALLAT	8.6	8.6	6.6	-	8.1	6.1	3.8
Medical	31.6	25.3	26.3	-	28.3	26.5	25.6
MoteStrain	12.1	13.4	16.5	-	16.2	15.9	8.5
N-ECG 1	17.1	18.5	20.9	-	17.8	15.9	15.9
N-ECG 2	12	12.9	13.5	-	11.2	10.5	9.2
OliveOil	13.3	16.7	13.3	13.3	10.3	10.4	6.8
OSU Leaf	48.3	38.4	40.9	45.4	25.3	21.2	19.9
SonyI	30.5	30.5	27.5	-	31.3	34.8	23.5
SonyII	14.1	14.1	16.9	-	15.9	19.01	8.4
StarLight	15.1	9.5	9.3	-	9.2	6.9	6.8
SwedishL	21.3	15.7	21	13.4	11.4	9.1	7.2
Symbols	10	6.2	5	-	4.9	4.4	2.8
Synthetic	12	1.7	0.7	4	3.3	3.3	3.3
Trace	24	1	0	18	1	0	0
TwoPatt.	9	0.1	0	9.4	0	0.05	0
TwoLead	25.3	13.2	9.6	-	12.3	15.7	4.1
uWaveX	26.1	22.7	27.3	-	25	23.5	22.7
uWaveY	33.8	30.1	36.6	-	33.5	33.3	31.0
uWaveZ	35	32.2	34.2	-	33.3	30.6	30.5
Wafer	0.5	0.5	2	0.6	0.5	0.3	0.3
Words	38.2	25.2	35.1	-	32.3	32.3	28.7
Yoga	17	15.5	16.4	16.7	14.9	14.9	14.9

TABLE III

COMPARISON OF THE RESULTS OF THE DIFFERENT METHODS FOR THE 50 WORDS DATASET

[Esling Philippe, Agon Carlos “Taking all advices in time series classification through multi-objective assessment”, DMKD, 2015 (in review)]



Micro-temporal (identity)

Macro-temporal (sequence)

Meta-temporal (musical piece)

Time series at
variable
granularities

Artificial Creative
Intelligence

Representation of time
series for learning



Orchestration

4 CORs CHROM.
EN FA

3 TROMPETTES
EN UT

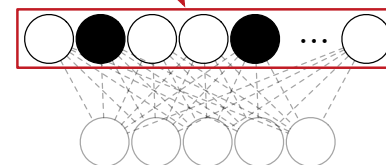
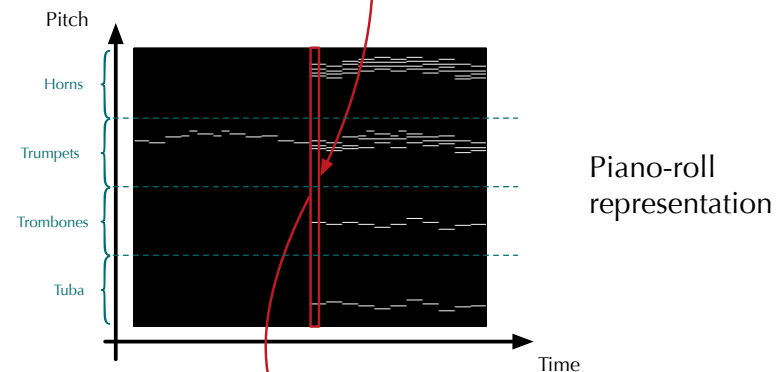
1^{re} TROMBONE

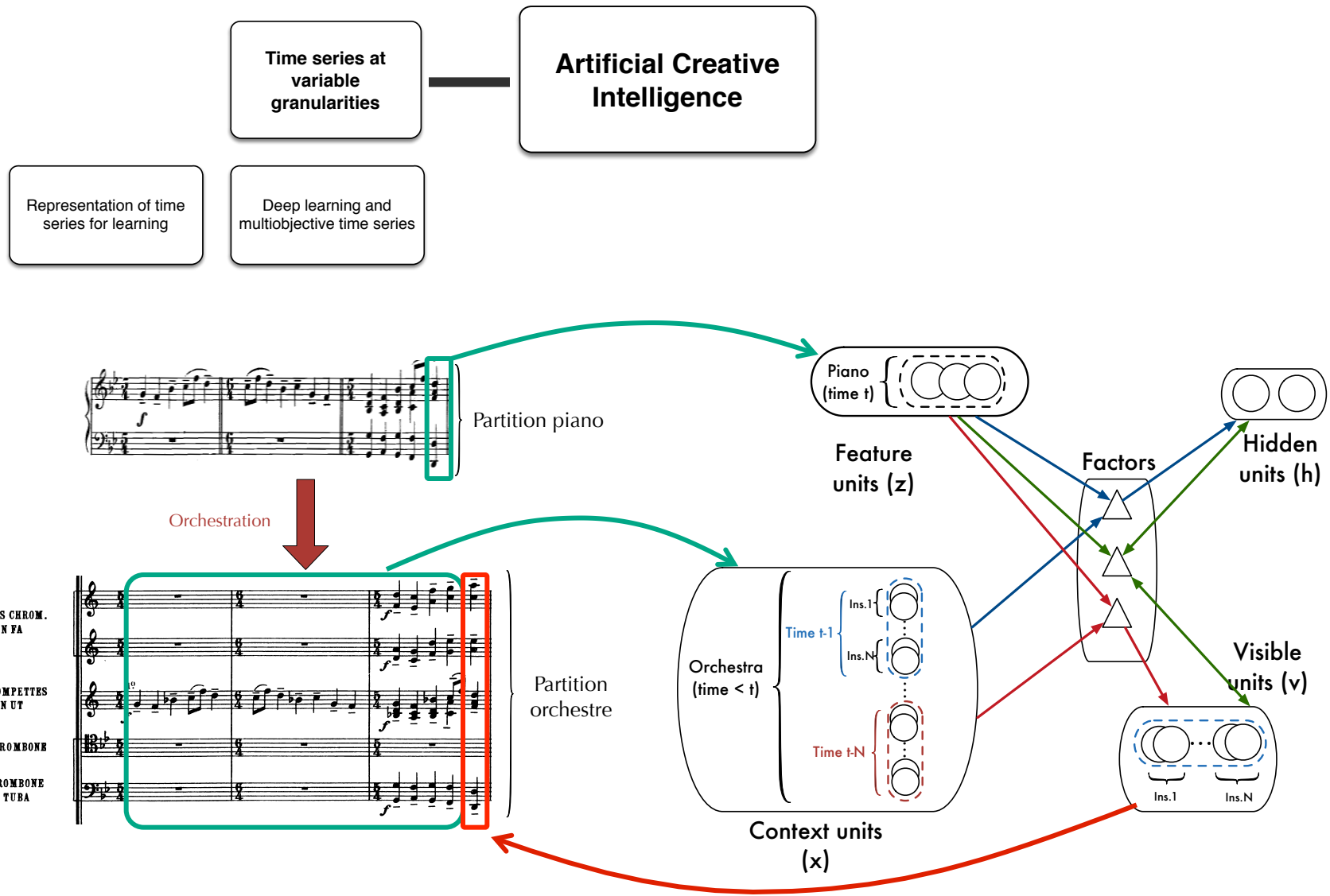
3^e TROMBONE
ET TUBA

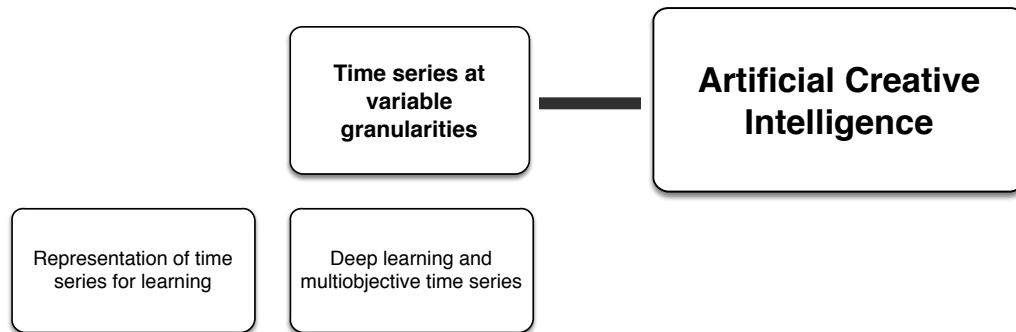
Partition orchestre

Horns 1.2.
Horns 3.4.
Trumpet 1 (C)
Trumpets 2.3.
(C)
Trombones 1.2.
Bass Trombone
(Tb.3)
Tuba

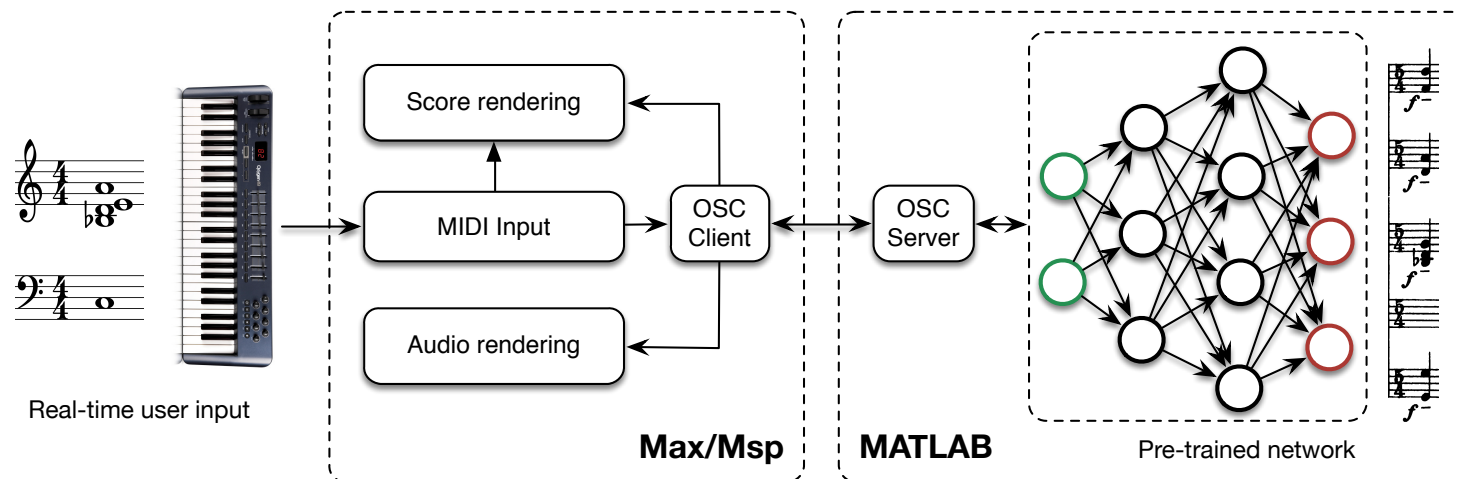
Original
score



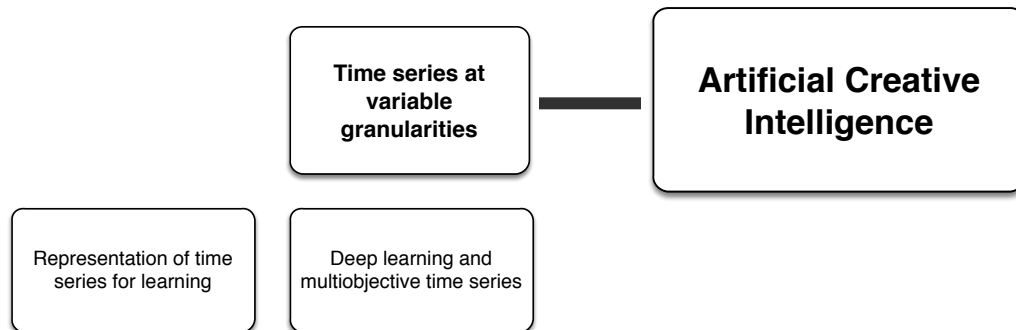




Model	Orchestral Event-level (%)
Random	0.5
Repeat	12.6
cRBM	23.2
FGcRBM	6.2

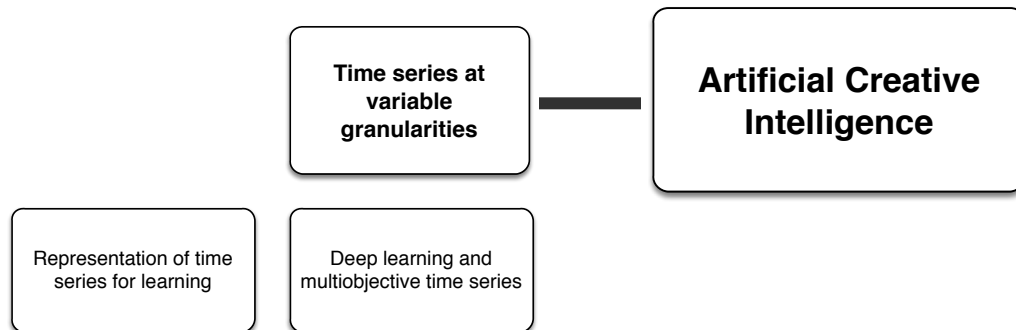


[Esling Philippe, Leopold Crestel “*Live Orchestral Piano*, the first system for real-time orchestration”, ICCC, 2016 (submitted)]



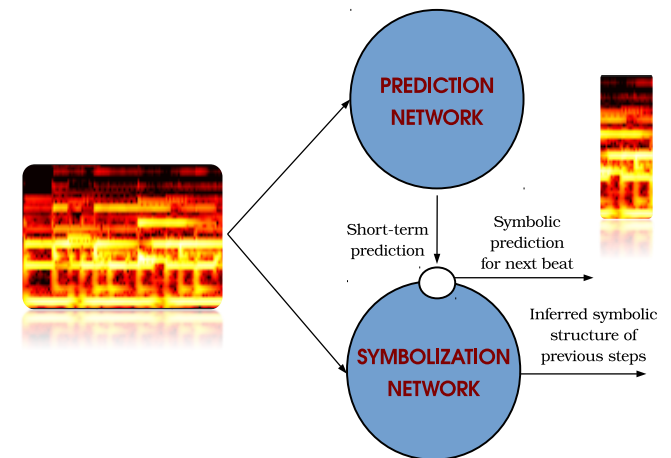
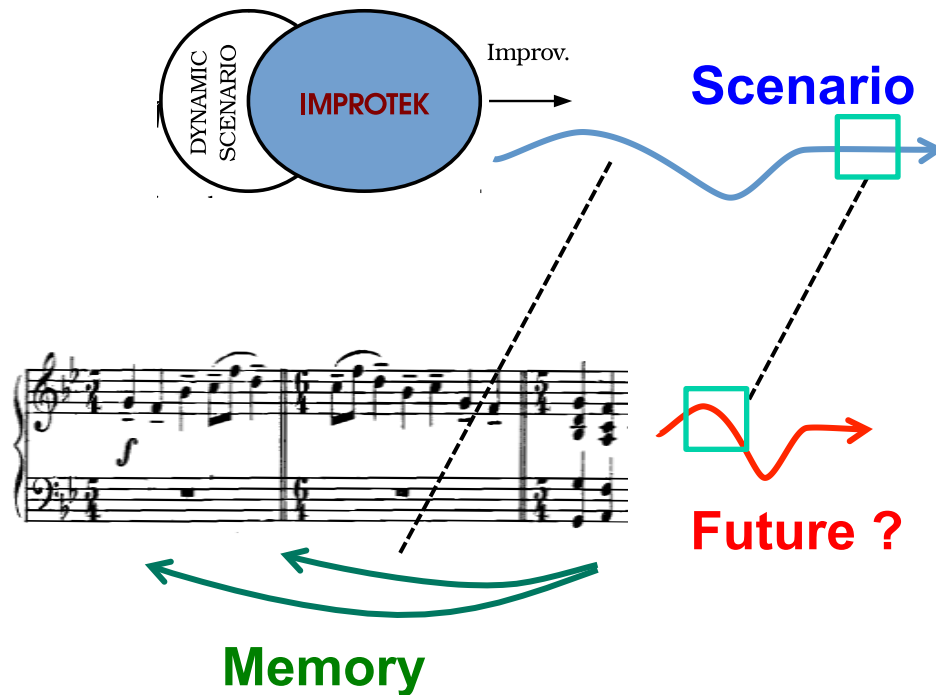
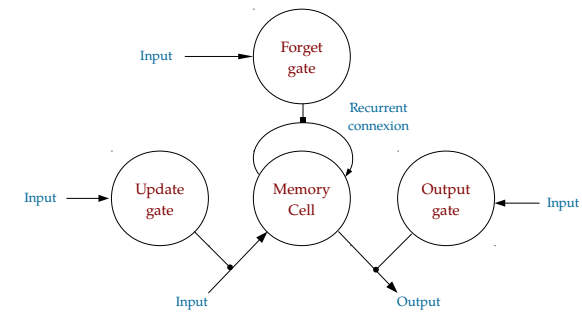
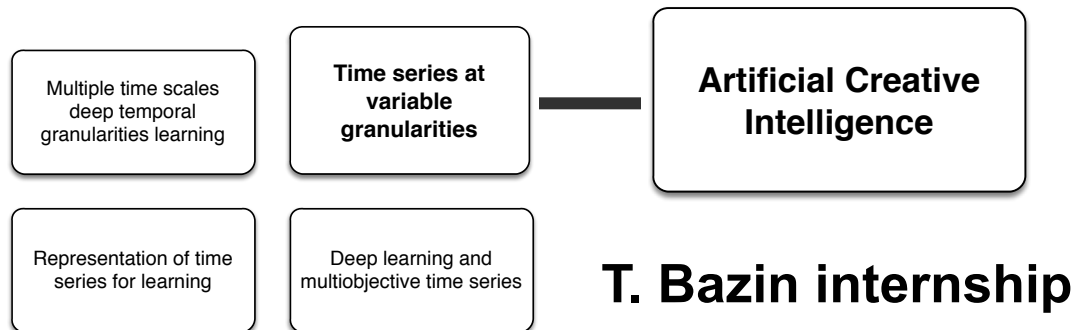
Current state (L. Crestel)

- New variational and conditional model
- Full force database (4Gb of MIDI - ~1M tracks)
- First symbolic orchestration database
 - Piano vs. orchestral versions
 - ~250 full tracks
 - Currently hand-screened
- We need a **baseline task** to evaluate models
 - Toy examples + reference DB
- We need a **correct measure** to evaluate this
- Also ... is **prediction a good proxy ?**
- Need to define new learning objectives, auxiliary tasks

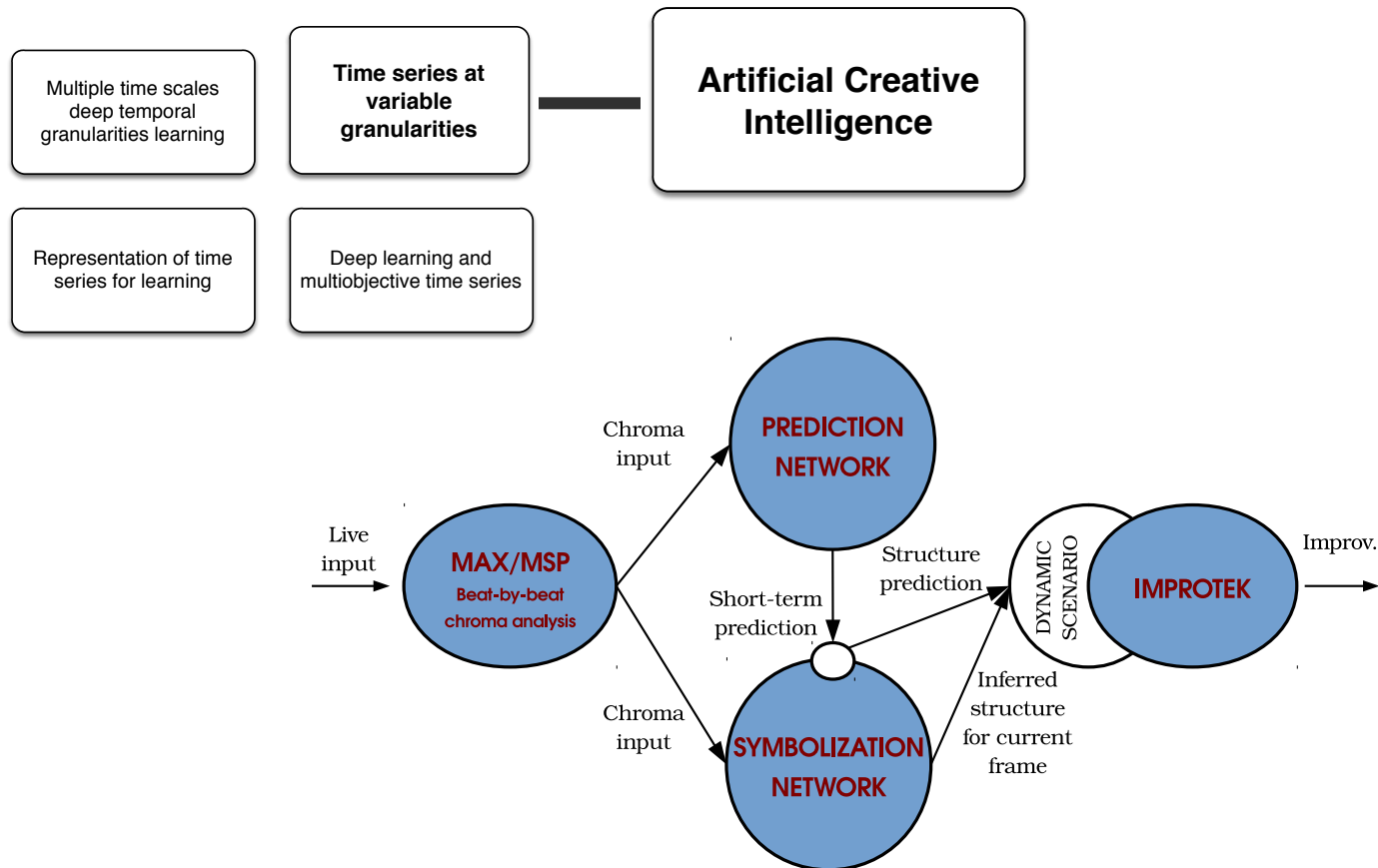


~1 month internship (M. Pariente)

- Generating an **embedding** of symbolic music
- What **data augmentations** to use for symbolic music
 - Dropout, masking
 - Transposition
 - Temporal warps
- We need a **baseline task** to evaluate models
 - Toy examples + reference DB
- Also ... is **prediction a good proxy** ?
 - cf. Skip-thought vectors
- Need to define new learning objectives, auxiliary tasks

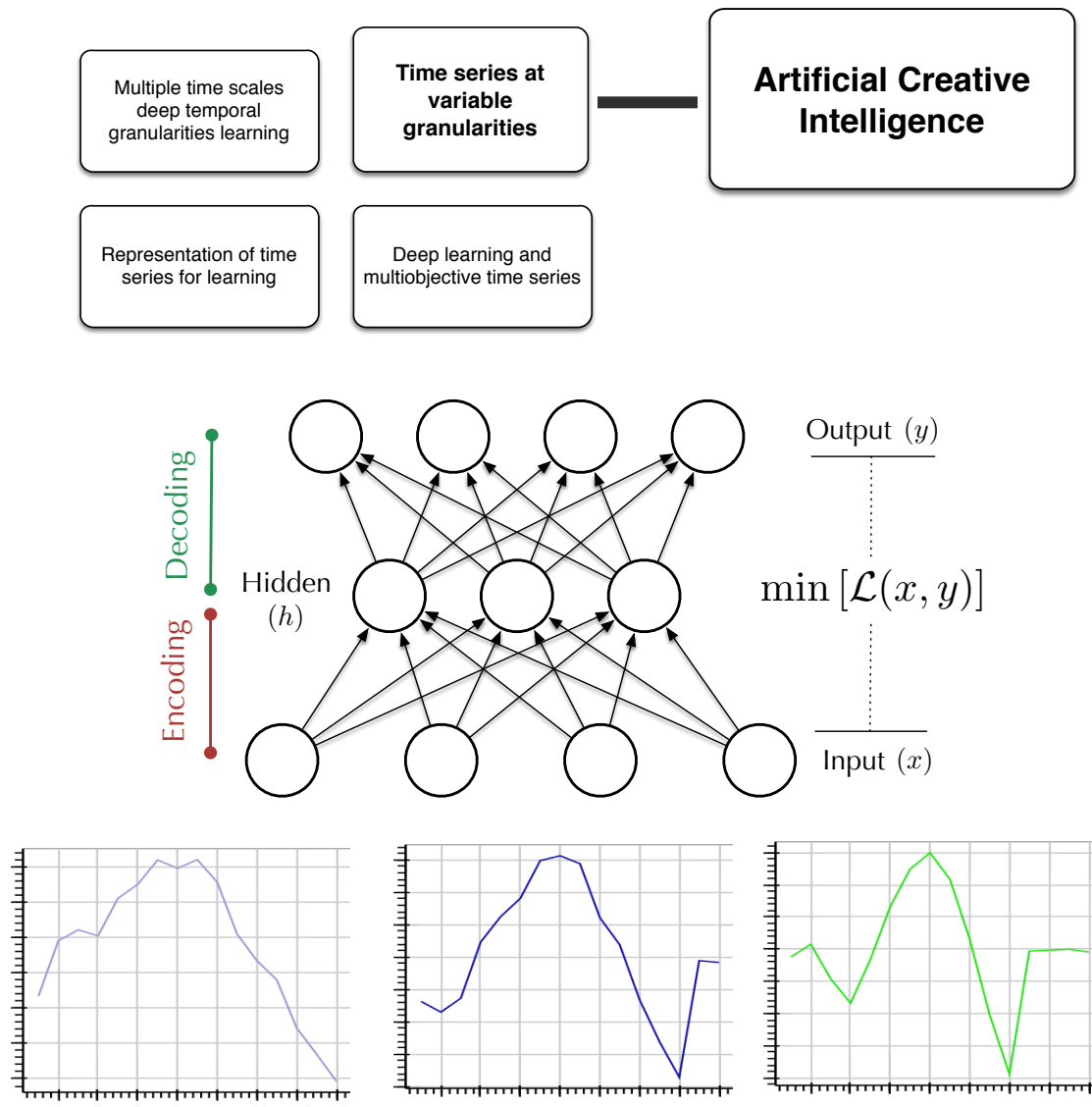


- Multiscale
- Multi-predictions
- Adaptive

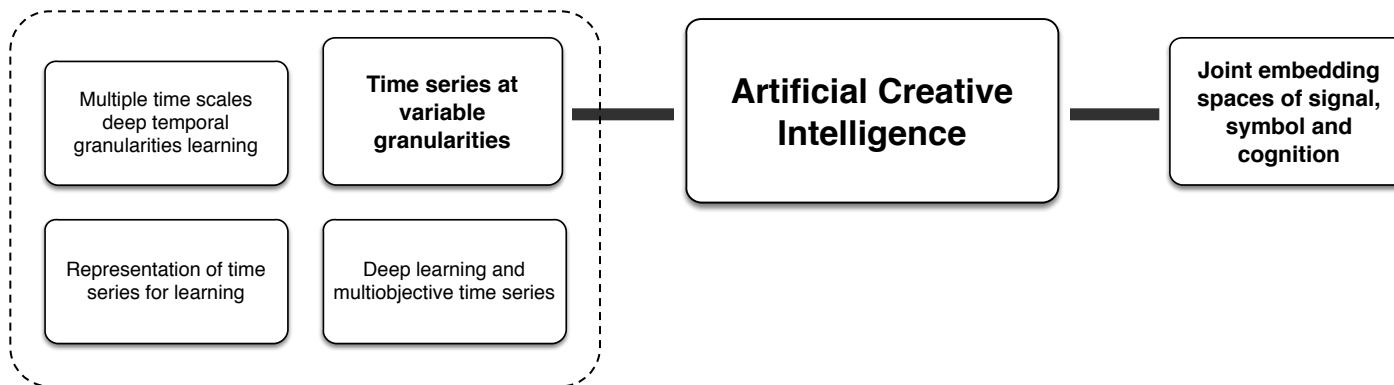


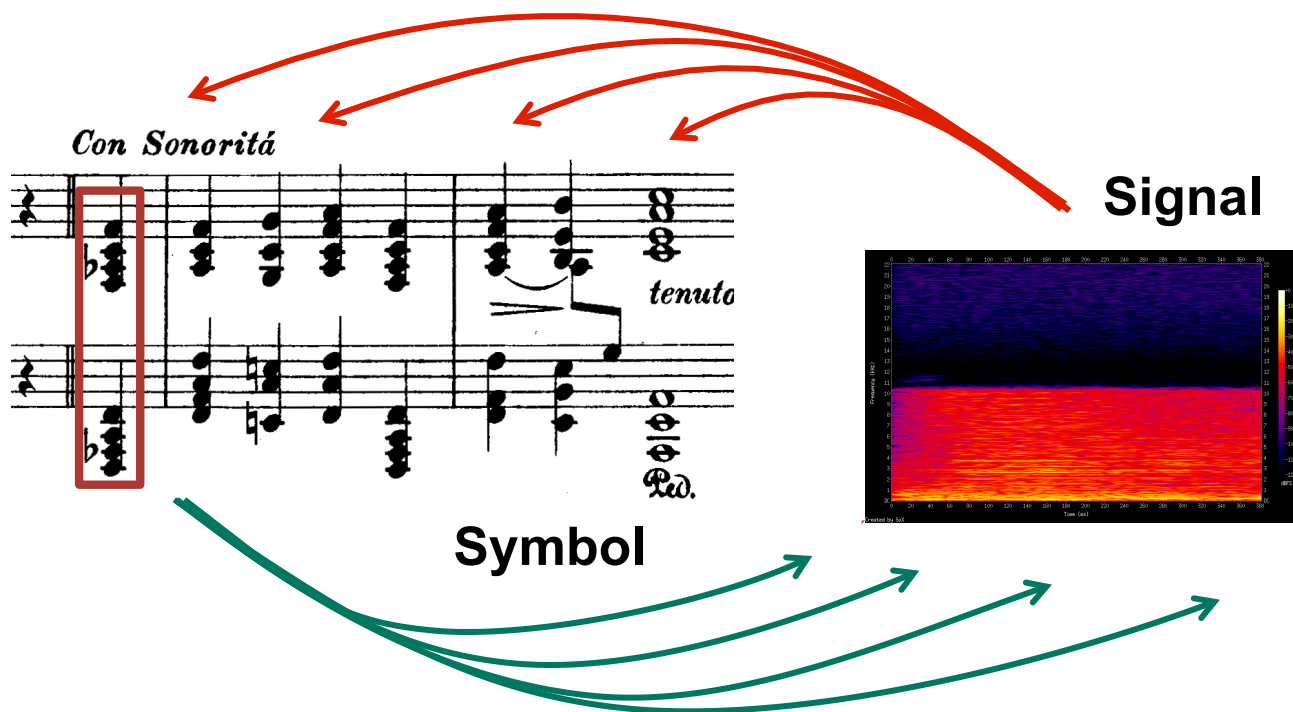
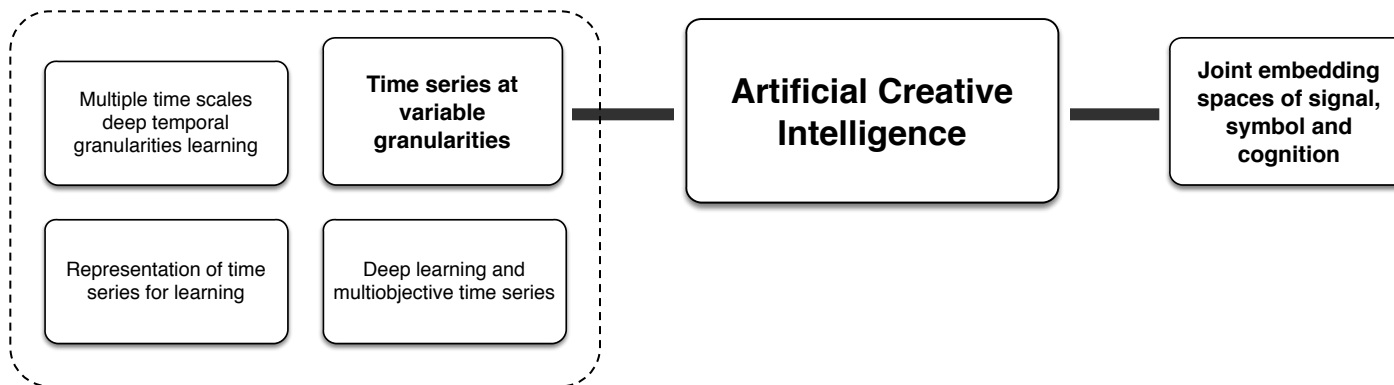
Lots of ideas on the matter

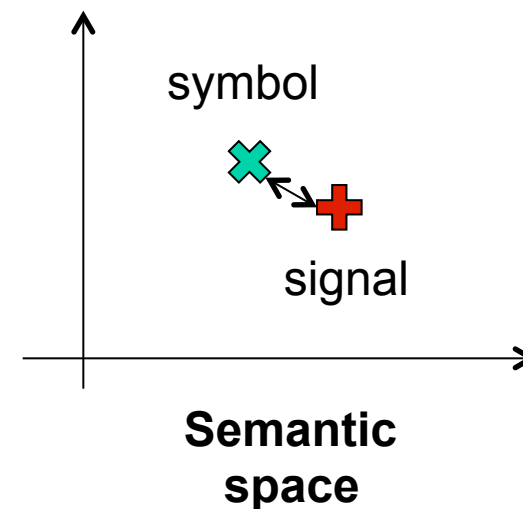
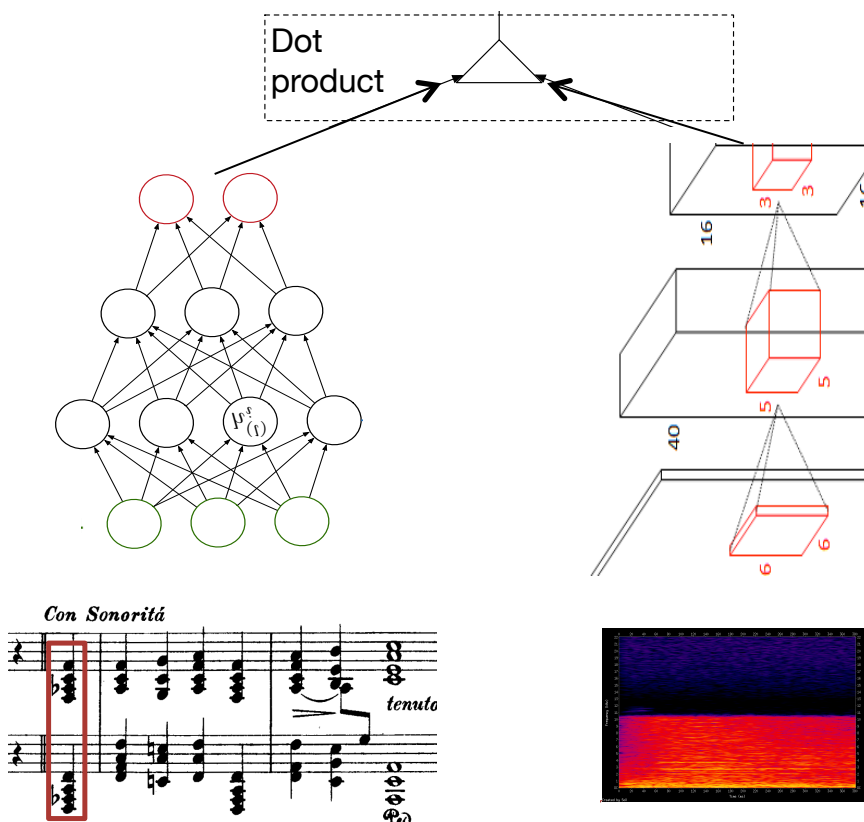
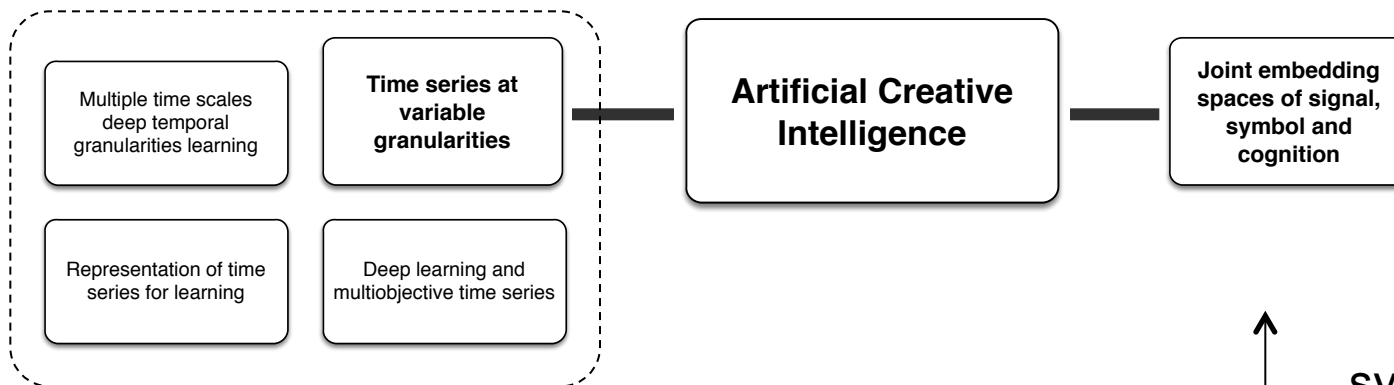
- New internship this year with **Dr. Nika**
- Let's do it all together ?

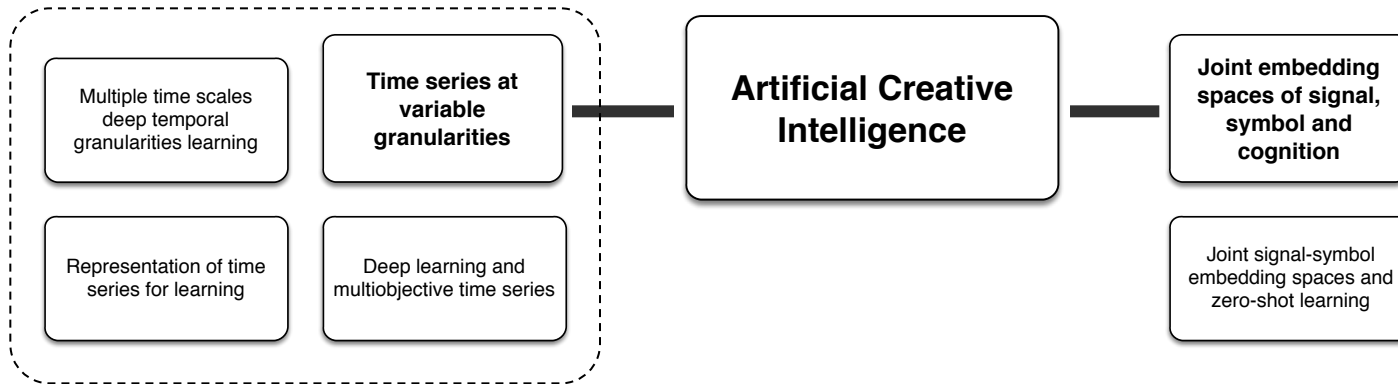


	DTW	TSE	AE	RAE	DAE	CAE
50Words	24.2	18.0	48.9	38.7	32.1	34.0
Adiac	39.1	35.3	34.6	33.5	31.7	31.7
ArrowHead	21.7	16	21.2	19.9	19.9	19.3
ARSim	44.3	10.3	28.9	21.8	20.7	22.4
Beef	46.7	36.7	30.8	25.7	23.3	28.7
BeetleFly	35	40	20	25	15	15
BirdChicken	35	35	25	25	25	25
Chlorine	35	36	45.8	40.3	35.2	35.5
Cinc_ECG	7	6.2	22.1	16.5	16.5	18.5
Coffee	17.9	0	0	0	0	0
Computers	12.4	11.6	51.2	49.4	44.3	44.1
DiatomSize	6.5	5.9	35.1	15.7	7.3	5.4
DistalPOA	20.1	22.3	48.6	25.1	21.6	21.6
DistalPOC	25.4	23.2	38.6	27.2	22.9	21.7
DistalPTW	32.4	31.7	45.6	31.7	31.7	31.2
Earthquakes	30.9	28.1	3.6	0	0	0
ECGFiveD	20.3	17.8	11.3	5.4	4.3	2.9
ElectricDevices	29.5	27.7	38.0	32.5	31.1	32.1
Face (all)	19.2	15.2	12.6	9.0	0	1.7
GunPoint	8.7	7	12.6	14.6	7.3	7.5
Haptics	58.8	58.4	67.2	63.2	57.2	55.2
Herring	34.4	29.7	54.7	42.8	39.1	39.4
InlineSkate	61.3	56.7	76.5	71.6	64.4	62.7
ItalyPower	4.5	3.9	4.8	3.9	3.9	3.7
LargeKitchen	26.4	23.2	36.4	31.7	23.2	22.7
Lightning2	13.1	11.5	27.6	20.9	14.7	13.3
Lightning7	28.8	23.3	8.7	6.8	6.8	3.6
MALLAT	8.6	5	15.6	5.6	5.6	7.7
MiddlePOA	53.9	47.4	51.9	61.5	52.1	57.5
MiddlePOC	19.9	21	22.4	25.6	19.1	19.1
MiddlePTW	68.2	63	57.8	55.5	49.4	50.3
MoteStrain	13.4	11.4	26.7	20.6	12.6	12.6
N-ECG 1	18.5	17.8	15.9	8.9	7.1	8.2
N-ECG 2	12.9	11.2	18.5	17.4	7.2	6.3
OliveOil	16.7	13.3	28.8	26.6	23.3	20.4
Phalanges	22.8	21.7	29.5	24.0	19.1	17.6
ProximalPOA	12.7	11.7	33.9	18.2	18.1	23.8
ProximalPOC	19.6	17.2	33.4	25.3	14.8	15.3
ProximalPTW	27.8	24.4	28.1	20	20	21.8
Refrigeration	51.5	42.4	61	61	61	64.3
ScreenTypes	44.5	44	52.8	48.3	38.1	35.7
SonyI	30.5	29.3	36.3	25.7	25	26.1
SonyII	14.1	12.4	27.8	21.2	15.2	16.5
StarLight	9.5	7.9	19.0	5.7	5.7	5.7
Trace	1	1	5.6	5.6	1	1.2
TwoPatt.	0.1	0	0.1	0.1	0	0
TwoLead	13.2	6.7	18.1	16.7	11.5	13.3
Wafer	0.5	0.3	5.4	5.4	0.2	0.2





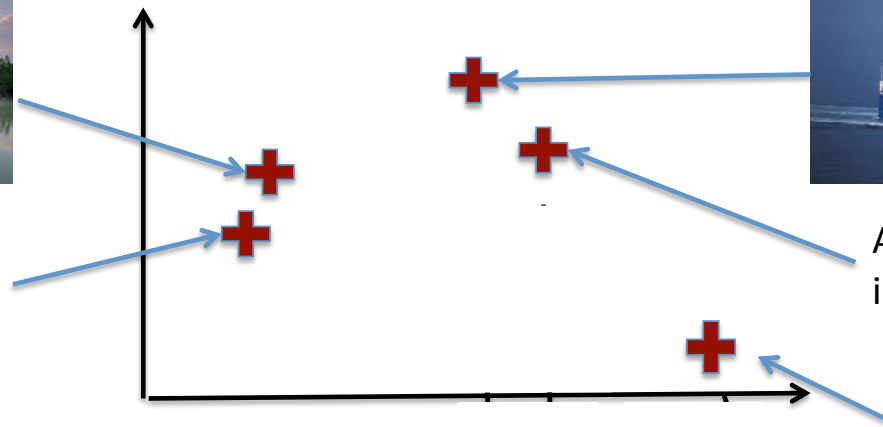




Joint Feature space

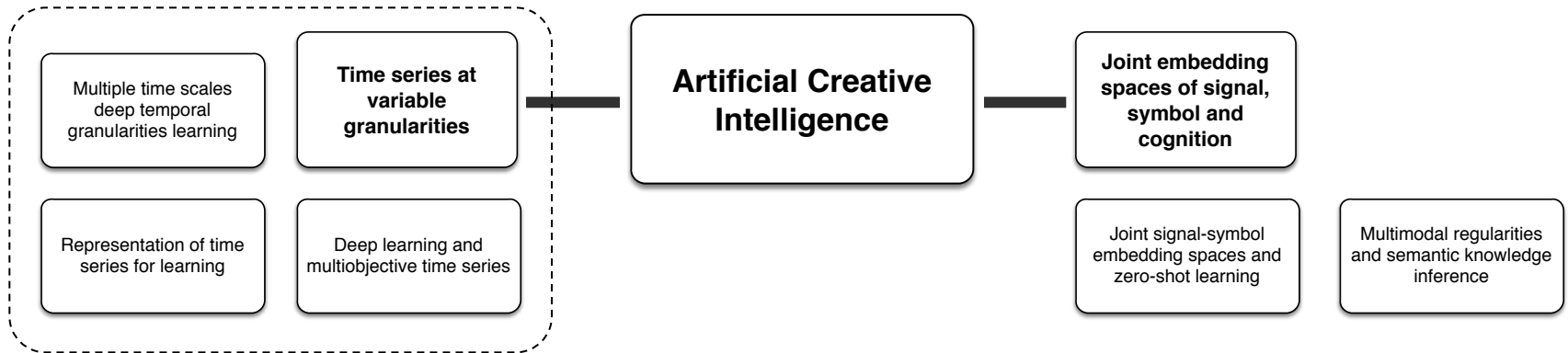


A castle and reflecting water

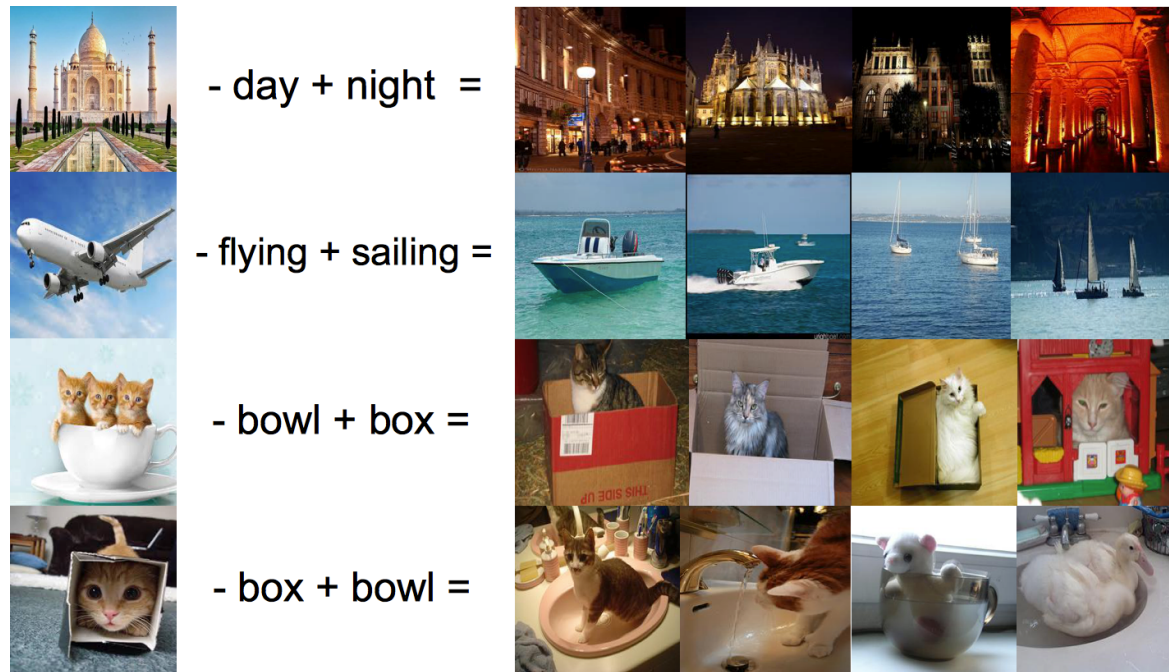


A ship sailing in the ocean

A plane flying in the sky



Nearest Images



(Kiros, Salakhutdinov, Zemel, TACL 2015)

